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SUPPLEMENT TO "THE ELECTRICIAN," OCTOBER 26, 1900.

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

VOLUME XLV.

(Second Series.)

FROM APRIL 27, 1900, TO OCTOBER 19, 1900.

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LONDON:

Printed and Published for the Proprietors by GEORGE TUCKER, at the Offices of "THE ELECTRICIAN," Salisbury-court, Fleet-street, E.C.

1900.

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VOL. XLV.

(Second Series.)

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,145. [Vol. No. XLV.] FRIDAY, APRIL 27, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents. or 80/r., or 70pf.

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NOTES.

THE ways of magistrates are often mysterious and their humour past comprehension. Mr. PLOWDEN, at the Marylebone Police Court, on Tuesday, raised an inexplicable laugh by the remark that "the electric light seemed to have flitted over the parish with the fitfulness and brilliancy of summer lightning: one never knew when it was coming." All because the Metropolitan Electric Supply Co. had not been able at all times to meet the enormous demand for current. He thought the company's explanations as to failure during the past year exculpated them from blame, but all the same he ordered the company to pay £1. 5s., and 10 guineas costs, on the original summonses to which they had pleaded guilty. Contrast this with the fate of the London Electric Supply Corporation at the Southwark Police Court on the same day. Mr. PAUL TAYLOR, without indulging in irrelevant jocularity, admitted the company's plea of *force majeure* and dismissed the summonses. At the Greenwich Police Court the same company advanced the same plea, but the magistrate reserved his decision until the 4th prox.

THE new Tramways and Light Railways Association, which enjoyed its inaugural dinner at the Hotel Cecil last Wednesday, should prove a valuable centre of tramway and kindred interests—and incidentally of electric traction—in this country. About two hundred members and guests assembled at the feast, which was under the presidency of Sir CHARLES RIVERS WILSON, G.C.M.G., C.B. There was a leaven of electrical men, including several well-known consultants, manufacturers and trolley tramway engineers; but there were also present many tramway men to whom the trolley wire is as yet an unfamiliar thing. Ere long the little leaven shall have leavened the whole lump. We wish the association every success, and rejoice that it has been promised already the hearty co-operation of the Institution of Electrical Engineers in safeguarding the interests of electric traction. In the newly-formed association we perceive the embryo of what should become a powerful and useful public body.

WITH regard to the question of overhead wayleaves for telephone wires on the Bedford Estate, referred to in our last issue, we learn that the matter is even more serious than might appear at first sight. We are able to state that it is no exaggeration on the part of the National Telephone Co. to describe the payments demanded by the ground landlord as prohibitive, and if the two parties to the dispute cannot come to terms the result may be a serious diminution of telephonic facilities in the metropolis. The Bedford Estate covers a small but important district to the north of the Strand, including one or two theatres (whose loss on being deprived of their telephones will not be slight) and several publishing houses and other business premises; and north of Oxford-street, the residents in Russell-square, Tavistock-square, Gordon-square, Woburn-square, Great Russell-street and part of Gower-street are tenants of the DUKE OF BEDFORD. In fact, from 700 to 1,000 subscribers are directly interested in the dispute, and, in addition, considerable alterations may be necessitated in the lines of other subscribers which pass over the estate on their way to the exchange, as a similar payment for wayleave is also demanded on these. The simplest and most reasonable solution of the way-leave difficulty would be for the Post Office, the Corporation of London, the London County Council, and the National Telephone Co. to arrive at an agreement permitting the latter to lay underground wires. The only result of the destruction of the company's business, so far as the Post Office is concerned, would be the loss of an important source of revenue to that department, for the sums received as telephone royalties go far towards diminishing the telegraph deficit; and as to the other authorities, in hampering the company's operations, they are doing their best to prevent that fair competition they profess to be so anxious to secure. In any case, the campaign against the company has been commenced too soon, for the Post Office telephone

(RECAP)

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system is not yet in operation; and those who are now deprived of the National Telephone Co.'s service will be entirely without telephonic communication of any sort for some months at least.

If any individual, hard to please or otherwise, was disappointed in Sir William Preece's "James Forrest" lecture on Monday last, he certainly must have felt abundantly compensated by the impromptu word-battle between the lecturer and Sir Frederick Bramwell, which took place after the discourse was over. Sir Frederick, in a smart little speech seconding the vote of thanks, uttered his well-known formula that "he was tired of hearing it said" that this country was behind the world in electrical engineering. The blame for this tardy progress lay not with engineers, but with those who had passed "a facetious Act of Parliament, in 1882, styled—he believed—an Act for the Encouragement of Electrical Enterprise."

The evil in this Act chiefly lay in the clause permitting a local authority to compel the sale of any electrical undertaking after 21 years, at a price which should take no account of past or future profits. He had described this Act to American engineers, when he was in the United States, and had been laughed at for his pains—it was perfectly incredible to them that such an insane Act could exist in any civilised country. Nor did the Act of 1888 much improve matters; it only extended to 42 years the period that might elapse before the local authority could seize the undertaking. To these caustic strictures upon our electric lighting legislation, Sir William Preece retorted that Sir Frederick was utterly wrong; no better Act than the Electric Lighting Act (1882) was ever passed. Sir William did not say why; and his *ipse dixit* made the audience titter without convincing it. He went on to say that the Act was modelled upon the Tramways Act (1870), which had the same "21 years' purchase" clause. And if ever a tramway company and a local authority were in dispute as to this clause, they were sure to appoint Sir Frederick as arbitrator.

Delicious as undoubtedly was the humour of this home thrust at the famous Bramwell decision, it was hardly fair to Sir Frederick. When acting as arbitrator on a matter connected with the 21 years' purchase clause, he is not called upon to decide whether that clause is iniquitous or radiantly beneficent; his plain and simple duty is to interpret the text of the clause as it stands. It is ludicrous therefore to blame Sir Frederick Bramwell for the unjust conditions of the Tramways Act (1870), because, forsooth, he will not close his professional eyes to their clear and undoubted meaning. No one, we venture to think, would more heartily concur in the abolition of these purchase-clause conditions than would Sir Frederick himself.

Mr. Campbell Swinton's article on "Electrical Conductors and Dirt," in another column of this issue, offers a fresh reason for the householder to insist upon the switches for his electric lamps being placed in the proper position. Mr. Swinton has found, by observation in his own office, that "flexible," charged to a potential of 200 volts, will attract dust to a greater extent than when it is at a lower or at zero potential. Most modern supply networks are now on the three-wire system with the neutral wire earthed; consequently, if switch lamp holders are eschewed and the switches placed before the flexible cord (*i.e.*, to the station side of it) and on the outer (unearthed) wire, as they should be, all parts of the cord remain at zero potential until the lamp is switched on, and resume this value as soon as it is switched off again. Mr. Swinton's suggestion that, on systems not intentionally earthed, all single-pole switches should be placed on the more positive of the two wires, owing to the greater surface leakage on the negative conductor, is also an excellent recommendation. It is not new, however, for it was suggested in our correspondence columns five years ago.

The Royal Society of Victoria.—Prof. Kernot has been elected president of the Royal Society of Victoria.

Institution of Electrical Engineers Conversazione.—We are officially informed that the annual conversazione will this year be held on Tuesday, June 26th, in the Natural History Museum, South Kensington.

The Institution of Mechanical Engineers.—The annual dinner, which was arranged to take place on April 25, has been postponed to Wednesday, June 27, when it will form part of the summer meeting.

South Western Polytechnic.—A university extension course of five lectures on "The Direct Current Motor" is to be given by Prof. C. A. Carus-Wilson, M.A., on Mondays at 8.30 p.m, commencing May 7.

The Zipernowski-Déri Patent.—Among the forthcoming legal actions set out elsewhere, it will be seen that Mr. Rücker is appealing against Mr. Justice Farwell's judgment in the case of Rücker *v.* London Electric Supply Corporation (Ltd.).

An American Physical Laboratory Burnt Down.—The physical laboratory of Lehigh University, Pa., one of the largest and best equipped in the United States, was burned to the ground on the 6th inst., and all its scientific apparatus destroyed. The loss is estimated at $200,000.

Personal.—Major R. E. B. Crompton, of the Electrical Engineers (R.E.) Volunteers, has been granted the temporary rank of Major in the army while serving with the volunteers section in South Africa. Second-lieutenants H. F. Bigge and F. P. Williams, also of the Electrical Engineers, have been appointed temporary Second-lieutenants in the army under similar conditions.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Para—Maranham	Mar. 2, 1900
Môle St. Nicolas—Cap Haitien	Mar. 7, 1900
Trinidad—Demerara	Mar. 30, 1900
Manila—Iloilo	April 9, 1900

Industrial Progress in Siam.—The American Consul-General stationed at Bangkok, in a communication to his Government on the industrial development of Siam states that most of the rice and teak mills in the country are equipped with electric light plants. All but one of these plants were furnished by English firms. He suggests that street transportation in Bangkok offers opportunities for the introduction of light-running vehicles. The workmanship and material must be of unexceptionable quality to meet the climate, which changes very quickly from extremely wet to hot and dry.

Iron and Steel Institute.—The annual meeting of the Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Wednesday and Thursday, May 9 and 10, commencing each day at 10.30 a.m. Among the Papers down for reading are: "The Manufacture and Application of Water-Gas," by Carl Dellwik (Stockholm);

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"The Solution Theory of Iron," by Baron H. von Jüptner (Donawitz, Austria); and "Iron and Phosphorus," by J. E. Stead, F.I.C. (Middlesbrough). Members who desire to participate in the discussion can have copies of Papers forwarded a week in advance. Visitors can also obtain tickets on application.

Municipal Electric Supply in Vienna.—The city of Vienna, which has hitherto been supplied with electricity by a company, is now to have its own municipal station, and the contract for building this has been awarded to the Austrian Schuckert Co., which is also to build a power station for the municipal electric tramways. The latter will contain five units of 3,000 H.P each and the former three units of similar size, with room for extensions embracing three and one more unit respectively. The tramway station is to be running by the middle of the year 1901, and to be completed by the end of that year; and the station for general supply should also be completed by then or soon after. A loan of £1,250,000 is to be obtained for the purpose.

German Patents Statistics.—During the year 1899 21,080 patents were applied for, compared with 20,080 in 1898 and 18,347 in 1897. Of these 7,430 were awarded after examination by the Patent Office, the corresponding number during last year having been 5,570. Thus, while the number of applications only increased by 3·7 per cent., the number of successful applications increased by 33·4 per cent. During the year, 5,171 patents have expired or become void, and the total number of patents in force is 22,198. The increase in the number of patents awarded is chiefly marked in the case of electrical apparatus and machinery. 265 patents were awarded in this class in 1898, and 439 in 1899. Patents granted to foreigners are also on the increase. United States leads the way with 722, England follows with 554, France 474, Austria-Hungary 372, Sweden and Norway 99, and Russia 85.

Eighty-Mile Electrical Transmission in Canada.—The *Electrical World and Engineer*, of New York, states that the works of the Showinigan Water and Power Co., by means of which the power developed from the Showinigan Falls will be transmitted to Montreal, a distance of 80 miles, will shortly be completed. These works consist of a canal and the necessary flumes, &c., for developing 30,000 H.P., which can be readily increased to 75,000 H.P. if required. The line will run along the Great Northern Railway to Jolliette; thence to the island of Montreal by an aerial line, and into the city. By reason of the low cost of generation at the Falls, and the studied economy in transmission, it is anticipated that the company will be able to deliver power in Montreal at very moderate prices. Initially only 5,000 H.P. will be delivered, which will be increased as required.

International Tramways Congress.—It is announced that an international congress on tramways will be held in Paris from Sept. 10 to 13, under the auspices of the Permanent International Union of Tramways. Particulars may be obtained from the general secretary (Mr. F. Nonnenberg), 85, Rue Potagère, Brussels, or from the secretaries of the Paris International Assembly, 5, Henrietta-street, W.C. The congress will include in its programme the questions of heating of carriages, brakes, electrical traction, &c., and proposes to go thoroughly into the question of tariffs. Of the 272 tramway companies—or officials—who constitute the ordinary members of the union, it is stated that not one is British, while Turkey is represented, and even the Philippine Islands contribute one member. Among the 140 extraordinary members, other than tramway companies, there are only five British engineering firms!

Wireless Telegraphy.—Various accounts have been circulated as to the cause of the removal of the wireless telegraph installation between the South Foreland lighthouse and the Goodwin lightship. As a fact, the installation was erected over a year ago chiefly for purposes of demonstration, and it can justly be claimed that it has proved the practical utility of the Hertzian system for signalling to lighthouses and lightships. As it appears that the Trinity House authorities had no funds at their disposal to purchase the instruments, and Marconi's Wireless Telegraph Co. requires the services of its assistants elsewhere, the company removed the installation a few weeks ago. Some assistants are being sent out to Honolulu to erect instruments for communicating between the islands of the Sandwich Islands group. The American company recently formed has, we are informed, no connection with Marconi's Wireless Telegraph Co., which still owns Mr. Marconi's American patents.

Obituary.—We regret to announce the death of Sir Francis Marindin, K.C.M.G., which took place on Saturday last at 3, Hans-crescent, S.W. The deceased, who was at the time of his death 62 years of age, was well known to our readers as an inspector, on behalf of the Board of Trade, of railways and tramways, including of course those worked electrically. His name will also be remembered in connection with the inquiries conducted in the early days with regard to the development of electric lighting companies in London. He entered the Royal Engineers in 1854, and saw service in Mauritius and Madagascar, and obtained the rank of Major before retiring in 1874 from a staff appointment which he held at the Chatham School of Military Engineering. In 1877 he joined the Board of Trade as Inspector of Railways, in which capacity he did much useful work by his strong and impartial criticism of railway management, more particularly in connection with overworked employés. Major Marindin obtained his C.M.G. in recognition of his services in connection with the Egyptian State Railways, and on the occasion of the Diamond Jubilee he was made a Knight of that Order.

Nominations for the New Council of the Inst.E.E.—The following is a list of the Council nominations for the election of Council and hon. officers for 1900-1901, as announced at the ordinary general meeting yesterday:—

President.
Prof. J. PERRY, F.R.S.

Vice-Presidents.
Mr. W. E. Langdon. | Mr. R. K. Gray.
Mr. James Swinburne. | *Mons. E. Mascart.

Members of Council.

Major P. Cardew, R.E.	Mr. Robert Hammond.	*Mr. C. P. Sparks.
*Mr. H. H. Cunynghame, C.B.	*Mr. Hugo Hirst.	Mr. A. A. Campbell Swinton.
	Mr. A. J. Lawson.	
*Mr. H. Edmunds.	Mr. P. V. Luke, C.I.E.	*Mr. A. P. Trotter.
*Mr. S. Z. de Ferranti.	Mr. W. M. Mordey.	*Mr. J. E. Kingsbury.
Mr. John Gavey.	Mr. R. P. Sellon.	

Associate Members of Council.
*Mr. W. R. Cooper, M.A., B.Sc. | Mr. S. Evershed.
Mr. R. W. Wallace, Q.C.

Honorary Auditors.
Mr. F. C. Danvers. | Mr. E. Garcke.

Honorary Treasurer.
Prof. W. E. Ayrton, F.R.S.

Honorary Solicitors.
Messrs. Wilson, Bristows and Carpmael.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the council in accordance with Article 45 of the articles of association. All the honorary officers being eligible are nominated for re-election.

The Institution of Civil Engineers.—At the annual meeting of the Institution of Civil Engineers, held on Tuesday evening, Sir Douglas Fox, president, in the chair, the result of the ballot for the election of officers was declared as follows:—President, Mr. James Mansergh; Vice-Presidents, Sir William White, K.C.B., Mr. Charles Hawksley, Mr. J. C. Hawkshaw, M.A., and Mr. F. W. Webb; other Members of Council, Mr. Barton (Dundalk), Mr. Horace Bell, Sir Alexander Binnie, Mr. B. Hall Blyth, M.A. (Edinburgh), Dr. Henry Taylor Bovey, M.A. (Montreal), Mr. C. A. Brereton, Mr. T. Forster Brown (Cardiff), Mr. R. Elliott Cooper, Mr. G. F. Deacon, Mr. W. R. Galbraith, Mr. G. H. Hill, Mr. J. C. Inglis, Mr. Alexander Izat, C.I.E. (Gorakhpur, India), Dr. Alexander B. W. Kennedy, Sir James Kitson, Bart., M.P. (Leeds), Mr. A. G. Lyster (Liverpool), Mr. John Allen McDonald (Derby), Mr. E. Pritchard Martin (Dowlais), Mr. William Matthews, Sir Guildford L. Molesworth, K.C.I.E., Mr. Alexander Siemens, Mr. Thomas Stewart (Cape Town), Mr. John I. Thornycroft, Mr. William Thwaites, M.A. (Melbourne), Prof. W. C. Unwin, B.Sc., and Sir E. Leader Williams (Manchester). The Council have made the following awards for Papers read and

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discussed before the Institution during the past session:—a George Stephenson medal and a Telford premium to Sir Lowthian Bell, Bart., LL.D., F.R.S.; Telford medals and premiums to Messrs. H. H. Dalrymple-Hay, B. M. Jenkin, F. W. Bidder, and F. D. Fox; a Watt medal and a Telford premium to Mr. J. Dewrance; a Crampton prize to Sir Charles Hartley; and Telford premiums to Messrs. C. N. Russell and R. A. Tatton. The presentation of these awards, together with those for Papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

May's Fire Annunciator.—A simple form of fire annunciator, devised by Mr. C. E. May, electrician to the New Zealand Government, is being introduced by the May-Oatway Syndicate. A copper wire of about 18 gauge and 20ft. in length is stretched on the wall of each room of the house in which the annunciator system is installed. To the centre of this wire a small carbon-tipped weight is suspended, and when the temperature of the room rises above a certain value, the sag of the wire causes the weight to come in contact with a platinum point, and thus close the circuit of a bell and indicator. The distance of this point from the carbon-tipped weight is adjustable, so that the annunciator can be brought into action for any required rise of temperature; $\frac{1}{32}$in. between the contacts is allowed per degree Fahrenheit. For houses within reach of the fire brigade, it is proposed to place the indicator on the front of the house, and to connect it with an automatic Morse transmitter. This latter is so arranged that an electromagnet is energised as soon as one of the crude thermostats mentioned above comes into operation, a magnet pulling over the starting lever of a train of clockwork. This turns a disc on which are projections to operate the Morse key and make the signal agreed upon by the fire brigade for that particular house. After the disc has revolved once, repeating the signal three times, a catch falls by gravity into a slot in one of the wheels of the train and stops further signals. For the purpose of testing the system, a spring is arranged by means of which the stretched wire can be momentarily loosened, allowing the weight and platinum point to come into contact, and a key is provided so that the wire to the fire brigade station can be switched off when testing. A guard for the stretched wire is also provided when deemed necessary.

Automatic Fault-Signalling on High-Pressure Networks.—The system of the automatic signalling of faults by means of test wires, which has been employed in Berlin (see *The Electrician*, Vol. XXXI., p. 103, Vol. XXXVII., p. 788, and Vol. XXXVIII., p. 51), has been modified to render it suitable for the high-pressure mains in Vienna, the modification being described by Herr Franz Probst in the *Zeitschrift für Elektrotechnik* of April 1st. In the Agthe system, employed in Berlin, the + pilot wire is laid up with the − cable, and the − pilot wire with the + cable, these wires being connected to their voltmeters through indicating relays, so that a fault is signalled by a bell as soon as it occurs, and its position is notified by the number of the indicator which has fallen. This method as it stands is obviously unsuitable for high-pressure cables, as it would be impracticable to lay up with the conductor a wire differing from it in potential by a couple of thousand volts. The difficulty is overcome by taking advantage of the low potential of the outer conductor of the concentric system, and laying two test wires insulated with impregnated fibre among the wires forming this conductor. The station ends of these test wires are connected through resistances and indicators to one terminal of the 100-volt winding of a transformer, the other end of this winding being earthed and the primary being connected to the 2,000 volt station 'bus bars. If the cable is injured externally, one of the test wires will get connected to earth, or, what is equivalent, to the outer conductor; and a circuit is thus established and the indicator drops, at the same time closing a local bell circuit. One of the two test wires is also connected in such a way that it signals the intrusion of water into junction boxes. It is stated that the system, which has been tried experimentally by the International Electricity Co. of Vienna, has given such satisfaction that it is to be extended to all the cables containing test wires.

The Formation of Planté Plates.—The original Planté process, by which it took two months to form the plates, gave very excellent results so far as the durability of the plates was concerned, but the time required was too long for practical purposes. Accordingly various methods were tried to expedite the formation of a sufficiently thick layer of active material on the surface of the plates, which consisted principally in rubbing into them a paste composed of one of the oxides of lead, or of employing a forming bath which contained a small percentage of chlorine or perchloric acid, or some other substance which would eat into the lead. But it was soon found that the impurities which the oxides of lead usually contain were very injurious to the life of the plates, and that unless the latter could be thoroughly freed from the solution used in the forming bath, this continued to eat into them after the cells had been formed and were at work. The fact that the formation process is thus continuing is shown by the increase in the capacity of the cell, and when this increase is rapid, it means that the life of the plates will be correspondingly short. Many attempts, therefore, have been made to find a bath which would hasten formation, whilst at the same time its action would not be continued after the plates had been removed from it and been set up in the working cells. Dr. H. Beckmann, in the *Centralblatt für Accumulatoren und Elementenkunde* states that he has been carrying out an extended series of experiments on the subject, and finds that an aqueous solution of sulphurous acid gives very good results if it is used as soon as it is prepared, and before the sulphurous acid has had time to oxidise to sulphuric, in which case the amount of peroxide formed is very small. The formation of peroxide of lead takes place readily in the presence of sulphurous acid, and in 23 to 24 hours the requisite capacity can be obtained, and it is claimed for this process that little or no subsequent increase of capacity takes place, since no substance injurious to the life of the plates is employed.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, April 27th.

PHYSICAL SOCIETY.

8 p.m. Ordinary Meeting in the Solar Physics Observatory, Exhibition-road, South Kensington. Agenda: (1) A Short Account of the Physical Problems now being investigated at the Solar Physics Observatory and their Astronomical Applications, by Sir J. Norman Lockyer, F.R.S.; (2) Weather permitting, the 36in., 10in., and 9in. telescopes will be used for the observation and photography of celestial objects and their spectra. The Appu-Spottiswood coil and 21ft. Rowland grating will also be in operation.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by the Rt. Hon. Lord Kelvin, F.R.S., on "Nineteenth Century Clouds over the Dynamical Theory of Heat and Light."

THURSDAY, May 3rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II.: "A Century of Chemistry in the Royal Institution," by Prof. J. Dewar, F.R.S.

RÖNTGEN SOCIETY.

8 p.m. Exhibition evening at 20, Hanover-square. The following demonstrations will be given: (1) A New Method of Localisation without Plumb-lines or Threads, by Prof. F. R. Barrell: (2) On a Form of Focus-tube Designed to be Self-heating, by Dr. Dellpratt Harris; (3) A New X-Ray Film—"Cristoid," by C. Williams. Mr. M. Davidson will show, if possible, the Stereoscopic Fluoroscope. Exhibits as follows have been promised: Mr. Bowron: (*a*) A portable 8in. Spark Coil with improved Break; (*b*) A semi-portable 15in. Spark Coil with improved Break; (*c*) A Milliampèrimeter, for measuring the Secondary Discharge of Induction Coils. Mr. J. H. Gardiner: Skiagrams of British Reptiles, &c. Mr. Isenthal: Jet Mercury Break, &c. Dr. F. H. Low: A portable 10in. Coil, &c. Messrs. Parsons and Eachus: A Portable 8in. Set. Mr. E. H. W. Shenton: Skiagrams, Localiser Couch. Mr. Wimshurst: Influence Machine with Vulcanite Plates.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Institution of Mechanical Engineers, Storey's-gate, S.W. Paper to be read: "The Calculations of Distributing Systems of Electric Traction under British Conditions," by H. M. Sayers. To be preceded, if necessary, by the conclusion of the discussion on Prof. Forbes' Paper, read on April 26th.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Identity of Radium and Cathode Rays.—H. Becquerel has made a discovery which appears to decide the nature of one kind of Becquerel rays, at all events, those called "radium rays" by Curie. These, according to Curie's experiments, transport an electric charge, a fact which already points out a close analogy with cathode rays. The analogy would be made perfect if it could be shown that radium rays were subject to electrostatic as well as magnetic deflection. This has been done by Becquerel, though not without encountering serious difficulties owing to the feebleness of the sources available and the consequent smallness of the deflection to be observed. He succeeded in proving photographically, by means of an electric field of a billion units, that the rays or particles proceed in a parabola having the vector of the electric field for its axis. Their velocity is something between half and two-thirds of that of light. On comparing the magnetic deflection of a beam with its electric deflection, the ratio e/m is found to be about 10,000,000, or the ratio of an infra-red vibration of the Zeeman ions. The energy expended is a few C.G.S. units per second, or a few ten-millionths of a volt. This would mean a loss of matter of about 1 milligramme in 1,000 million years. This explains the inappreciable loss of matter actually found.

[H. Becquerel, *Comptes Rendus*, March 26, 1900.]

Dissociation Theory of the Arc.—By photographing a narrow longitudinal section of an alternate-current arc on a long moving film, Brown showed that the arc is formed by the coalescence of two light-fronts, starting from the positive and negative carbons respectively. The negative light-front starts first, but the positive one moves with the greater velocity. The former circumstance is easily explained, as the negative carbon was positive during the previous half-period, and was therefore the hotter of the two. As regards the difference of velocity, it is difficult to account for it without having recourse to some ionic hypothesis. Such an hypothesis has been framed by C. D. Child, who supposes that the negative ions move more slowly than the positive ions. This is the reverse of what happens in the case of dissociation by Röntgen rays. The greater velocity of the positive ions would not only explain the fact observed by Brown, but also the greater fall of potential at the positive pole. Manometric experiments show that the pressure near the positive carbon is greater than that near the negative carbon. The author explains this on the ground that owing to the smaller speed of the negative ions their number between the poles at any given time must exceed the number of the positive ions. Hence they exert a greater attraction upon the positive pole than do the positive ions upon the negative pole.

[C. D. Child, *Phys. Review*, March, 1900.]

Electrolytic Convection in Vacuum Tubes.—J. J. Thomson does not think that Morris-Airey's experiment (see *The Electrician*, May 16, p. 732) disposes of his theory of electrolytic convection in vacuum tubes. That chlorine should be found in all parts of the tube is inevitable when as large amounts of chlorine are mixed with the hydrogen as in Morris-Airey's experiments. For the increase of the partial pressure of the chlorine must accelerate its diffusion throughout the tube. In Thomson's original experiment a very small quantity of chlorine was mixed with the hydrogen, and the effects observed were not merely the presence of the chlorine lines at the anode and their absence at the cathode when the current was steady, but it was found that on reversing the current, so that the old anode became the cathode, the chlorine lines at first flashed out brightly at the new *cathode* and were faint at the anode. Then there was a short interval during which they were faint at both electrodes, and finally they became bright at the new anode and invisible at the cathode. This seems a very complete proof of the transport of chlorine to the anode, and of the electrolysis of gases in a vacuum tube.

[J. J. Thomson, *Phil. Mag.*, April, 1900.]

Change of Volume by Magnetisation.—There is still a popular impression, based upon the results of Joule's experiments, that the volume of a magnetic substance does not change on magnetisation, though its length does. Cantone found that this is not strictly true, and H. Nagaoka and K. Honda have therefore studied the behaviour of iron, steel, and nickel ovoids in this respect. They found that a change of volume becomes very apparent when stronger fields are used. They used a field-strength of some 2,200 units. Iron and steel ovoids, they found, show a considerable increase in the volume change on annealing. Tungsten steel is not affected by annealing, but the volume change, or increase of volume on magnetisation, is twice as great as it is in soft iron, being 2·5 millionths at 1,400 units of field strength. As regards the effect of torsion, the transient current, as well as the longitudinal magnetisation produced by twisting an iron or steel wire, is opposite to that of nickel in moderate fields; it reaches a maximum in weak fields; but in strong fields the direction of the current as well as the longitudinal magnetisation is the same in iron, steel, and nickel.

[Nagaoka and Honda, *Phil. Mag.*, April, 1900.]

The Echelon Spectroscope.—A valuable addition to our instrumental resources for observing the Zeeman effect is the "echelon" spectroscope invented by Michelson two years ago. Its principle, it will be remembered, is radically different from both the prism and the grating. It is made up of a number of glass plates of graduated sizes, each a little shorter than the previous one, and built up in the form of a pyramid, the base of which is turned towards the source, while the summit is turned towards the observer's telescope. Lord Blythswood and W. E. Marchant have constructed a spectroscope of this kind with an echelon of fifteen flint-glass plates each about 7·5 mm. thick, set with steps 0·5 mm. wide. It was found that the yellow and green mercury lines were far easier to examine than the blue, on account of the diminution of the dispersive power of the instrument for the shorter wave-lengths. To obviate this drawback the plates should be made thinner and more numerous, Otherwise the working of the instrument is highly satisfactory, while its cost is, of course, very considerably below that of a grating of equal resolving power. The ratio e/m for the mercury lines varied from $28{\cdot}0 \times 10^6$ at $\lambda = 4{,}358$ to $17{\cdot}2 \times 10^6$ at $\lambda = 5{,}790$ A.U.

[Blythswood and Marchant, *Phil. Mag.*, April, 1900.]

The Electric Light in Photo-Micrography.—In many branches of photography the electric light has been found to yield results frequently more satisfactory than those obtained by ordinary sunlight. One of the most recent and most effective applications is in connection with photo-micrography, and is described in the *Electrical Review* of New York. An automatic focussing arc lamp is placed in a nearly horizontal position, so that most of the light given will be projected vertically upwards, passing through a condensing lens and the object to be photographed, to the sensitive plate. The lamp gives 2,000 c.p., and, by varying the resistance, it can be made to furnish 5,000 c.p., or even more; and for work upon living organisms, magnified as high as 200 diameters, an exposure of $\frac{1}{40}$th of a second has given good results. In the work for which this lamp is used the light passes through the condensing lens and thence to the microscope stationed directly above. The object which is to be photographed, if a living specimen, is placed in a drop of water upon a piece of thin clear glass and the light turned on. A special shutter containing a total reflecting prism is placed in such a position that no light can pass to the sensitive plate which is all the time exposed inside the camera bellows, but after passing through the microscope is turned upon a ground-glass screen at the end of a conical view tube, which enables the operator easily to study the movements of the specimen. When it assumes the desired position, a pneumatic release allows a spring instantly to remove the prism from its first position and the light passes through an opening in the shutter to the plate.

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THE ELECTRICAL EQUIPMENT OF THE ELECTRICAL ENGINEERS (R.E.) VOLUNTEER CORPS.

As we have already announced, 58 men and six officers of the Corps of Electrical Engineers (R.E.) Volunteers sailed for South Africa on March 16th, under the command of Capt. Lloyd, R.E., and took with them two complete search light trains, each consisting of two search lights, two waggons, and one traction engine, each traction engine being fitted with its own dynamo. In addition to this a spare dynamo was taken, as well as 24 arc lamps with portable lanterns, and 200 incandescent lamps. A number of cycles, some of which were fitted with special cable-laying drums, were taken out to work in connection with the field telephones, and to facilitate communication in general. On April 14, Major Crompton, together with a second contingent of about ten men, sailed for South Africa, taking with them a third traction engine. In all probability, this third engine will join the first contingent, as we understand that Major Crompton himself has received instructions to proceed independently of his corps to the very front, with a view of discussing with Field-Marshal Lord Roberts certain problems relating to electricity in the field, as well as to the question of transports generally in South Africa.

Major Crompton has submitted to the War Office a scheme for working the transport service of an entire division of the army, independently of all railways, and it is in connection with this that he has received instructions to proceed to the front and explain personally the problems connected with it. We understand that the general principles of the scheme have been favourably criticised by the War Office authorities, and knowing the special study which Major Crompton has made of traction engines—for he was, in fact, actively engaged for nine years in experimenting on road traction for the Indian Government, long before he thought of electricity—we feel that the War Office could not obtain the services of a better man.

The plant taken out by the corps is described further on, and, in passing, attention might be drawn to the fact that an equipment of this description is quite novel, the field search light hitherto consisting of an ordinary ship search light mounted usually on railway trucks, a combination which is quite unsuitable for work in active warfare. Major Crompton has consequently had no light task in getting this equipment designed and assembled in the short period available, as everyone is aware of the difficulties of obtaining material at the present time with reasonable deliveries. The plant which has already arrived in South Africa can be used for various purposes, and where one application is not suitable another will no doubt be found. The traction engines can be used for ordinary transport purposes, or they can be used for driving the dynamos either for working the search lights or for running a motor. The search lights will find use either for signalling or for reconnoitring purposes. The possibility of being able to lay telephone wire at the rate of eight to 15 miles per hour is likely to be of importance, and one can confidently expect that considerable use will be made of a portion of the present corps in facilitating the difficult problem of keeping adequate communication between various points by this means.

Traction Engines.—In Fig. 1 is shown the type of traction engine which has gone out. An engine to perform the various duties required of it, as in the present case, is not an easy thing to find, yet these, built by Messrs. C. Burrell & Sons, of Thetford, seemed very suitable for the work. They are light, weighing between eight to nine tons, whilst indicating 18 H.P. In fuel consumption they are reasonable, consuming under ordinary conditions of working between six and eight cwt. of coal per eight-hours day. They are of single crank compound type, the two cylinders being arranged one above the other, whilst the two piston rods work on a single crosshead, to the centre of which the connecting rod is attached. The engines are arranged to carry a load of 12 ton each, and it was found that on an average road they could travel for six miles with the water carried on the locomotive. It was expected after the sappers had got used to the handlines of the engines that the water consumption would be somewhat reduced.

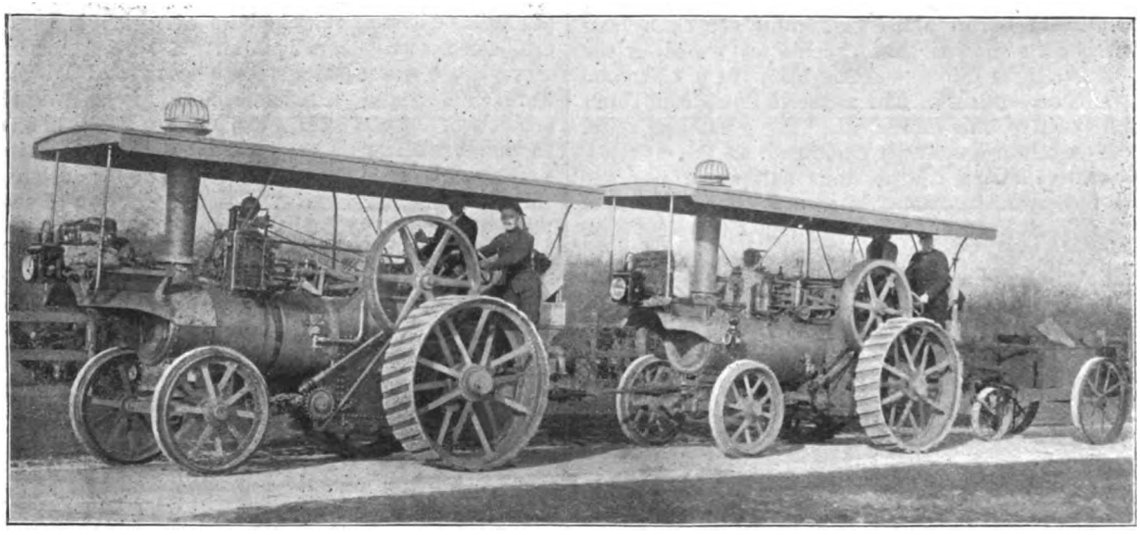

FIG. 1.—TRACTION ENGINES FOR THE WAR IN SOUTH AFRICA.

When driving the dynamos about 32lb. of water per hour per electrical horse power developed was consumed, though this would in all probability be reduced to 28lb. when in thorough working order. Water consumption is one of the most important items for traction engines in South Africa, and with a view of still further economising this, the third engine has been fitted with partial condensation. It was intended that one waggon per traction engine should be used exclusively for carrying additional water and coal, to minimise the number of stops necessary for these purposes. The dynamos, although not shown in Fig. 1, were fitted up on the bracket provided in front of the engine. In the illustration this space has been occupied by the sappers' luggage.

The dynamos are of the multipolar semi-enclosed type, manufactured by Messrs. Laurence, Scott and Co. and Messrs. D. Bruce Peebles & Co., being designed for an output of 110 volts and 80 to 100 amperes at 750 revs. By using 110 volts, two arc lamps can be run in series, which would of course have been impossible with the standard pressure usually adopted for search-light volts—viz., 80 volts. It was found necessary to fit some special spring arrangements to the front of the engine, to prevent as much as possible the jolts from being transmitted to the dynamos. The dynamos are belt driven off the engine flywheel. Finally, as shown in Fig. 1, the

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engines are completely roofed over, and by means of waterproof blinds dropped from the top, but not shown in the illustration, they can be completely covered in.

Search Lights.—The details in connection with these have had to be specially designed. Fig. 2 shows the general arrangement of the search light plant, on the left hand side being the projector mounted on its trail, whilst on the right hand side is the limber belonging to the search light. The gun metal bases of the search lights are arranged to revolve on balls over turntables, and a degree circle is fixed in the centre with a moveable pointer to facilitate getting the search lights into line should a number be used for reconnoitring purposes. The object of the dial and moveable pointer is to facilitate the working of a number of projectors at a distance by means of commands given on a telephone. It will be noticed that the trails are similar to gun carriages, but are mounted on springs. The wheels on which these trails were mounted, were made at the Royal Arsenal, which ensures their easy renewal in the field. If it should be required to use the search lights for stationary purposes, they can be detached from their trails and used on the ground, their four feet being each adjustable as to height. Aluminium is used for mounting the mirrors, glasses, and divergers, whilst the reflectors manufactured under Coles's patent are of deposited copper, faced with silver, with a thin coat of palladium to prevent tarnishing. The divergers are manufactured by Messrs. Chance Bros. and Co. Major Crompton has however taken out one of Parsons hyperbola-parabola diverging mirrors. This mirror causes the beam to cross in a narrow slit of light outside the barrel, thus enabling the projector to be totally protected by sandbags or other armouring.

The pattern service lamp was found far too heavy and clumsy for work of this description, and consequently it has been found necessary to entirely remodel the mechanism of the lamp. It was thought also that the arc striking arrangement would have been damaged by the vibration of the moving carbon, when the lamp was being moved about. The new mechanism in the lamp is arranged to lock the moveable carbon holder in position when once the arc has struck, the feeding movement being controlled by a shunt coil acting on the other carbon holder.

Owing to the somewhat higher pressure adopted, a drop of 52 volts can be allowed between the dynamo and search light, and consequently the search lights may be at least a mile from the traction engines. This distance can be increased on emergency by laying two conductors in parallel. The elevating motion of the search light, which is not required to be worked rapidly, is worked by a worm, and is thus self-locking. The horizontal motion, however, used largely for signalling purposes, has to be worked quickly, and is consequently pulled round by hand. Accuracy is not of so great importance in the horizontal as it is in the vertical motion.

Like ordinary field guns, these search lights have draghooks arranged on the end of the axle, and by means of these they can be hauled along by hand. They are usually when travelling attached to their limbers, and the two drawn together. The trail of the search light is fitted with a powerful screw brake, which can be worked from the back when travelling. It is arranged to allow of attaching an ammeter, voltmeter, and main switch, the latter being permanently fixed. The instruments can be attached at either end, whilst the holes for attaching the main switch are also arranged at both ends.

The search light trails have been made by Messrs. Thorneycroft and Co., whilst the design and manufacture of the search light has been undertaken by Messrs. Crompton and Co.

Limbers.—Fig. 2 gives on the right hand a very good view of one of the limbers, which are made up of wooden boxes lined with steel, the underframes being built up of angle iron. They are mounted on springs, whilst the axles and wheels are made interchangeable with those of the search light trail. By using a pole they can be drawn either by mules or traction engines, and by using ropes they can be drawn by hand. A flap door is fitted at the end of these limbers, and by lowering this the inside of the box, which is thoroughly lined with felt, can be got at. Shelves arranged on the inside are made to accommodate two projector lamps, two mounted mirrors, one plain glass, and one diverger. A box is arranged underneath the seat to accommodate carbons, tools, drag ropes, ammeter, and voltmeter. A screw brake is fitted on the driver's seat, which is capable of carrying two persons. On the roof of the limber will be seen a small box, containing the necessary variable resistance, and this can be used either in position or on the ground. This design of resistance, consisting of short lengths of solid wire fixed between asbestos clamps, is specially suitable for rough work of this description, as little risk is run of short circuiting when the wire becomes heated and expands, and is also much stronger to resist vibration. The limbers were made by the Gloucester Railway Carriage and Waggon Co.

FIG. 2.—ONE OF THE SEARCH LIGHT SETS.

Cable Drum Carriages.—Special carriages had to be designed for carrying the cable drums for paying out the cable, and these were made to take three drums, each drum holding about 200 yards of cable. The cable, capable of carrying about 100 amperes, is chiefly concentric, with the outer

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conductor bare and braided, to prevent its unwinding should it become cut at any point. There were also taken out some special unions for rapidly connecting up this concentric cable in the field.

The fittings, such as ammeter, switch, &c., would be fixed on the earthed conductor, so that any coupling-up necessary could be carried on without fear of shocks. Each drum has a brake fitted to it to prevent its unwinding; after use the cable is wound up by hand. Here, again, it is arranged that the wheels and axles of the cable carriages should be interchangeable with the ones used on the projectors. The drums can be pulled in either direction either by means of a traction engine or by hand. They can also be attached to the back of the search light, so that the mules dragging the search light and limber also do the work of laying the cable.

Telephones.—Several complete sets of telephones have been taken out, and in addition a number of cycles suitable for paying out the wire for these telephones. Six out of the 20 cycles taken out were fitted with spindles over the back wheels, to which two light cable drums were attached, each drum holding nearly two miles of fine bare copper wire. These drums are shown very clearly in Fig. 3, whilst the telephones themselves are carried on the back of the sapper. It was found that by this means the cyclist could lay the wire as fast as he could ride—say 8 to 15 miles per hour.

Fig. 3.—A Field Telephone Bicycle.

To keep the wire from overrunning small brakes without much friction are fitted on the drums. The drums are placed in such a position that the cyclist can stop them by hand when forced to slow down so rapidly that these automatic brakes are not sufficient. To pick up the wire after use a handle is attached to the drum, and the cyclist, wheeling the bicycle forward with one hand, winds with the other. It is possible to pick up the wire at the rate of about four miles per hour. The telephone wire is bare, and it was found that by using the earth as the return, even on wet ground, it was possible to speak up to three to four miles, with the wire trodden into the ground and even broken. The telephone wire, being very light and cheap, would be left on the ground in the event of its becoming damaged. The telephone itself is of the Swedish cavalry pattern, and can be used either for speaking purposes or for signalling in the Morse code by means of the "buzzer." This would only be done where the length of the line was such that distinct speech was impossible.

The telephones are arranged with a third terminal through a condenser, which enables an enemy's wire to be tapped by connecting it to the third terminal. This can be done without in any way interrupting the conversation, and it is thus possible to hear all that is going on.

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

BY C. E. GROVE.

(*Continued from Vol. XLIV., page 928*).

Electric Lighting.—The first installation of electric lamps on a warship was put in H.M.S. "Inflexible" in 1881. It consisted of a set of arc lamps run in series from a Brush dynamo, with glow lamps arranged 18 in series on the high-tension mains. The arc light has disappeared. Modern war vessels are usually too much subdivided and have too little head room to justify the use of arc lamps, although these are again becoming somewhat common on merchant vessels. The parallel glow lamp system became standard practice almost as soon as it was introduced, and the number of lamps employed has been steadily increasing. Thus, in the battleship "Colossus," fitted in 1884, 350 lights were installed; in the "Blenheim," first-class cruiser, fitted in 1890, 525 lights were installed; the "Majestic" class of battleships, fitted in 1896, carry between 800 and 900 lamps; the "Albion" and her sister battleships of the "Canopus" class, just completing, carry about 950; the "London" and "Duncan" classes of battleships now building will carry from 1,000 to 1,050 lamps; while the first-class cruisers of the "Drake" and "Monmouth" classes now building will carry approximately 1,000.

		FITTINGS														TOTAL FITTINGS	CIRCUITS					
DECKS	CIRCUITS	BULKHEAD	PENDT/GUARDS	BRACKT. + PENDT/CABIN	BRACKT. + PENDT/SPECIAL	HAND	TABLE	BUNKER	PEDESTAL	SIGNALS	PILOT	MAGAZINE	YARD ARM			FORWARD	MIDSHIP	AFTER	STORE	ENGINE ROOM	MAGAZINE
ABOVE BRIDGE	AFT					1				1			8					10			
	FOR					1				9			8			18					
BRIDGE	AFT	3	2		2		3			3								13			
	MID									3							3				
	FOR	3	2		2					5	2					14					
UPPER	AFT		8	8	5	2	2	2										27			
	MID		28														28				
	FOR		10	9			1									20					
	ENG			11																11	
MAIN	AFT		18	1	27	19		12										77			
	MID	36	35	6			2										79				
	FOR	15	10	5	5			1								36					
	ENG			12																12	
MIDDLE	AFT		14	9	6	23												58			
	MID	18	22	1					19								60				
	FOR	19	7	11								3				40					
	ENG			11							1									12	
LOWER	FOR	1	2			2	2														
	STORE	5	42	25		8	10	1											91		
	ENG	2	9	26			8		14											59	
	STORE	2	32	13		1	13												61		
PLATFORM	ENG	6	27	52			2				2									85	
	MAG											44									44
HOLD	STORE		4			6						6							16		
	ENG		6	2			2													10	
	MAG											38									38
TOTALS		110	278	202	47	44	17	47	16	33	11	12	3	91	16	927	135	170	179	169	195	82

Fig. 10.—Schedule of Electric Lighting, H.M.S. "Albion."

It is usual to arrange the electric lamps in six circuits, one circuit being exclusively devoted to engine and boiler rooms, one to magazines, one to central citadel, one to the crew spaces forward, one to the cabin spaces aft, and one to the stores and machinery rooms below the belt deck. It is desirable to have separate circuits for those portions of the ship which are protected by armour, rather than to mix up the lighting of protected and unprotected portions, though this is by no means generally done. A schedule showing the arrangement of lamps, fittings, and circuits on H.M.S. "Albion" is given in Fig. 10. In the United States navy the lamps are arranged on two main circuits, known respectively as the "battle" circuit, which includes the lighting of all parts of the ship occupied in action, and the "lighting" circuit, which includes those parts where general illumination is required for ordinary purposes. Feeders running from the switchboards connect to the respective circuit networks through junction boxes. At "general quarters" the ordinary lighting circuits, which include all the exposed lights on the upper decks, are disconnected at the switchboards. This arrangement prevents stray light shining out-board.

Lead-covered cables and wires, first introduced into the Japanese cruiser "Naniwa-Kan," built at Elswick, are universally used in our navy, and the insulation is now vulcanised indiarubber in all cases. For single lamps a pair of 1/16 wires are employed; stranded wires which group the sets of lamps through fuse-boxes up to the circuits

* Paper read before the Institution of Electrical Engineers, April 5th.

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are universally composed of multiples of single 20-wire, the standard sizes being 7/20, 11/20, 15/20, 30/20, 60/20, 80/20, and 150/20 ; while for dynamos and heavy motor circuits 350/20 and 550/20 are employed. The current density is usually a little below 1,000 amperes per sq. in., which ensures in the lengths dealt with a very moderate voltage drop. The present mode of fixing the wires and cables is to attach battens of teak to the bulkheads and to run the wires side by side along the teak under brass cleats or saddles. Thus all the wires are visible. According to Admiralty specifications, steel battens may be used as an alternative to teak, but they would be much heavier, and the author is not aware of any ships so fitted. The introduction of these teak battens into our navy took place but a few years ago, and the step appears to have been quite a retrograde one. The employment of wood allows of fewer holes being drilled in decks and bulkheads than would be otherwise necessary, but the aggregate cost of the wiring work is considerably enhanced, useless weight is worked into the ship, and the danger of fire increased. The Japanese have in their latest battleships had the cables and wires attached directly to the decks and bulkheads, dispensing with backings, except where necessary for the heaviest runs or as packing to carry heavy runs of the larger cables over obstructions such as flanges of angle-bars, rows of rivet heads, and the like. This makes a very substantial and satisfactory job. The practice in the United States navy very much resembles land practice. Lead-covered wires were employed at one time, but it is said that the quality of the lead and of the insulation was such as to give trouble and to cause them to revert to the old system. In their latest ships they have run braided wires in wood mouldings in cabin spaces, and in iron pipe or conduit in machinery spaces ; while in the crew spaces and in some of the fore and aft runs the wires are supported below the decks on porcelain insulators, and protected by thin iron guard plate put over them. None of these methods appear to be so safe or so thorough as the British Admiralty method of lead-covered cables closely packed together, and visible and accessible throughout their length.

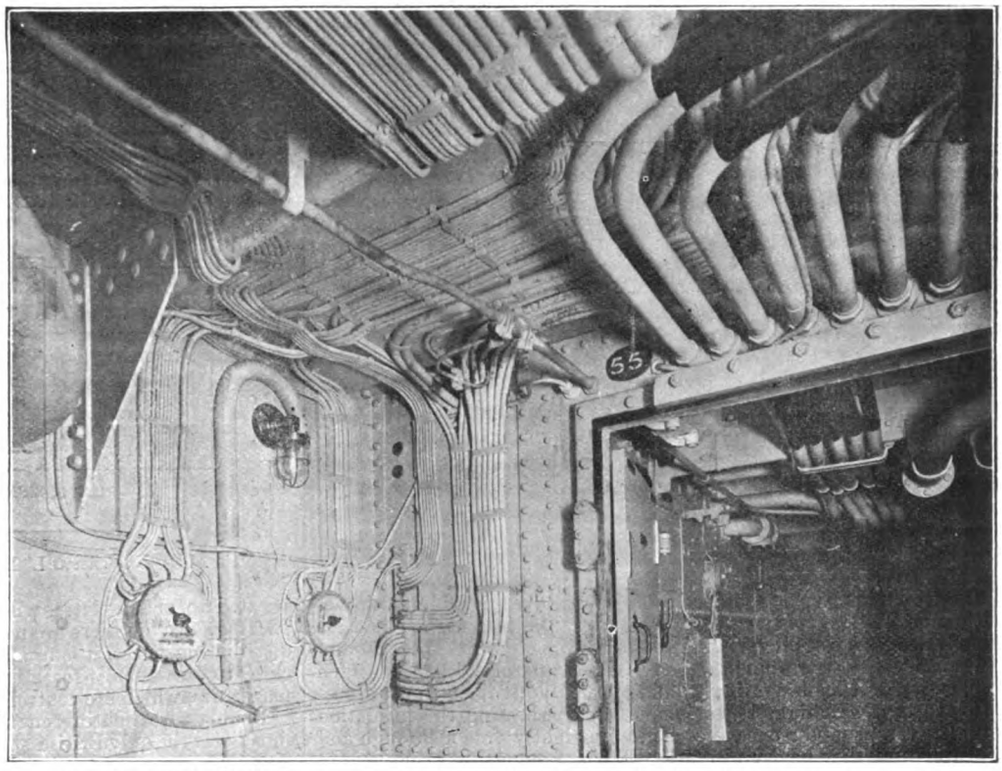

FIG. 11.—Cable Work at entrance to an Ammunition Passage, showing Plate Watertight Glands.

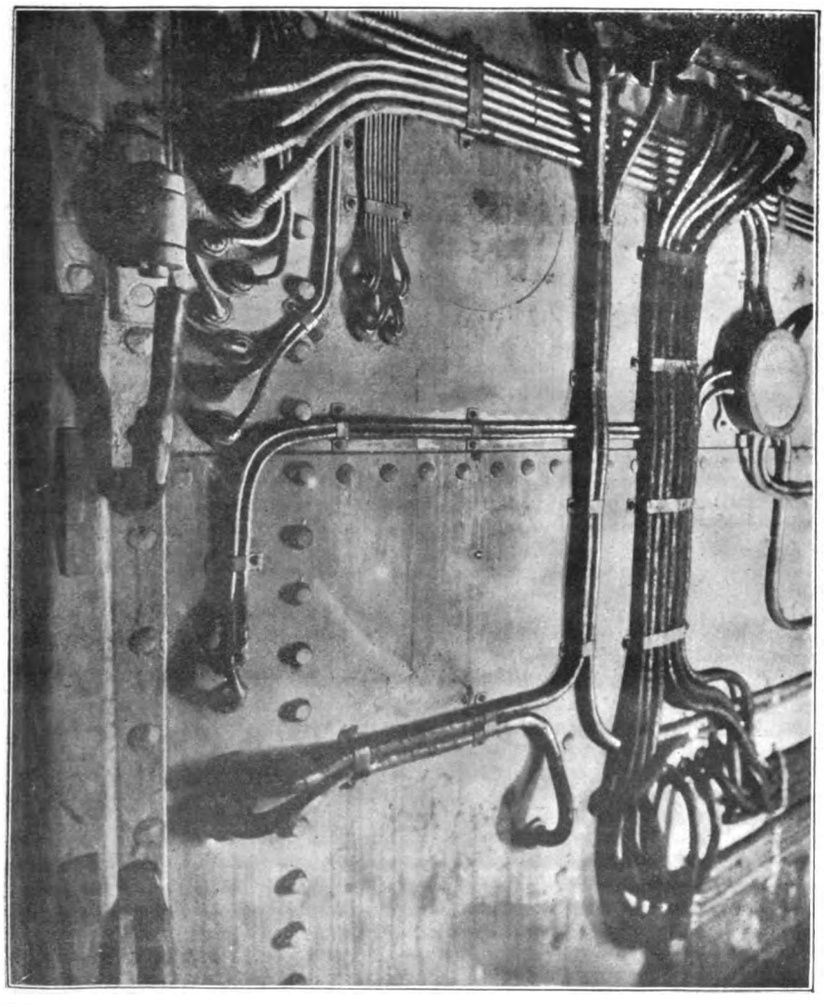

FIG. 11A.—Cable Work behind Switchboard, showing Tubular Watertight Glands.

Watertight Work.—Where the wires go through watertight bulkheads or decks, of course the bulkheads and decks must be made watertight behind them. Until recently the method of making the cables watertight at the decks consisted in providing a length of iron tube lined with fibre, with a stuffing box and gland at the top end, by means of which an indiarubber packing was screwed down upon the cable ; and similar glands were used where the cables passed through bulkheads. One disadvantage of this arrangement was that where a number of cables and wires had to be dealt with, a considerable amount of space was taken up by these pipes in order to provide room for spanners to work in tightening up the nuts. A simple, compact, and effective method is as follows: Two pieces of wrought-iron plate are drilled with holes slightly larger than the size of the cables that are to go through the bulkhead ; similar blocks of india-rubber about ½in. thick have holes formed in them just the neat size of the cable ; the bulkheadis drilled with clearing holes ; a slab of rubber and an iron plate are placed on either side of the bulkhead, the cables are drawn through, and then the plates screwed up tight. By this means pressure is put upon the rubber, which tends to make the holes through which the cables pass smaller, so that the cables are gripped and the holes are left watertight. The arrangement was used by the author throughout the Japanese battleship "Fuji," both for decks and bulkheads. Fig. 11 shows a grouping of cables through such glands at the watertight bulkhead alongside the entrance of an ammunition passage. Many ships fitted at Portsmouth have

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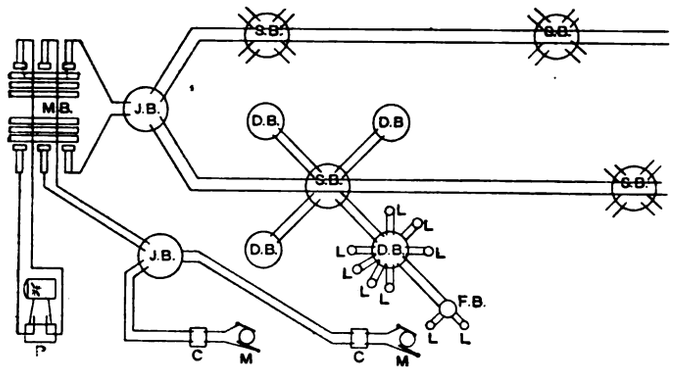
rubber-packed plate glands, though these are fitted only on one side of the bulkhead.

A new arrangement (Fig. 11A) was introduced by the British Admiralty in 1898. Brass glands of tubular form screwed to take a nut at one end, and having central holes, previously tinned, about ¼in. larger in diameter than the cable intended to pass through, are inserted in the bulkheads and made watertight on



C.—Controller. J.B.—Junction Box. M.B.—Main Board.
D.B.—Distributing Box. M.—Motor. S.B.—Section Box.
F.B.—Fuse Box. P.—Projector. L.—Lamps.

FIG. 12.—Diagram of Admiralty Distributing System.

the iron by means of red lead. The lead-covered cable is drawn through, and its tape stripped back to bare the lead at the gland ; a split tinned ferrule is then inserted to fill the clearance space around the cable, and the whole is then sweated up solid by means of a blow-pipe. This is a rather tedious method until the men get accustomed to it, and there is some danger of overheating the insulation unless care is used : once the cables are tightly drawn through and sweated up, they have a neat and solid appearance; but they cannot be drawn back, and when repairs become necessary it seems likely that the cables will have to be cut, which is a great disadvantage.

Distribution System.—The main circuit cables from the switchboard pass, in the case of the heaviest circuits, through junction boxes, into which they split usually into two branches protected by fuses. Each of these branches then passes through a series of section boxes, which are circular watertight boxes containing a switch and four pairs of terminals for the attachment of fuses

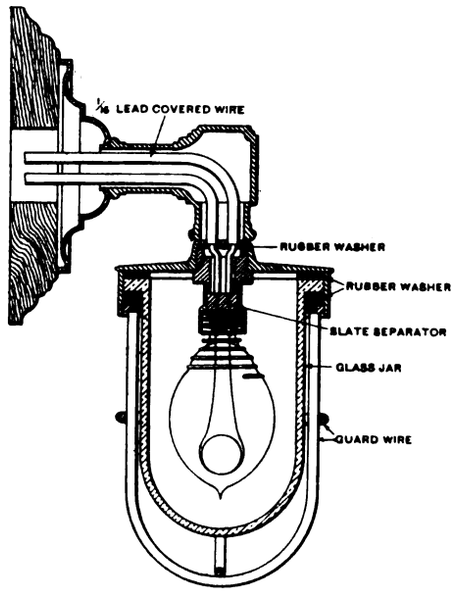


FIG. 13.—Admiralty Pattern Watertight Bracket.

and the branching of cables. Each of the four pairs of cables running from a section box terminates in a distributing box, which is a similar box to the section box and contains fuses and a double-pole switch. From each distributing box eight pairs of wires are taken, each pair leading direct to the terminals of one lamp. Fig. 12 illustrates the arrangement. As explained in the next section no lampholders, properly speaking, are employed. This distributing-box system was introduced into British warships about 1892. It is a modification of a method previously developed and used in wiring hotels, blocks of mansions, and such like places. Its advantages are that it enables the electric light system to be entirely laid out without any joints or branches in wires, thus dispensing at once with what is usually an important source of trouble. In the event of any part of the system becoming injured, it can at once be switched off at the nearest distributing or section box, and the working of the system in general is not interfered with. The system allows of the work being rendered more completely watertight than could otherwise be accomplished. The lead covering of the wires is stripped back sufficiently to enable the wires to enter the terminals in the box ; the lead is then

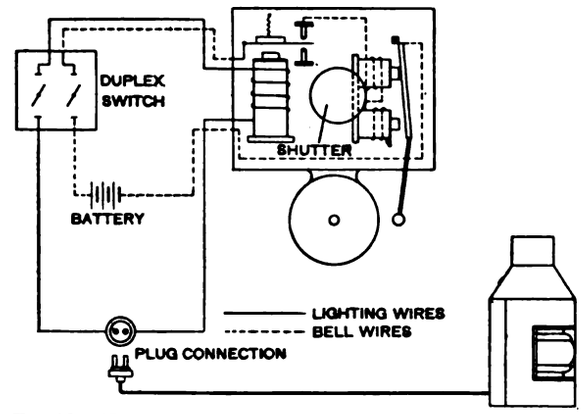


FIG. 14.—Navigation Lights Alarm, "Fuji" and "Shikishima."

sweated to gland plates, which are made watertight with red-lead packing. While there are no single-light fuses employed except in distributing boxes, it is usual to employ single-light switches placed close to the fittings for all lights except those in crew spaces and magazines, which are controlled in groups.

Double-wire lighting circuits are universal. H.M.S. "Polyphemus" was the only British ship in which single wiring was employed, and this was soon converted. Concentric systems, with or without

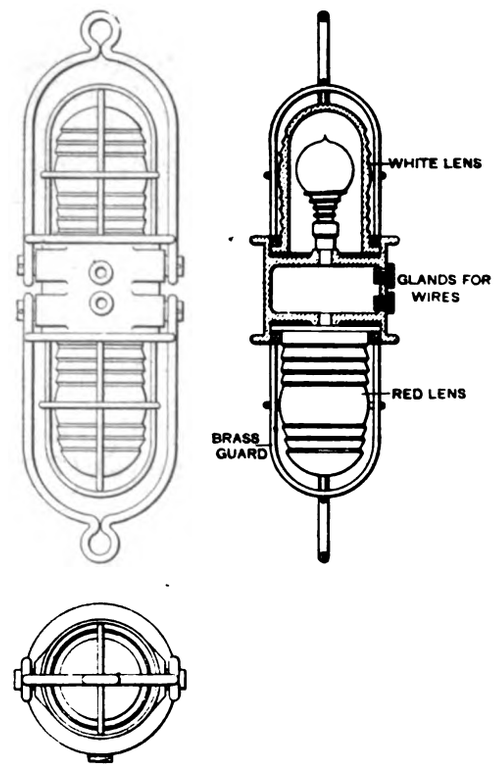


FIG. 15.—Ardois Lantern.

the outer conductor earthed, have been frequently advocated for warships, but they do not lend themselves so readily to the repair of small injuries as the twin-wire circuits employed.

Fittings.— Fig. 13 illustrates a typical Admiralty watertight fitting, showing the method of wiring. The lead-covered wires are drawn through an indiarubber washer pierced with two holes, which fits tightly into the neck of the fitting, thus excluding moisture ; the lead and the insulation are then stripped back, and the bare wires led through holes in a slate disc which forms a separator ; no lampholder, properly speaking, is used, but the ends of the wires are turned back with pliers to form hooks, and on to these bottom loop

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lamps, having twisted spiral platinum loops, are hung. Loop lamps are used because they best stand vibration and shock due to gun fire. But this method of wiring is capable of considerable improvement. If the hooks in the wires are not properly formed and are not of exactly the right length, bad contact and sparking result and the wires are burnt. If from any reason the hooks get injured or broken off, little pieces of wire have to be soldered on, which is not good. It would be much more satisfactory if the wires terminated in fixed contact blocks, and the fitting, wired complete and provided with spring contact plungers, were then independently attached. In the "Shikishima," combination fittings, carrying electric lamps and candles, were wired in this way by the author with success, the removal of four fixing screws allowing the fitting to be bodily taken away without disturbing the main wiring.

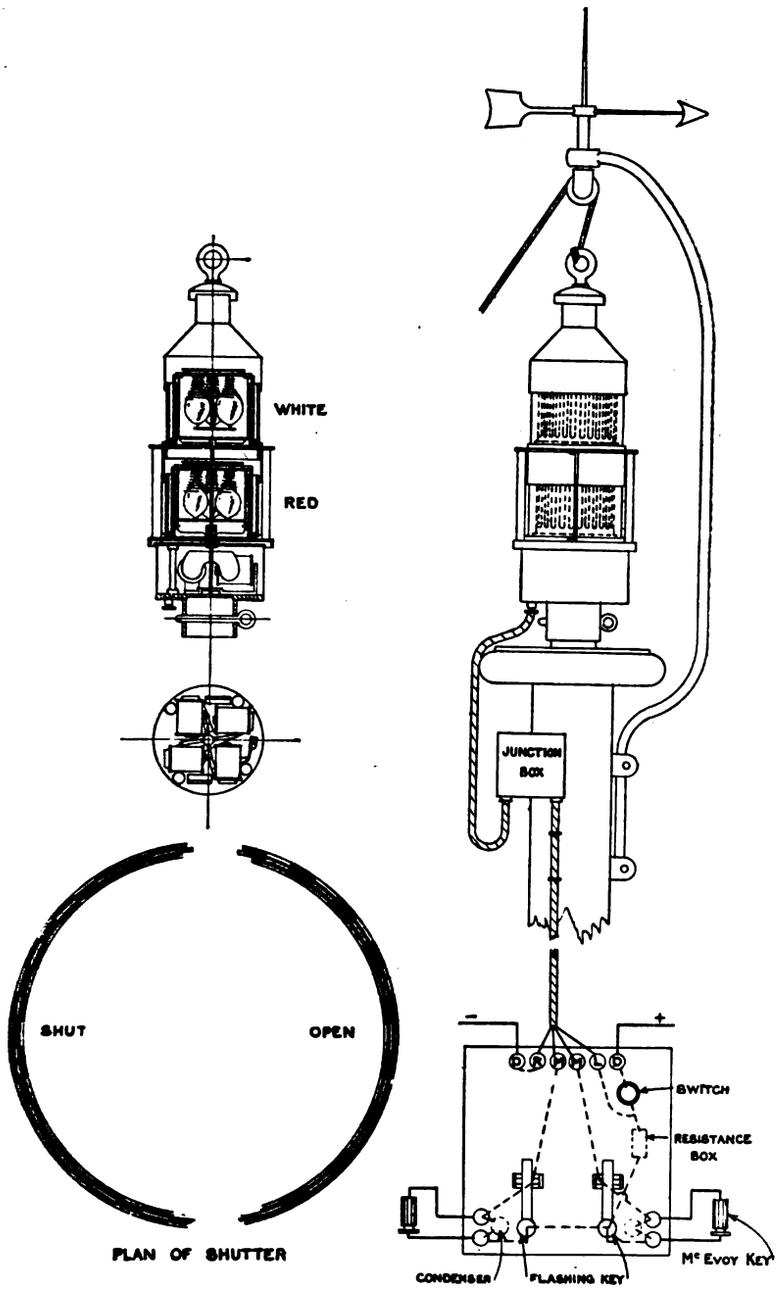

FIG. 16.—Double Mast-head Flashing Lantern, "Scott" System.

Signal Lights.—Every ship of course carries the ordinary international navigation lights, port side red, starboard side green, and mast-head white, which must be alight all the while the vessel is under weigh, together with white riding lights, which have to burn when the ship is at anchor. In British ships, so-called "position lanterns," two in number, are carried on the ensign staff when at anchor. In order to provide against failure of the navigating lights, the lanterns sometimes contain two lamps with an automatic switch for throwing the second into circuit if the first fails. This does not, however, make a good arrangement, because both lamps cannot be placed in the focus on the Fresnel lens, and if one is right the other one must be out of position. Tell-tale alarms (of which there are several kinds) are used on some ships to give warning if one of the navigating lights fails. Fig. 14 shows the arrangement devised by the author for the "Fuji" and "Shikishima." An electric bell is provided with a relay wound to one-tenth of an ohm and carrying the full current of the 50 c.p. lamp employed, say 2½ amperes. This relay magnet holds a spring contact out of connection with the bell circuit while the lamp current is on. On the failure of the lamp current, the spring contact completes the bell circuit, and the bell rings continuously. A duplex switch in one watertight case switches both lamp and bell circuit on together. A plug connection is attached near the lamp position, so that the lamp can be removed without disturbing the wiring. The bell circuit can be tested by merely switching on with this plug connection out, when of course the bell will ring if all is in order.

The Ardois lantern is largely used abroad for speed signalling. This lantern (shown in Fig. 15) is really a double lantern, one half having a white Fresnel lens and the other a ruby lens, each enclosing a 50 c.p. lamp. As used by the Japanese, the lantern is hung over a sheave from the fore starboard yard-arm, this sheave being surmounted by a single lantern of similar design showing a white light. When the white light in the movable lantern is shown burning close up to the fixed light it means "Full speed ahead," while the red light in this position indicates "Full speed astern." If the white light is shown half-way between yard-arm and rail it means "Half speed ahead," a red light in the same position indicating "Half speed astern." When the movable light is shown quite low down, it means "Slow speed ahead," and the red light in the same position "Slow speed astern" The white lenses are slightly obscured, because it is thus more easy to see the two separate lights when close together than if clear glasses are used. Two white lights and a central red one, in lanterns on the after-bridge rail, are used for the same purpose, and screened so that the light shows only astern. Among minor signals may be mentioned that employed to indicate "Admiral aboard." On British ships, three lamps are hung respectively at the ends and centre of the after-bridge rail, and one from the military top; on Japanese vessels three lamps are hung in triangular fashion from the after military top. The same three lanterns hung in various positions are used by the Japanese for other signals.

For general fleet signalling, flashing lamps carried at the truck of the foremast are in fairly general use. They are designed so that any communication can be effected by the use of the ordinary Morse code. In one design of mast-head lantern due to Capt. Scott, and made by Messrs. Armstrongs, the lamps, which burn continuously, are enclosed in a lantern surrounded by two louvre screens, one fixed and the other movable. The movable screen is attached to the armature of an electro-magnet, through which currents are sent when the signalling key is depressed. The lantern may be arranged so that openings in the louvres coincide and the lights are visible when everything is at rest, the movement of the screen cutting off the light and thus representing the interval between the signals, or *vice versa*. A modification of the Scott lantern as used by the Japanese is shown in Fig. 16 It consists essentially of two lanterns, one above the other, the lower one being enclosed in a ruby glass screen. There are independent signalling keys for the two lanterns, the contacts of which are shunted by a condenser and resistance to kill the sparking. In the figure the screen is shown to a larger scale for clearness. The British mast-head lantern is of different design, the lamp current itself being interrupted by the signalling key. The United States Navy uses for fleet signalling four Ardois lanterns, the upper light in each being red and the lower white. These are suspended about 10ft. or 12ft. apart on a couple of wire jackstays from the after-mast. A special controlling switch is used, having sets of contacts corresponding one to each possible combination of four lights, the two lights in one lantern never being used together. Each combination denotes a letter of the alphabet or a figure. By moving the switch-handle about the top dial of the switch and depressing at the proper contacts, words are spelt out.

Searchlights.—The searchlight installation is usually considered one of the most important sections of the ship's equipment, and use was found for searchlights five years before electricity was used for the general illumination of ships. The first projector was installed in 1876 in H.M.S. "Minotaur." It had a vertical lamp burning square carbons, a parabolic mirror, dioptric and diverging lenses, and flashing screen. The lamp was hand-fed and took alternating currents. In 1878 the Siemens holophote projector, with automatic lamp, was tried on H.M.S. "Triumph"; and many other forms of projectors and lamps were experimented with between that date and 1881, when the "Inflexible" was fitted with a Mangin projector, having a Mangin mirror instead of dioptric lens, and an inclined hand-feed lamp, current being furnished by a Gramme dynamo. The Mangin mirror is ground to spherical surfaces, the front and back having different radii of curvature. The parallelism of the beam is due to refraction through the thick glass between the front surface and the silver surface of the back. This remained standard in our navy until about 1893, when it gave place to the Parsons mirror, which is a thin parabolic mirror of high quality. The Mangin system is, however, in use by most foreign navies. The inclined hand-feed lamp is still the standard of the British navy;

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the carbons are tilted about 20deg. from the vertical, and the light falling upon the mirror has its maximum intensity at or near the centre of the mirror. On the Continent and in the United States automatic horizontal carbon lamps are coming into favour. The crater of the positive carbon is, of course, turned towards the mirror, the arrangement in this case giving the maximum intensity of the light at the outer edges of the cylindrical beam. The British War Office has also adopted the horizontal carbon lamp for its standard projectors. The ascending current of air is apt to displace the arc, which is specially inconvenient with horizontal carbon lamps. To get over this difficulty the Schuckert projector, Fig. 17, which is the standard in the Austrian Navy, is fitted with a soft iron ring surrounding the carbon. This ring becoming magnetised when the current flows produces a magnetic field along its axis in which the carbon lies, and so keeps the arc in the proper position.

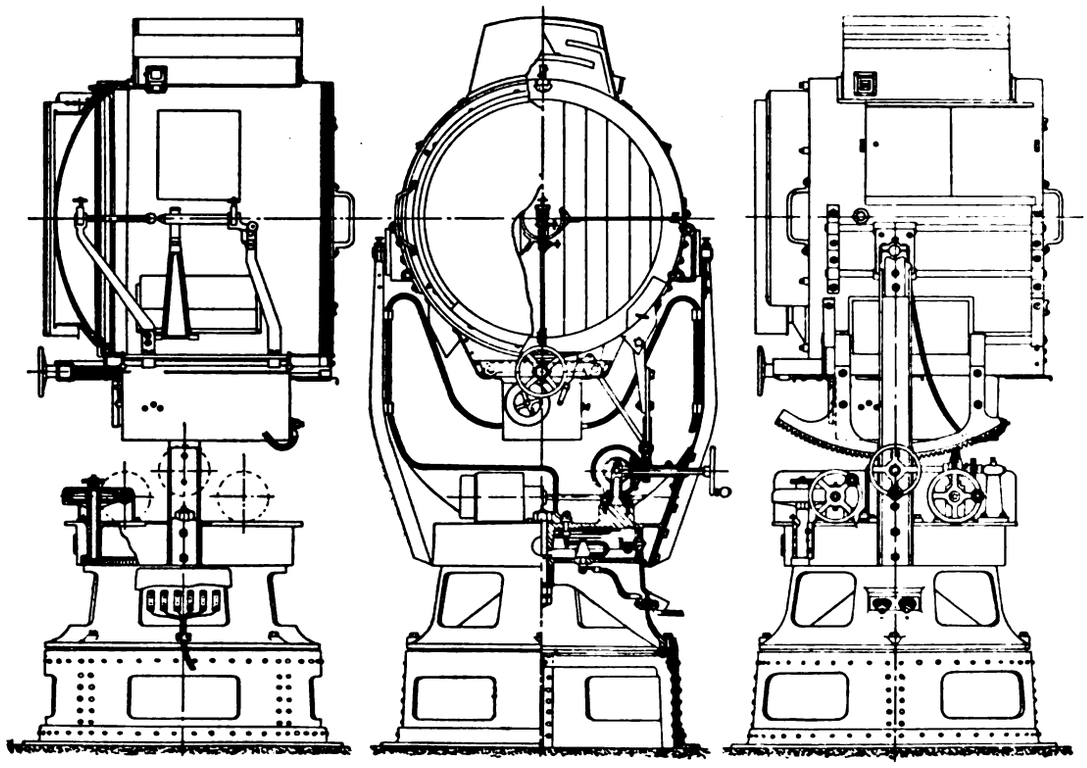

FIG. 17.—Schuckert Automatic Projector.

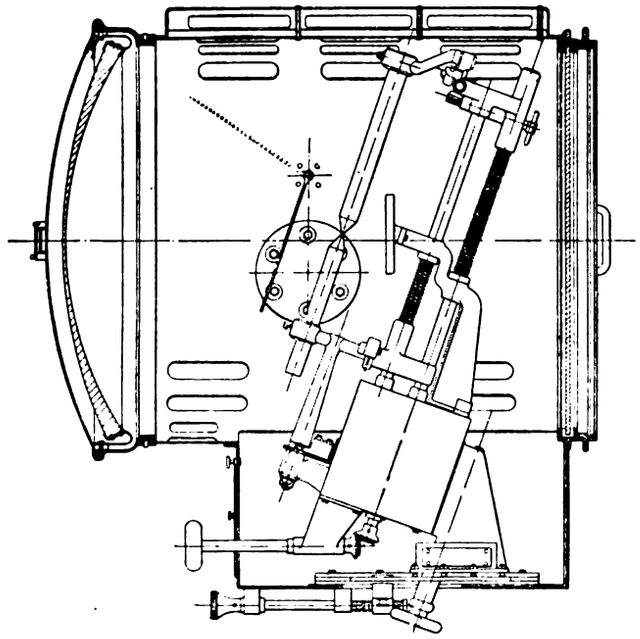

FIG. 18c.—Siemens Automatic Projector.

It is now becoming common practice by foreign nations to operate searchlights from a distance. An observing officer can see the object illuminated very much better if he occupies some different position from that of the searchlight, so that he does not have to look along the beam. But as he must have a means of directing the light, it is becoming common to provide projectors with electric motors, one to train and one to elevate the projector barrel, including lamp and mirror, and also to fit projectors with automatic lamps. This operation is specially advantageous as regards projectors fitted at the tops of the military masts which can be conveniently operated from the bridges. Fig. 18 shows a Siemens electrically controlled projector of this kind. It is worked by a combination switch consisting of two motor starting switches mounted at right angles to one another and worked by a single handle. The operation of directing the searchlight is done by moving the switch-handle precisely as if one had hold of the back of the projector itself. The projector is instantly stopped upon a given object by bringing the handle to the "off" position, which short-circuits the motors. As fitted on the bridges of ships, projectors have two positions, a working position right out, and a stowing position in board. At the stowing position they are secured by chains and turn-buckles to anchor-plates in the deck; in the working position they are secured by a small eccentric motion, worked by a hand-lever, which lifts the projector base slightly from its trolley wheels and jambs it on to the underside of a flange in the rail on which the projector runs. Searchlights are used a good deal now for long-distance signalling, and very great distances indeed have been covered. The common way is to make use of a round disc suspended on a spindle running through the projector barrel between the lamp and the mirror, and vibrating this disc by means of a small lever-handle on the spindle. The arrangement is seen in Fig. 18. In some recent foreign projectors a flashing screen, resembling somewhat a Venetian blind with the laths vertical, has been fitted in front of the front glass; the laths are linked together, and their movement from the

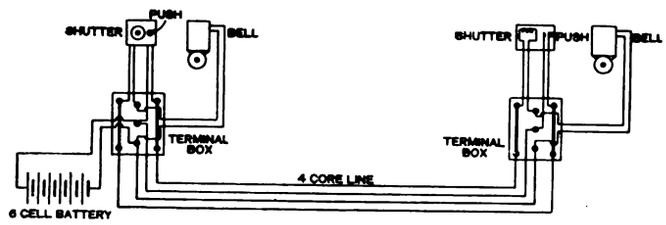

FIG. 19.—Voice-Pipe Bell Instruments. Diagram of Connections.

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position in which the full light is shown to that in which all the light is cut off, is controlled by a small lever-handle mounted at the side.

Voice-Pipe and Bell Communication.—The problem of maintaining communication between the several compartments, cabins, and military positions in a warship is not less important than the problem of maintaining general illumination, but it is far less successfully solved. As regards the communications between officers in their cabins and their subordinates and sentries, a simple system of bell signals with annunciators or "shutters" is all that is required; but communications between the navigating officers on the bridge and the engine rooms, and between combatant officers in the conning tower and the gun and torpedo stations, for

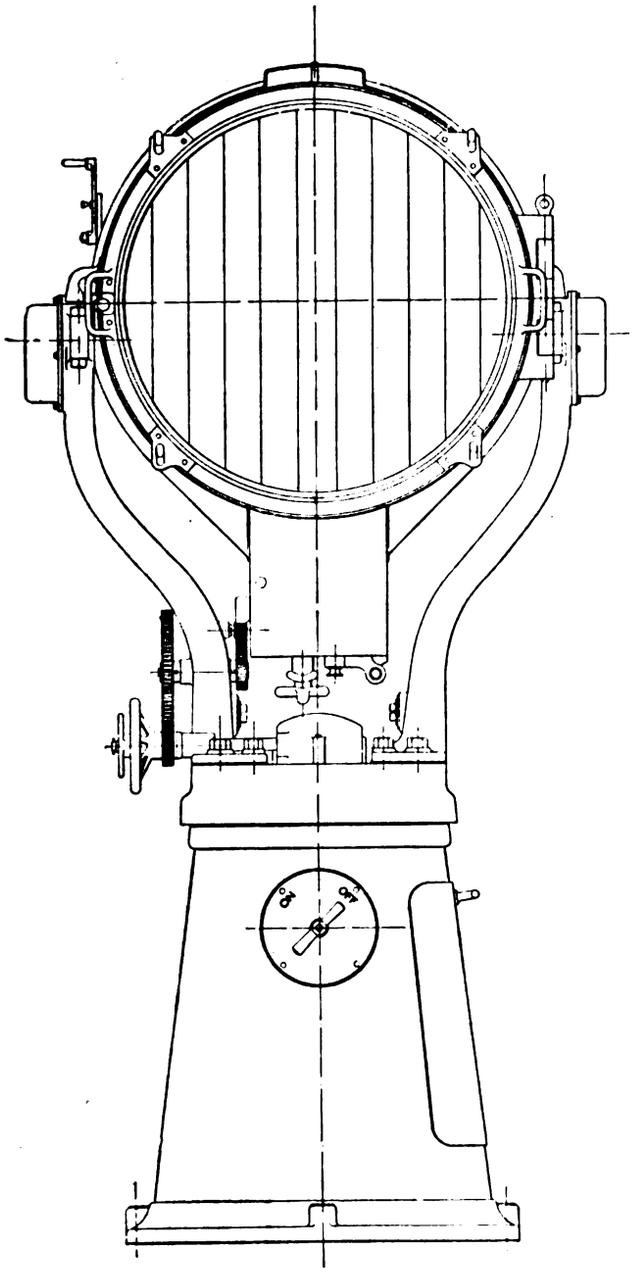

FIG. 18A.—Siemens Automatic Projector.

example, may often be of a much more complex and special character than can be easily given by a simple code of bell signals. Beyond a certain point, means of verbal or telegraphic communication becomes necessary. Such communications in our navy are effected by speaking through copper voice-pipes of 2in. diameter, fitted with whistles or electric bells, pushes, and shutters, the latter serving merely to direct attention to the voice-pipe. These electric-bell communications are very extensive in a modern ship, the number of points from which verbal messages can be sent or received being about 100 in the battleships of our "Majestic" class and about 140 in the "Canopus" class. A greater elaboration, however, than in any other ships afloat was affected in the Japanese battleships "Fuji" and "Yashima," which were equipped with as many as 256 electrically-connected speaking points, in addition to 44 cabin bell-push points. The connections between stations are effected by four-core cable, the conductors being 1/16, separately insulated with rubber, and covered with different-coloured cotton coverings to facilitate making and tracing connections. The electrical connections of a pair of instruments are given in Fig. 19. When, as is usual, several pipes and instruments occur at the same station, all the branching and jointing is done in terminal boxes. One bell is usually fitted common to the group, and one six-cell battery supplies several groups, the connections being made through suitable battery terminal boxes. The whole system is watertight, and no jointing of wires is done outside boxes.

The problem of communication is, however, not solved by the present arrangements, the difficulty being that when the electric bells have done their duty, and the officers who wish to communicate are at the opposite ends of the voice-tube, there is often so much extraneous noise that it is impossible for them to hear one another. It has been usual in recent years carefully to insulate the tubes from

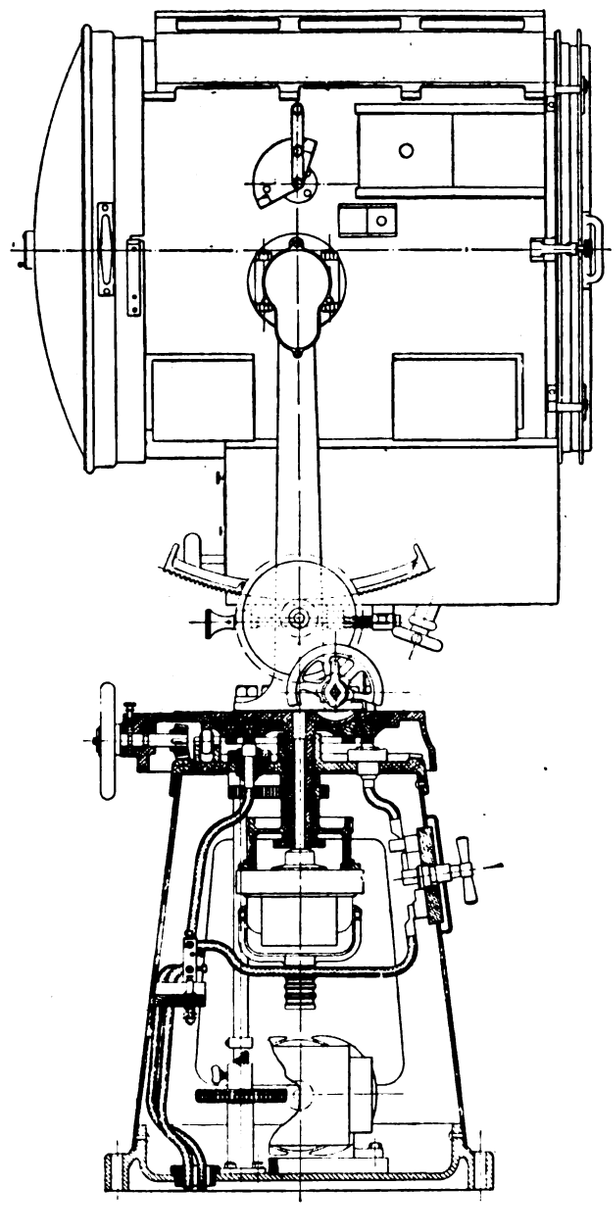

FIG. 18B.—Siemens Automatic Projector.

the main structure of the ship, so that they shall not pick up sounds by conduction, and the device has been employed of leading the speaking-tubes to about six exchange stations where messages are received and transmitted, so that the length of tube spoken through between point and point is reduced to the smallest limits. The transmission of messages at exchange stations, however, introduces delay and sometimes error.

Telephones.—The failure of voice-tubes has given telephones their opportunity, the speaking qualities of the latter being practically independent of distance. Among the earliest to use telephones on warships were Russia and America. One of the best forms of naval telephone, and one that is now being largely used, not merely by the British, but by many other navies, is Alfred Graham's. It is a loud-speaking instrument, the transmitter taking the current of four or six large agglomerate Leclanché cells, and operating without an induc-

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tion coil. The transmitter is of granular type, enclosed in a water-tight case. It is turned half-round every time the telephone is used by the switch which puts the line connections from "ringing" to "speaking." In spite of the large power employed there is no hissing. The receiver is contained in the same case. A considerable number of British battleships and cruisers are fitted with voice-tubes and bells between the port-engine room and the bridges and conning towers, and with these telephones between the starboard-engine room and the bridges and conning towers, the intention apparently being to gain extensive experience of the relative efficiency of voice-tubes and telephones under identical conditions. Telephone connections in a typical case are shown in Fig. 20. The most advanced instance of naval telephones yet fitted is to be found in Her Majesty's new yacht "Victoria and Albert," which has a large telephone installation. Trials are also being made of the applicability of these telephones to communications between casements.

It would appear, however, that during actual warfare, amid the noise and rattle of quick-firing guns, any instrument that depends upon the transmission of the human voice must fail. It is reported that in the battle of Santiago the Americans found their telephones useless. Unless a large number of men are to be told off as messengers to carry orders, what seems to be wanted is a system of printing telegraphs, the instruments being of a not too sensitive character, so that they could work without giving false signals due to vibration and shock, the general design of the instrument being somewhat

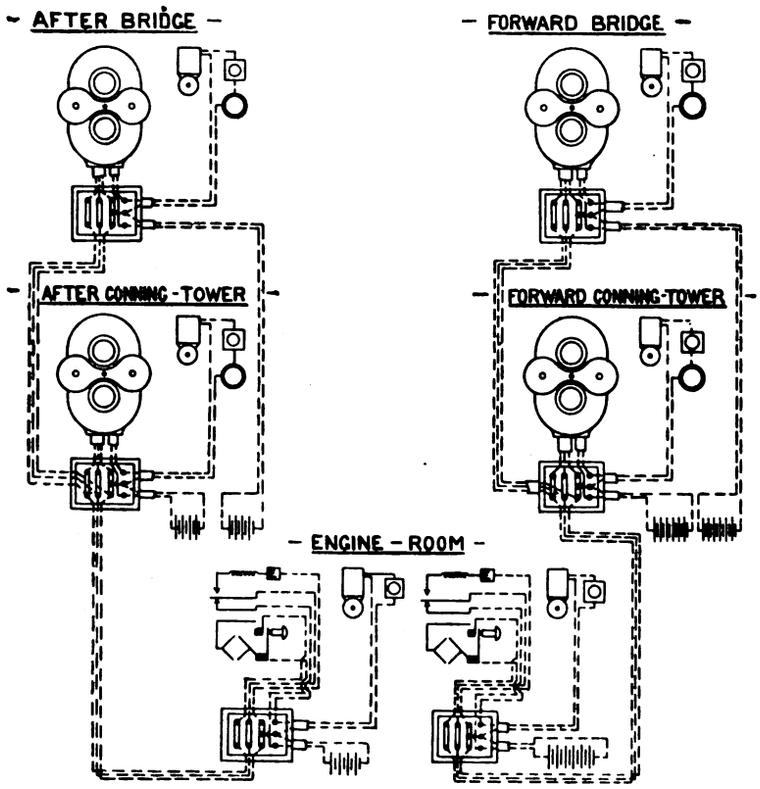

FIG. 20.—Graham's Loud-Speaking Telephone Connections.

after the fashion of that used by the Exchange Telegraph Co, printing in ordinary Roman letters. Such an instrument would have a relatively slow speed of action, but its result would be more positive, inasmuch as the message could be read by a person without a telegraphic training, and if by chance a false letter were printed, it would not necessarily prevent the word from being recognised. Probably its speed—12 to 20 words a minute—is as quick, all things considered, as the average voice-pipe communication now. Of course messages making inquiries or giving instructions in accordance with understood requirements could be transmitted by abbreviated signals.

Before leaving the subject of communications it may be mentioned that steps are being taken to introduce into the navy the Sullivan galvanometer for enabling ships at sea to speak with the land through ordinary submarine cables. There is some prospect also that warships will make general use of the Marconi telegraphic apparatus for fleet and ship-to-shore communications. This apparatus proved very useful in the 1889 manœuvres, and equipments have since been supplied to some of the battleships of the Channel Squadron.

Among internal bell communications may also be mentioned alarms connected with thermometers for calling attention to the attainment of certain temperatures in magazines, coal bunkers, &c. The arrangement is obvious.

(To be continued).

ELECTRICITY WORKS ACCOUNTS.

Dover Electricity Supply Co. (Ltd.).

Another year's accounts of the interesting undertaking at Dover are before us. The results, on the whole, are most satisfactory, culminating, as the year's operations have, for the first time, in the distribution of a dividend of 3 per cent. on the ordinary shares. Nor is this ultimate result quite a fair measure of the position of the concern; for it must be observed that the average total revenue obtained per unit sold is at Dover far below the mean of company worked stations, with double the output. In fact, the mean total revenue per unit at Dover is below the average of municipal stations with higher outputs.

Last year the increase in the connections to the mains raised the total by 10 per cent., with 85 new consumers. The total output sold showed an advance of nearly 24 per cent. The traction load demanded a maximum supply of 175 kw., while the consumption on this account reached 244,287 units, or no less than 46·6 per cent. of the total output. The public lighting absorbed another 16 per cent. of the total output. Unfortunately the official accounts do not give the total maximum supply demanded, but only the separate figures of the supply demand for traction and for lighting. From these figures we find the traction load factor to be about 15·9 per cent. and the lighting one 11·7 per cent.

There has been a general reduction in the costs, and, while a few of the items are still unsatisfactory they are balanced by some excellent results in other departments.

We are surprised to find the fuel item still keeping so high—quite 0·3d. above what, in our estimation, it should be. The other generating charges, including the item of repairs and maintenance, although this has increased, are all satisfactory.

Thanks to the influence of the very moderate management and property charges, the aggregate costs are decidedly below the average, notwithstanding the somewhat high works costs.

In the following table are repeated particulars relating to this concern, during the four complete years it has been in operation:—

Year	Equiv. lamp connection.	Units sold. Total.	Sold for traction	Sold for public lighting	Total rev. per unit.	Total cost per unit.	Working profit. Total.	Working profit. % to mean capital	Ord. div.
1896	7,904	154,200	...	87,984	4·42d.	5·13d.	-£456	-0·92	nil
1897	10,137	234,074	27,116	78,624	5·38d.	4·17d.	1,778	3·13	nil
1898	20,000	423,057	179,844	83,459	4·3·d.	2·92d.	2,533	3·80	nil
1899	22,000	523,829	244,287	84,192	4·07d.	2·59d.	3,239	4·43	3%

The Folkestone Electricity Supply Co. (Ltd.).

Our second table refers to a very near neighbour of Dover—viz., Folkestone. The accounts which are summarised cover the period of a year and a fraction between the date of commencement of working and December 31 last.

A very superficial study of our analysis is necessary to show how rapidly this undertaking has reached a satisfactory position. In the first complete year of working the cost sheet presents a most gratifying aspect considering the low output (303,116 units sold) and load factor (6·5 per cent.) upon which the results were obtained. Among the items of works costs and management charges, there is not a single one which to us does not appear to stand well below the average under similar conditions.

In view of the very moderate average revenue received per unit the working profit of £2,084, representing 3·99 per cent. of the mean capital expended, is a most creditable performance. We should like to have seen something more substantial put by to reserve before the distribution of a dividend like 4 per cent. As it is, nothing having been paid in 1898, the call made upon last year's gross profit was only about £42, since £405 was brought forward from the preceding year, and more than covered the £400 placed to reserve. The dividend absorbed £1,900, leaving about £142 balance carried forward;

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	DOVER.		FOLKESTONE.	
Undertaking Worked by	Dover Electricity Supply Co. (Ltd.)		The Folkestone Electricity Supply Co. (Ltd.)	
Date of Commencement of Supply	April, 1895.		November, 1898.	
System of Supply	High-pressure alternate-current sub-stations[a]		Three-wire continuous-current.	
Chief Engineer	L. W. Woodman.		T. Hesketh.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.***	DEC. 31, **1899.**
QUANTITIES—				
Units generated	514,340	627,398	—[a]	373,393
" SOLD (TOTAL)	423,057[b]	523,829[k]	74,577	303,116
" sold to consumers	159,754[c]	183,440[c]	74,577	209,931
" sold for public lighting, &c.	83,459	84,192	—	93,185 (estimated)
" used on works	10,437	9,342	500 (estimated)	70,277
UNITS SOLD PER 8 C.P. LAMP CAPACITY	25·8	31·9	4·70	18·9
Maximum supply demanded	355 kilowatts	273 kw. lighting, 175 kw.	—	529 kilowatts
Number of public lamps	40	40 [trac.	64	64
Number of consumers	165	200	90	80
Connections to mains in 8-c.p. lamps	20,000	22,000	10,089	17,834
CAPACITY OF PLANT IN 8-C.P. LAMPS	16,400	16,400	16,020	16,020
CAPACITY OF PLANT IN KILOWATTS	525	525	513	513
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£75,000 / £143	£75,000 / £143	£50,000 / £97·5	£50,000 / £97·5
Share	50,000 / 95·2	50,000 / 95·2	50,000 / 97·5	50,000 / 97·5
Loan (including Debenture charges)	25,000 / 47·6	25,000 / 47·6	— / —	— / —
RECEIVED (TOTAL)	49,300 / 93·8	75,000 / 143	34,734 / 67·8	49,963 / 97·4
Share	24,300 / 46·3	50,000 / 95·2	34,734 / 67·8	49,963 / 97·4
Loan (including Debenture charges)	25,000 / 47·6	25,000 / 47·6	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	25,700 / 49·0	nil / —	15,266 / 29·8	37 / 0·072
Share (unissued)	25,700 / 49·0	nil / —	nil / —	nil / —
Share (uncalled)	nil / —	nil / —	15,266 / 29·8	37 / 0·072
Loan (including Debentures)	nil / —	nil / —	— / —	— / —
REPAID (TOTAL)	nil / —	nil / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	—[l] / —	— / —	— / —
DEPRECIATION FUND	166 / 0·316	416 / 0·793	— / —	— / —
EXPENDED (TOTAL)	70,484 / 134	75,899 / 145	41,568 / 81·0	62,968 / 123
Lands and buildings	14,981 / 28·5	15,252 / 29·1	6,622 / 12·9	10,879 / 21·2
Plant	35,580[f] / 67·8	39,752 / 75·8	16,789[b] / 32·8	25,068 / 48·9
Mains	19,234 / 36·6	20,206 / 38·5	17,555 / 34·2	25,873 / 50·5
Miscellaneous	689 / 1·31	685 / 1·30	600 / 1·17	1,148 / 2·24
BALANCE OF CAPITAL ACCOUNT	−21,184[g] / −40·4	−899[g] / −1·71	−6,833[c] / −13·3	−13,006[c] / −25·4
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£7,685 / 4·360d.	£8,885 / 4·072d.	£1,482 / 4·771d.	£5,777 / 4·575d.
Revenue from supply	6,157 / 3·490d.	7,281 / 3·336d.	1,452 / 4·675d.	4,144 / 3·282d.
" meters, &c.	144 / 0·082d.	180 / 0·083d.	26 / 0·084d.	166 / 0·132d.
" public lighting	1,182 / 0·671d.	1,179 / 0·541d.	— / —	1,441 / 1·141d.
" sale of lamps, &c.	— / —	150 / 0·069d.	— / —	20 / 0·016d.
" miscellaneous sources	202 / 0·115d.	95 / 0·044d.	3 / 0·010d.	5 / 0·004d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£5,152 / 2·922d.	£5,646 / 2·587d.	£1,076 / 3·464d.	£3,472 / 2·750d.
WORKS COSTS	4,357 / 2·472d.	4,845 / 2·220d.	699 / 2·250d.	2,350 / 1·861d.
Generation of electricity	*3,959 / 2·246d.*	*4,404 / 2·018d.*	*643 / 2·070d.*	*1,904 / 1·508d.*
Fuel (including cartage, &c.)	2,397 / 1·360d.	2,580 / 1·183d.	422 / 1·358d.	1,138 / 0·902d.
Oil, waste, water, stores	115 / 0·065d.	145 / 0·066d.	55 / 0·177d.	74 / 0·059d.
Wages at station	979 / 0·556d.	1,047 / 0·480d.	166 / 0·535d.	559 / 0·443d.
Repairs and maintenance at station	324 / 0·184d.	493 / 0·226d.	— / —	134 / 0·106d.
Distribution of electricity	*232 / 0·132d.*	*266 / 0·122d.*	*49 / 0·158d.*	*120 / 0·095d.*
Wages, &c.	189 / 0·107d.	247 / 0·113d.	49 / 0·158d.	100 / 0·079d.
Repairs, renewals of mains, &c.	43 / 0·024d.	19 / 0·009d.	— / —	21 / 0·017d.
Public lighting	*166 / 0·094d.*	*175 / 0·080d.*	*7 / 0·023d.*	*326 / 0·258d.*
Attendance	74 / 0·042d.	68 / 0·031d.	7 / 0·023d.	260 / 0·206d.
Renewals	92 / 0·052d.	108 / 0·050d.		66 / 0·052d.
MANAGEMENT AND PROPERTY CHARGES	795 / 0·451d.	801 / 0·367d.	377 / 1·214d.	1,122 / 0·889d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*137 / 0·078d.*	*137 / 0·063d.*	*13 / 0·042d.*	*145 / 0·115d.*
Management	*658 / 0·373d.*	*664 / 0·304d.*	*364 / 1·172d.*	*977 / 0·774d.*
Salaries	319 / 0·181d.	336 / 0·154d.	279 / 0·899d.	771 / 0·610d.
Stationery, &c.	77 / 0·044d.	70 / 0·032d.	71 / 0·229d.	81 / 0·064d.
Establishment charges	161 / 0·091d.	190 / 0·087d.	14 / 0·045d.	110 / 0·087d.
Law charges, &c.	101[h] / 0·057d.	68 / 0·031d.	— / —	15[d] / 0·012d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.
WORKING PROFIT FOR YEAR	£2,533 / 3·80%	£3,239 / 4·43%	£405 / 0·974%	£208[e] / 3·99%
Sum carried to Depreciation Fund	400 / 0·60%	500 / 0·683%	— / —	— / —
Sum carried to Reserve or Sinking Fund	nil / —	nil / —	— / —	400 / 0·765%
Net interest on loans (incl. Debenture charges)	2,509 / 3·77%	1,414 / 1·93%	— / —	47 / 0·090%
BALANCE FROM LAST ACCOUNT	−3,725 / −5·60%	— / —	— / —	405 / 0·775%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	1,326 / 1·81%	405 / 0·974%	2,042 / 4·67%
Deficit	*4,101 / 6·16%*	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	3% / —	— / —	4% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	67·1%	63·6%	72·6%	60·1%
Expenditure per kilowatt capacity	£9. 16s. 2d.	£10. 15s. 0d.	£2. 2s. 0d.	£6. 15s. 5d.
REVENUE PER KILOWATT CAPACITY	£14. 12s. 7d.	£16. 18s. 0d.	£2. 17s. 10d.	£11. 5s. 0d.
Expenditure per 8-c. lamp capacity	6s. 3½d.	6s. 10½d.	1s. 4d.	4s. 4d.
REVENUE PER 8-C.P. LAMP CAPACITY	9s. 4½d.	10s. 9¾d.	1s. 10¼d.	7s. 2½d.
REVENUE PER 8-C.P. LAMP CONNECTED	6s. 11¾d.	8s. 0¾d.	2s. 11¼d.	6s. 5¾d.
Price charged for lighting, per unit	7d. to 3d.[i]	7d. to 3d.[i]	7d., 4d. and 2d.	7d., 4d. and 2d.
Price charged for power, per unit	6d. to 3d.[j] [per ann.	6d. to 3d.[j] [ann.	—	7d. to 1d.[f]
Price charged for public lighting	£29. 10s. 10d. per lamp	£29. 10s. per lamp per	—	3·72d.

DOVER.—REMARKS—*a* With continuous-current plant for the tramway supply. *b* Includes 179,844 units to tramways. *c* Exclusive of output to tramways. *d* Of which 155 kilowatts is by tramways. *e* Being the equivalent in lamps of 12,560 8-c.p. lamps, and the (estimated) equivalent in motors for traction of 8,000 8-c.p. lamps. *f* Including £1,567 on street lamps and £7,867 on "traction, plant and machinery, including connecting mains and electrical instruments." *g* Over-expended. *h* Includes £40 to auditing and £61 to "law charges, insurance and royalties." *i* Maximum demand system, 1½-hour scale. *j* Maximum demand system, 1-hour scale. *k* Includes 244,287 units to tramways. *l* The suspense account has a debit balance of £3,813.

FOLKESTONE.—REMARKS—* For the *period* ended Dec. 31, 1898. *a* Figures not available; no station meters fixed. *b* Includes £1,508 on accumulators and £1,318 on meters. *c* Over-expended. *d* Auditing. *e* After deducting £221 preliminary expenses. *f* On max. demand system: 1 hour scale.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,
1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.
Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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THE "JAMES FORREST" LECTURE FOR 1900.

SIR WILLIAM PREECE delivered, on Monday evening last, the eighth of the series of "James Forrest" lectures before the Institution of Civil Engineers. He took for his subject "The Relations between Electricity and Engineering." The discourse, which was illustrated by numerous experiments and lantern slides, occupied somewhat longer than the allotted hour; but even this interval was all too short for the adequate consideration of so ramified an engineering topic. The prodigious task of recounting the relations of electrical science and practice to engineering is not one that can properly be performed in a single lecture of only an hour's duration. Doubtless the lecturer felt this as keenly as the most sympathetic of his hearers, for he abandoned from the outset all attempts to discuss the subject on the philosophical basis of broad principles, and confined his discourse almost exclusively within the limits of a category of the miscellaneous uses to which electricity has been, and in future may be, put to achieve engineering results. We confess to feeling disappointment at his choice, but the treatment he adopted was one that probably was best suited to his favourite style, and it certainly lent itself more readily to a popular review of the subject. Nevertheless, we hope that at some future date a "James Forrest" lecture will be given in which there shall be discussed on logical, rather than historical, lines the interconnection between electrical means and engineering achievements. Not that the fundamental phenomena of electricity were passed unnoticed by the lecturer. On the contrary, to many electrical engineers present, accustomed as they are to hear recondite matters of electrical practice discussed between the same four walls, the preliminary display of experiments may have appeared childishly simple. These, however, should reflect that the audience was composed mainly of civil engineers—men who, perhaps, had spent all their long lives in building docks and canals, and who hitherto had missed every opportunity of seeing a magnetised poker pick up iron nails. But it certainly was irresistibly comical to see a select group of some six or seven of these venerable gentlemen crowd in front of the lecture table round a bit of platinum wire, striving to discern its ineffectual radiance, while over their heads the electrolier

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shone brilliantly by the selfsame world-familiar process. What need of ruddy-glowing platinum wire amid such a profusion of carbon filament?

Our abstract of the lecture, printed on another page, will enable readers who were not present to learn its contents and scope. We need not summarise all those contents here, but different sections of our readers will be interested in various ways by the following statements, among others, made during the discourse. *Apropos* of alternating currents, the lecturer observed that "MAXWELL proved the identity of electricity and light by showing that they moved through the ether with the same velocity." The same physicist, he said, had pronounced the discovery of the reversibility of the dynamo to be "the greatest invention of the century." Of the extensiveness and ease of applied electricity, no man holds higher opinions than Sir WILLIAM PREECE: "No magician or poet," he said, "ever conceived so potent a power within the easy reach of man." Under the somewhat startling heading, "The Annihilation of Space," the lecturer referred to several applications of electricity familiar even to budding civil engineers: "Sitting on the shores of the Atlantic in Ireland, one can manipulate a magnetic field in Newfoundland so as to record simultaneously on paper in conventional characters slowly written words. Thus we have bridged the ocean and annihilated space. We do this on a smaller scale in our own domestic circles." While thus dealing with telegraphic matters, the lecturer made the announcement that "the Post Office is using aluminium for telephone circuits," and that he had "recommended its use on a very large scale in the interior of Africa." Incidentally, he stated his belief that the "Cape to Cairo" telegraph line would be ten times better if of aluminium than of iron. We must not omit reference to a novel theory of electrolysis which, we feel sure, will interest our electro-chemical readers. Referring to the action of an electric current upon various conductors, the lecturer said that "in liquid conductors the motion probably becomes revolution. The result is decomposition by the activity of the centrifugal force overcoming chemical affinity. The atoms fly away in fixed determined lines and collect at opposite poles." With regard to wireless telegraphy, Sir WILLIAM stated that there was "no commercial business in it," and that the Post Office had been developing it for 16 years and several extensions were now in hand. Mr. C. E. GROVE recently read a voluminous and comprehensive Paper on "The Electrical Equipment of Ships of War," before the Institution of Electrical Engineers. This Paper is now appearing serially in our columns. Sir WILLIAM PREECE compressed the whole of this subject into the following short paragraph:—

> The battleship is the home of electricity. It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the fans, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the search light, and to communicate with his tender or with his commanding officer across space independent of weather, night, season, fog or rain.

Our readers will find it of no little interest to compare these statements with what Mr. GROVE has said on the same subject.

These few quotations will serve to indicate not only the extensive scope, but also the novel treatment adopted by the lecturer. We observed a fair sprinkling of electrical engineers in the audience. These, notwithstanding the elementary nature of the early part of the discourse, must all have felt when the lecture was ended that they had heard many things they had never heard before, and had had presented to them in an altogether novel light many of the familiar everyday facts of electrical engineering.

ELECTRICAL CONDUCTORS AND DIRT.

BY A. A. CAMPBELL SWINTON.

Everyone must have noticed how electrical wires and fittings gather dust. Hot-water pipes have a similar tendency, and for a long time I was of the opinion that the action was similar in both cases, and was due to air currents produced by heat. Recently, however, I have had reason to alter my views, and the matter appears to be of sufficient interest for detailed description.

In a new office I have now occupied for five months there are in my own room five plain pendant fittings. As the ceiling is of concrete, and as it was necessary not to disturb the tenant above, these pendants all consist of plain flexible cords of the usual twisted pattern, which start from ceiling roses on the wall near the cornice, and are led through insulated eyes across the ceiling to the points from which they hang. The supply is the continuous-current supply of the Westminster Co. at 200 volts. Three of the pendants are upon one switch, the two others being upon another switch. Of the set of three, two are of 16 c.p. and one of 32 c.p. I mention this latter fact, though it has nothing to do with the phenomenon observed. All the lights are in practice used at once, so that in this respect the conditions are the same in each case. The following, however, are the results, which are sufficiently remarkable to deserve notice.

Within a week or two of my entering into occupation of the office and using the lights it was observed that, whereas the three flexible cords connected with one switch remained clean, the two cords on the other switch were rapidly accumulating dust. The latter were repeatedly dusted, but the effect always repeated itself. At present, after some five months use, while the one set of three cords are still comparatively clean, never having been dusted, the other set of two cords are thickly covered with an aggregate of dust particles, which in some places project fully one quarter of an inch from the cord. Further, while the plaster of the ceiling in the case of the set of three cords is absolutely white, and the ceiling roses at the ends of these cords retain their original colour, the ceiling immediately above the set of two cords is blackened with a well-defined broad dark line, while the ceiling roses that serve these two cords are also covered all over with a dark deposit.

Now for the reason of this strange phenomenon. It is very simple. In the case of the set of three pendants the flexible cords and ceiling roses of which do not become dirty, the switch is in the positive pole. In the case of the other set of pendants, whose cords and roses become covered with dust, and which even blacken the ceiling with which they are not in contact, the switch is in the negative pole. Now, as is well known, the negative conductor in the street mains has a tendency to earth itself to an extent which is sufficient to cause the negative lead to be always almost at the same potential as earth. Consequently, the positive conductor is always at nearly 200 volts potential above that of earth, and therefore above that of the dust particles present in the atmosphere. This point has been tested in my office with a voltmeter, with the results that from the negative there are only about 30 volts to earth, while from the positive there are 170 volts to earth. The reason for the effects observed is thus obvious. In the case of the three pendants, whose switch is in the positive, it is only when the switch is turned on a few hours per diem out of the 24 that there is any appreciable difference of potential between the cord and the surroundings. Even then it is only one conductor in the cord that has this potential, and the exterior of the covering very possibly always retains zero potential. In the case of the other set of two lamps, whose switch is in the negative, the result is far different. When the switch of this set is turned on, no doubt the conditions are similar to the other set when the latter's switch is also turned on. But during the many hours every day when the switch is turned off, in the case of the two-light set, both of the conductors remain constantly at a potential 170 volts above that of its vicinity. The dust is therefore caused to deposit upon the cord and upon the ceiling rose by electrostatic attraction. No doubt the use of 200 volts, which will

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give four times the attraction afforded by 100 volts, has made the effect more marked in this particular case.

I should not have thought it worth while bringing the above facts forward publicly had they not been so marked as to be a serious nuisance in the case of the pendants whose switch is in the negative. From the point of view of the wiring of decorated rooms in a town with an atmosphere like London, the matter is of very considerable importance. It will be found that with the switches in the negative, an amount of dirt will be deposited in a few weeks that would take years to accumulate with the switch in the positive. I am well aware that from a totally different point of view, in damp situations, there is an advantage in putting the switch in the negative, for the reason that otherwise the metallic mechanism of the switch is liable to be corroded away by electrolytic action. In dry places, however, where it is desired to keep electrical wires and fittings clean, I have no doubt that in an atmosphere such as we have in this great city, switches should always be placed in the positive conductor, so that the exteriors of such fittings and wires should remain as far as possible at earth potential.

AUTOMOBILE BATTERIES.

In view of the increasing attention which is being paid to the employment of accumulators for electric traction, or, as Herr Vollmer prefers to call it, "accumobilimus," he has devoted an article in No. 7 of the *Centralblatt für Accumulatoren und Elementenkunde* to discussing the relative merits of the Planté and the plug plates for particular classes of work. The Planté type possesses the great advantage that it can be discharged at a very high rate when necessary without any loss of economy, and it can also be charged very rapidly, so that a battery of 80 ampere-hours can be charged in 15 minutes. It has also a somewhat greater durability, but these advantages are counterbalanced by the great weight of the cell, its large volume, and its small capacity. Taking the lightest type of these cells, weighing 18 kilogrammes each, then the total weight of the 44 cells required to propel a vehicle to carry four persons would be 572 kilogrammes, and its capacity of 80 ampere hours at a three hours discharge rate would be about 6·15 ampere hours per 1 kilogramme of total cell weight, and about 12·8 ampere hours would be yielded per 1 cubic dcm. of the space occupied by the battery, while the distance which could be travelled by such a carriage without recharging the battery would be about 25 to 30 kilometres under the most favourable conditions.

The properties of the plug accumulator are almost the exact reverse. With smaller volume and weight it possesses a very much greater capacity, but its discharge rate is very low, and if this is exceeded at all, the capacity and durability of the cell are quickly injured. The time required for charge is very long; for instance, it would take a battery of 80 ampere-hours' capacity fully 4 to 5 hours to charge it. This disadvantage is got over by calculating the amount of current required at the normal five-hour discharge rate of the battery for the normal rate of speed of the vehicle, and determining the size of the battery from this. Assuming as before, a capacity of 80 ampere-hours at a three-hours' discharge rate, we find that the battery would have the following proportions:—

Total of 44 cells at 10 kilogrammes each	440 kilogrammes.
Capacity per 8 kilogrammes cell weight.....	8 ampere-hours.
Capacity per cubic decimetre cell volume	21·4 ampere-hours.

Provided with such a battery a four-seated carriage would travel 40 to 45 kilometres for each charge, because the vehicle would be lighter on account of the smaller weight of the battery.

From a comparison of these data, the superiority of the plug accumulator over the Planté is at once apparent, but when the life of the accumulators is taken into account, then the Planté are the most economic, as they will yield about 200 discharges, while the most that can be obtained from the plug accumulators are 150. With regard to the size of the batteries it may be mentioned that the best results which have been as yet obtained from automobiles show that they require 80 to 85 watts per ton-kilometre-hour on good level roads. When the working conditions are known, the type of accumulator to be employed can be easily determined from the foregoing considerations, the Planté cells having the advantage when the demand for current is high but the distance to be travelled is not great, while the pasted plates are most suitable for light running vehicles used for pleasure where economy is not an important consideration.

THE RELATIONS BETWEEN ELECTRICITY AND ENGINEERING.*

BY SIR WILLIAM H. PREECE, K.C.B., F.R.S.

The nineteenth century is distinguished in our profession chiefly by the knowledge we have obtained of the constitution of *matter* and of the qualities of the materials we utilise for the service of man, of the presence and characteristics of that medium—*the æther*—which fills all space, and of the existence indestructibility and protean character of that great natural source of force, motion, work and power which we call—*energy*. Electricity is only one of many forms of this energy. It is measurable in well-defined and accurately-determined units. It is produced and sold, utilised and wasted. It is therefore something distinctly objective. It has even been defined by Act of Parliament. There are four great principles underlying the practical applications of electricity: I. The establishment of a magnetic field. II. The establishment of an electric field. III. The disturbance or undulation of the æther. IV. The work done by the generation and maintenance of electric currents in material systems. It will smooth our journey over somewhat difficult ground if I commence by illustrating these principles with some elementary experiments.

When the current is alternating it is always either rising or falling and changing its direction. The behaviour of alternating is more complicated than that of continuous currents, but each are subject to well-known conditions and to simple mathematical treatment. Each has its own particular sphere of usefulness. Some of the energy is wasted in the form of heat in the conductor, in the dielectric, and in the iron; some in the neighbouring conducting mains, and some is conveyed away—dissipated in limitless space. Alternating currents differ in their frequency. Those generated at Niagara pass through each cycle 25 times per second. The favourite frequency in the United Kingdom is 50, but many installations in the United States reach as high as 130. These frequencies in closed circuits can, however, be increased to millions per second in open circuits. In fact, Maxwell proved the identity of electricity and light by showing that they moved through the æther with the same velocity—196,400 miles per second—and in the same undulatory fashion. If the alternations could be generated with a frequency of 50 billions of waves per second we should see electric waves as light rays. Electric waves and light waves differ only in their length. Hertz detected and measured these electric waves. Attempts have been made to utilise them, but so far not with much practical success.

If a conductor itself be free to move, and a magnetic field be projected through it while it is maintaining a current, it is forced into motion, and it becomes a rotating machine or *motor*. The electric energy of the current is transformed into its mechanical form. Its torque, or turning moment, depends upon the intensity of the magnetic field, on the length of the conductor, and on the strength of the current. This reversibility of the dynamo is of immense commercial value. Maxwell said it was the greatest invention of the century. Tram cars in our streets, trains on our railways, tools in our shops, and mills in our factories, are thus worked by electricity. Dynamos and motors are subject to laws and conditions so thoroughly well known that exactness is assured and waste reduced to a minimum. There is no more perfect machine than a dynamo. Motors are nearly as good. Electricity as a science is fascinating to everyone, but it is deeply fascinating to the engineer. No magician or poet ever conceived so potent a power within the easy reach of man.

The Doing of Work.—The maintenance of an electric current through a conductor means the expenditure of work upon that conductor, and this expenditure of internal work means molecular motion. In solid conductors the result is *heat*. If the current be gradually increased, this motion is similarly increased. The result is successively incandescence, white heat, fusion, and disruption. In liquid conductors the motion probably becomes revolution. The result is decomposition by the activity of the centrifugal force overcoming chemical affinity. The atoms fly away in fixed determined lines, and collect at opposite poles. In gases the transference of electric energy in the form of sparks means dissociation. Compound

* Abstract of the Eighth "James Forrest" Lecture, delivered before the Institution of Civil Engineers, April 23.

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gases are broken up into their component elements under the same directing influences. Work is done upon the gas as in the previous instances. Joule established the law of the relations of current and heat upon a definite and accurate basis. Faraday developed the laws of electro-chemistry with equal exactitude. Prof. J. J. Thomson has determined the action of currents on gases. The principle of work that lies at the very root of the profession of the engineer enables all these operations to be measured in definite mechanical units.

The Purification of Matter.—The elements and their useful compounds are rarely, if ever, found pure. Impurities have to be sifted away. According to Prof. Borchers, the eminent electro-metallurgist, the world manufacture of calcium carbide for the production of acetylene gas is utilising a power equal to 180,000 H.P., that of the alkalies and the combinations of chlorine for bleaching 56,000 H.P., of aluminium 27,000 H.P., of copper 11,000 H.P., of carborundum 2,600 H.P., and of gold 455 H.P. Electroplating is one of the staple manufactures of Sheffield and of Birmingham. There are nearly 200 firms working at the former place, and over 100 at the latter. The decomposing bath and the arc furnace are revolutionising many industries. Phosphorous is now being produced in England in large quantities from corundum, and aluminium from bauxite is extending in use and being reduced in price. The Post Office is using aluminium for telephone circuits. I have recommended its use on a very large scale in the interior of Africa, where transport is so costly. We can get the same conductivity as with copper with half the weight, and at a less price, and we can put up a line telegraphically ten times better than of iron for less money.

The Annihilation of Space.—The elements of Volta and the battery of Galvani—zinc, copper and a solution of sulphuric acid—gave a convenient generator of electric currents which could be directed along wires to great distances, and thus, by establishing magnetic fields, could deflect needles in such a way as to form the alphabet and so transmit words and, therefore, thought. In wires of great length, while the initial speed is that of light, it takes time for the electric waves to rise and fall, so that the number of currents which can be sent per second is limited Between London and Liverpool the speed of speaking is virtually unlimited, but between Ireland and America it is restricted by the so-called *capacity* of the cable submerged in the ocean. This capacity absorbs energy and retards the rate of rise and fall of currents. While a thousand currents per second can be sent in the former case, only six per second are available in the latter. Nevertheless, sitting on the shore of the Atlantic in Ireland, one can manipulate a magnetic field in Newfoundland so as to record simultaneously on paper in conventional characters slowly written words. Thus we have bridged the ocean and annihilated space. We do this on a smaller scale in our own domestic circles when we press a button and ring a bell in our servants' quarters. The sound of a bell and the drop of an indicator is a message—"You are wanted in the drawing-room." When the button is supplemented by the telephone, as it is in so many houses now, you can speak your message, "We want coals," and thus the servant is saved two journeys, and you have gained some time.

The regulation of the ever-growing traffic on our railways and the safety of passengers is secured by similar means. The telegraph not only places the manager of the line in communication with every station upon his system but electric signals control the motion of every train. Trains are kept apart by a considerable space. Collision would be impossible were the human will infallible; but the world is made up very much of fools and temporary maniacs. We all do at times what we ought not to do. The annual return of violent deaths is an interesting document. When in England alone 138 persons choke themselves at their own tables, and 765 die by falling downstairs, we must not condemn the railway signalman, who is responsible for the death of only 58 in 1898. A railway signal-box is an electrical exhibition. Every line is protected by its own electric signal. Every distant outdoor mechanical signal is repeated back. The danger signal is locked and cannot be lowered to "line clear" until it is unlocked by the train itself or by the distant signalman. Mr. F. W. Webb is not only working the outdoor signals themselves by electrical energy, but he is moving the points and switches by the same means So far the experience gained at Crewe during a period of about twelve months, from the working of a signal cabin containing about 60 levers, has been such as to justify confidence and the extension of the system, and some ten cabins containing about 1,000 levers will be provided. The apparatus has been designed to work in with as far as possible the standard signalling apparatus of the London and North-Western Railway. The interlocking frames may be said to be the ordinary mechanical frame in miniature, occupying one-third of the space. The levers—about 6in. in length—are placed in two tiers, and are manipulated in the same way as the levers of a mechanical frame, consequently the signalman accustomed to the old type has nothing to learn in the new. The levers are mechanically locked by means of tappet locking, and they control carbon switches by which the 110-volt electric current is transmitted to the motors. The object of this electric working is primarily to reduce the manual labour of the signalman, and enable him to pay more attention to the movements outside his cabin; increased speed of working; the removal of obstructions on the ground caused by the numerous wire and rod connections necessitated by the present system; and, finally, a reduction in the number of signalmen employed.

Wireless telegraphy, or, as it is better termed, ætheric telegraphy, has made but small progress, owing to the simple fact that the demands for its services are so very few. There is no commercial business in it. The fascination of electricity and the sensation of breaking down space by apparent magical means have led to much gratuitous advertisement on the part of the Press. I wrote in 1888, "The influence which electric currents exert on neighbouring wires extends to enormous distances, and communications between trains and ships in motion, between armies inside and outside besieged cities, between islands and the mainland, has become possible without the aid of wires at all by the induction, which is exerted through space itself." The Post Office has for 16 years been developing this system. Several extensions are now in hand.

Transmission of Power.—It is not considered advisable to construct dynamos giving higher voltages than 2,500 volts, although in many cases 5,000 volts are produced; but these high voltages are easily and safely converted by transformers to any other higher pressures. Energy is also transformed in its continuous form by rotary converters, but in this case the process is usually the reverse. Direct continuous currents of 100 amperes and 3,000 volts are reduced to 500 volts by acting as motors to rotate generators, giving 600 amperes, for, say, tramway working. Again, at Tivoli, 18 miles from Rome, the energy of the falling water there is transmitted to Rome in the form of alternating currents at 6,000 volts, and is there converted by rotary transformers into direct currents at lower voltages for battery, traction, and motive purposes.

The sun is the *fons et origo* of all the available energy upon the surface of the earth. Coal and oil are extracted from its crust; oxygen is found in its atmosphere. Grasses, corn, fruits, and vegetables become food and fuel for beast and man. Waters are converted into vapour, forming clouds, rain, brooks, rivers, torrents, and falls. The atmosphere is disturbed by wind, and the waters of the ocean by tides. Energy is thus found available for useful work in many different forms. The problem before the engineer is how to utilise these waste energies of Nature so as to secure the best economical result. Falling water can, by a turbine or impulse wheel, convert the energy it possesses in virtue of its fall into the form of electricity. By the aid of transformers it can be raised to very high voltages; 40 000 volts is employed in California, 11,000 in Niagara. We use 10,000 between Deptford and Trafalgar-square. It can thus be transmitted to any reasonable distance, and there it can be utilised to do useful work. The waste forces of Nature are thus within our reach. The waterfalls of the Highlands may work the tramways of Glasgow; Niagara already works those of Baltimore.

We underrate very much the progress made in the United Kingdom in different industries, owing to the secretiveness of the British manufacturer. He will not report what he is doing in the Press, and the Press leaves him severely alone. Electricity as an economiser, by increasing the speed of output and by reducing waste, is as much at the disposal of the British as of the American manufacturer. But John Bull clings with affectionate and conservative fervour to the capital expended by his grandfather, while Uncle Sam does not hesitate to chuck obsolete plant on the scrap heap if, by doing so, he can increase his business. Progress in the States is also not so seriously checked by trades unionism as it is here. I am told that the Bricklayers' Union in England limits a man's daily work to laying 400 bricks, while in the States he does 1,200! This limiting of the output of labour is a much more serious tax on the nation than a war tax. It drives trade out of the country; it restricts the intelligence and lowers the tone of morality of our working classes. It is a disease to be grappled with.

Traction.—It is for traction purposes that electricity is making such gigantic strides. In the United States tramway working by its means has become practically universal. In the United Kingdom it is making rapid way, and in connection with electric lighting it is giving great economical results. The combination of the two systems is most effective. In St. Helens, in Lancashire, where 13,435 8 c.p. lamps are connected, and a small tramway system of nine cars simultaneously running is at work, the works costs have been brought down from 3·23d. per unit to 0·67d. per unit. The price for electric light has been reduced from 6d. to 4½d. per unit, and it will probably be lowered to 3½d. This is after only 8½ months' working. St. Helens is an object lesson to all municipalities, especially to Glasgow, where a very false start has been made. Electric railways are also growing apace. A bold attempt is being made by the metropolitan railways to work the existing line in such a way as not to interfere with the existing traffic or even with the permanent way. A new train of six coaches weighing 180 tons, having a motor car at each end weighing 54 tons, is about to run between Earl's Court and High-street, Kensington. Each motor car is mounted on bogies, and each bogie has two electric motors, so

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that there are eight driving wheels, each bearing 6·75 tons. The driving wheels have diameters of 47in. The length of the train is 240ft. Each motor is rated at 200 H.P, or a total of 800 H P. for each motor car. But there is a wide margin, and we have already applied 950 H.P. in starting a load of 270 tons on the incline of 1 in 43. Electric traction has an immense advantage over steam traction in impressing a continuous and uniform torque or turning moment on the shaft, and consequently a continuous and uniform effort on the trend of the wheel. The action of the steam locomotive is intermittent and the bite not continuous. Hence such frequent slipping on greasy rails. Again, the maximum torque can at once be applied by the current, and, in combination with the constant effort, it increases the acceleration so that a train acquires its maximum speed much more quickly. We shall increase the mean speed of the metropolitan trains from 11 miles per hour to 15, and thereby increase the capacity of the line over 30 per cent. The stoppages on the underground railways are so frequent that the trains are always either accelerating or stopping. They never reach their top speed as they do on main lines. Electric traction enables them to start quicker and stop more promptly. On the Metropolitan the 180-ton train acquired 20 miles an hour in 200ft., and, when going at the same speed, it was stopped in 130ft.—half its length. Smart work on such a railway depends on the rate at which trains can be emptied and filled. The English system of compartments and side doors facilitates this. It would be still further expedited if we could have one platform for entry and one for exit, and one class only.

The Liverpool and Manchester Lightning Express Railway, promoted by a very powerful representative syndicate of these two great commercial centres to carry out the scheme of Mr. Behr, is a very bold and promising venture. The line is to be monorail, 31 miles long, direct between the two cities, without any intermediate station and with no crossing. There are to be cars every ten minutes. The speed is to be 100 miles per hour, and the time of transit 20 minutes. I know of no reason why this should not be done with safety and comfort.

The automobile car of the future has not yet seen the light. It will be electrical. Immense progress has been made in motors and in batteries. Lundell has shown how to store up the energy now wasted in descending hills, and to recover some of that absorbed by the inertia of the car. Although a battery has already been able to drive a car 100 miles with one charge, we are waiting patiently for the real automotor storage cell.

Electricity in War.—A strong contingent of electrical engineers has volunteered for service in South Africa. They are all scientifically-trained practical young engineers. Bicycles, field telegraphs, telephones, arc and glow lamps, cables, search lights, traction engines, and generating plant will be under their care.

Electricity has been extensively applied to the development and utilisation of explosives in both the civil and military divisions of our profession. Charges are safely fired under water and blasted in mining and demolition operations by small exploding dynamos, magnetic-electric machines or induction coils acting upon high tension fuses. Our Honorary Member, Sir Frederick Abel, has especially distinguished himself in this direction. His fuse, composed of phosphoride and subsulphide of copper, is universally used by our War Department. Time guns are thus fired at stated hours at different sea-ports by currents originating in Greenwich Observatory. Broadsides in battle-ships and guns in turrets are similarly discharged. Torpedoes are even directed by currents from the shore. The defence of our coasts by submarine mines and their explosion by currents when the enemy's ships are properly located by position-finders is the last development of the application of electricity to war. Electrical blastings has revolutionised the operations of tunnelling and driving galleries. It is much used in quarrying with great security to the men. The deepening of harbours and channels and the removal of obstructions such as wrecks and rocks are facilitated.

The battle-ship is the home of electricity. It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the fans, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the search-light, and to communicate with his tender or with his commanding officer across space independent of weather, night, season, fog, or rain.

Sanitation.—No branch of our profession fulfils the true function of the engineer more efficiently than that which deals with sanitation. Pure air, pure water, pure food, pure soil, pure dwellings, and pure bodies are the panacea for health and comfort. Electricity helps us very much in attaining some of these qualities. An electric glow-lamp does not vitiate the air. It does not throw into circulation in the air any product of combustion. The question of ventilation is very much reduced in importance and rendered more simple to effect. Much less air need pass through our sitting-rooms and meeting-places. The air vitiated by our lungs can be easily withdrawn and fresh air can be forced in by fans worked by electric motors. Even the air during its entrance can be warmed, and impurities floating in it can be sifted out of it by the attraction of electrification. Heating by Dowsing's luminous electric radiators is very much on the increase; they consume 250 watts, which cost about ½d. per hour. In many post-offices sealing wax is melted and kept in a liquid state by currents. Water can be sterilized by ozone, a product of electrification, and even by the nascent oxygen, when broken up into its constituent elements by electric currents. Sea-water thus electrolysed supplies us with chlorine, and converts the water into a powerful antiseptic, disinfectant, and deodoriser. Its economy is, however, doubtful, and in consequence its adoption has been much restricted.

Industries.—The applications of electricity to other industrial processes are innumerable. I have time to mention only one. Mr. T. A. B. Carver, who was a pupil of Lord Kelvin and an officer on our staff in this Institution, has brought out a new Jacquard loom for weaving; 600 hooks are controlled electrically. The twill as well as the pattern is under complete management. It has been warmly taken up in Glasgow, and a factory has been started there. The pattern on this cloth is woven directly from a photo-print of the artist's design, mounted on a metallic sheet. The threads of the warp being picked up by electromagnetic action, owing to the figure of the pattern being cut away, and thus allowing the circuit to be completed by the metallic sheet.

THE PROTECTION OF PUBLIC BUILDINGS FROM LIGHTNING.

On Monday last Mr. Killingworth Hedges, who has recently been advising on the re-arrangement of the lightning conductors on St. Paul's Cathedral, read a Paper on the above subject before the Royal Institute of British Architects. He quoted from a Paper read before the same Institute by Col. the Hon. Arthur Parnell in 1884, in which an analysis of a number of disasters to buildings fitted with lightning rods showed that there were 828 separate instances of mechanical force, as against only 228 of heat, exercised on various substances by lightning. Mr. Hedges also repeated Dr. Lodge's statement that the problem does not end with the actual rod, owing to the large difference of potential existing between the conductor and earth, however well the two are connected. He expressed himself in agreement with Dr. Lodge as to the oscillatory nature of the discharge, and expressed the view that the side flash was the result of self-induction in the conductor. On one matter, however, Mr. Hedges' theory was somewhat remarkable. He considered that when a discharge occurred at one point between the thundercloud and earth, a corresponding discharge occurred in the reverse direction at another point of the cloud. He referred to these as the "downward" and "upward" discharges, and stated that he had frequently seen in Colorado "upward" flashes arising from the ground! In connection with available reports and statistics of lightning accidents, Mr. Hedges regretted that no official reports of this nature had been published since that of the Lightning Rod Conference in 1882.

Not the least interesting part of Mr. Hedges' Paper was a description of the lightning conductors attached to several important buildings abroad. On the Notre Dame Cathedral, in Paris, the main conductors are three in number, each of the two on the towers commencing at a massive wrought-iron terminal rod about 20ft. high and 4in. square at the base. To this a wrought solid iron rod about 1in. square is secured by straps, and run in lengths, jointed at intervals, over the roof and outside the tower to the ground. This rod is supported about 7in. from the lead roof and stonework by stanchions insulated by half-round stone or porcelain insulators secured by shackles. At a later period a copper strip had been connected to each of the conductors at the roof and run independently to the ground below. The spire has an elaborate finial with numerous points and this appears to be connected to earth in a similar manner, and also to the crest running along the ridge of the roof. The speaker considered this method of protection to be a source of danger at present. The flash received by one of the main rods had two paths open, one by the old iron conductors and a second by the new copper band. The current could be prevented from dispersing over the lead roof by the insulators of the conductors, and owing to the resistance of the joint would consequently jump from the central rod to the small copper one.

On the Cologne Cathedral he considered the protection far more advanced than that of Notre Dame. Stranded copper cables are used, run through galvanised iron stanchions with flat feet by which they are bolted to the stonework. To avoid galvanic action, the eyes of these supports are bushed with lead. They keep the conductor about 7in. away from the structure so that the cable can be stretched tight by tightening screws and not run round projections. A somewhat similar arrangement is used for the horizontal conductors which run each side of the roof and are kept away from it. The terminals of

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the lightning rods, Mr. Hedges continued, were almost always plain spikes without branches, but German buildings had many of these both on the highest portions and along either the tops of the walls or ridge of the roof, the whole being connected together by a horizontal conductor run in the method described. A timber shed near Frankfort had these vertical rods about 15ft. apart and a petroleum storage tank at intervals all round its circumference.

The lightning conductor of the Palais de Justice of Brussels is very similar to that of the Hotel de Ville, which has been described in text-books. It is on the Melsen system, and consists of a network of metal rods connected together at the top and furnished with an aigrette or bundle of eight 4mm. copper rods spread out like a feather, so that, after passing over the roof, the terminal points project so little that they can hardly be seen from below, yet they break up the area of the buildings and leave little space unprotected. The conductors are of copper, but where they descend a special iron box is employed in which they are embedded in zinc, and from this the down rods can be continued in iron and also connected to the rain-water pipes and other ironwork of the building. The Palais de Justice was struck soon after the lightning conductor was completed, but no more damage was done than the partial fusion of some of the points of the aigrette which received the flash.

French architects, Mr. Hedges said, seem to prefer the long single point. The standard rod or *tige* is 6 metres high and about 6cm. diameter at the base, tapering to nothing at the top. The rod is firmly connected to the woodwork of the roof, and the copper or iron conductor is fixed at the base by means of a shackle. The conductor is usually kept away from the building by supports, and is carefully led into moist earth—or, in the case of rock foundations, it is connected to a network of wires running for a considerable distance under the surface. Where a well can be used, the earth connection is prepared by plaiting up galvanised iron strips to form a basket, which contains a sort of grapnel, the latter being attached to the conductor and the basket being filled with coke and lowered into the water.

The method adopted in most American cities at present, the speaker continued, is the employment of a round iron rod about half-an-inch in diameter, extending from the ridge of the metal roof about 4ft. above the top of the chimney or other elevated projection, its lower end being connected to a piece of iron in the form of a saddle, soldered to the metal roof. To this the top of each rain pipe is joined, or, where the gutters are below the roof, special tinned iron strips connect the two. It is said that each rain-water pipe 4in. diameter is equal in capacity to an iron rod $\frac{9}{16}$in. diameter. The connection between the pipe and the earth is made as follows: Above the elbow portion, a galvanised socket is fitted, and to this is soldered a flat bar which is led directly to the nearest water pipe or to the earth. The form which seems to give the best results, he said, is constructed of a pipe driven into the ground so that its perforated end rests in moist earth; its upper end is left about 6in. below the surface, so that it can be watered artificially or by rain. To assist the collection of moisture a larger sleeve is placed outside, furnished with a perforated top and set flush with the gutter. With slate or wooden roofs, bands of tin plate or galvanised iron are often placed underneath the slate covering on the rafters of the roof, being connected at the top with the "air terminal" conductors, and below with the gutters and rain-water pipes as previously described; in the case of a Mansard roof the sheet metal or flushing is also connected to the system.

Mr. Hedges was called in, in 1898, to report on the condition of the lightning conductors of St. Paul's Cathedral. He was informed that they were put up in the year 1872, having taken the place of the original system erected under the advice of the Royal Society about 144 years ago. The conductors were throughout of $\frac{1}{2}$in. stranded copper. Four of these conductors passed from the iron supports of the cross down the outside of the dome branching into eight conductors which were cross-connected by the railing of the gallery. Lower down they were united together and carried down to the ground. Each tower had two conductors with a cross connection, and there was also a single conductor passing over the ridge of the choir to an earth on either side. In the metallic connection with the cross there were several iron straps passing down inside to the level of the gallery, where the ends apparently disappeared in the stonework. This, in Mr. Hedges opinion, constituted a danger. The statues on the three sides of the building were not protected. The earth connections were also most unsatisfactory. These had originally been laid in a brick sewer passing round the building but in alterations since executed, earthenware pipes had been laid within the sewer, the brick sewer being no longer employed, and the conductors were therefore left either resting on the top of the earthenware pipe or placed within them so that they were insulated from earth. The joints were in all cases wrapped and not soldered.

The plan of re-arrangement recommended by the author, taking into consideration the large amount of copper cable already disposed about the building, was to run three new cables from the metal-work of the framework supporting the cross to the roof of the dome (making interconnection with the iron supports of the structure); there connecting them with the eight existing conductors and reuniting them at the base of the dome to the existing system, which was to be increased by running a new $\frac{1}{2}$-in. seven-ply copper cable on the top of the parapet entirely round the building. From this horizontal conductor, aigrettes, consisting of five pointed copper rods, were teed at intervals by means of special brass boxes tinned inside, into which the cable was placed, the aigrettes first secured by binding, and the whole united by running in hard solder. Great difficulty was found in securing new earths. One set of conductors was united to the hydraulic main supplying the power to the organ, and the other to the 8-in. water main. This connection was made by cleaning the outside, then wrapping the strands of the conductor around it, and then enclosing the whole in a metallic clamp which was filled with molten lead and screwed up tight. An additional earth was made by means of a perforated wrought-iron pipe furnished with a steel shoe, which was sunk to the requisite depth to secure moist ground. The stranded conductor was dropped into the pipe, soldered to a lead cap on the top, and shielded from electrolytic action by wrapping it in a lead tube. The pipe has a bend at the upper end, projecting above the ground and closed by a plug so that water can be poured down. There are other earths of ordinary copper plate buried in a mixture of charcoal and broken electric light carbons, and the old system of conductors, as well as the new, is attached to all the new earths. It is also proposed to establish connection with the ends of the rain-water pipes where they look out of the stone walls, down which all the conductors are laid.

In concluding his Paper the author repeated some of the practical suggestions with which Dr. Lodge concluded his 1889 Institution Paper (see *The Electrician*, Vol. XXIII., p. 68), adding a few suggestions of his own. He does not agree with Dr. Lodge that the use of copper is a needless extravagance, but prefers it to iron, as a lightning conductor is costly to renew and iron perishes more quickly than copper.

The Paper was illustrated by a number of excellent lantern slides, some of which had been kindly lent by the Royal Meteorological Society. These included several very interesting photographs of lightning flashes, and an excellent photograph showing the arborescent markings on the arm of a man struck by lightning.

A short discussion followed the reading of the Paper. Mr. Marriott, secretary of the Royal Meteorological Society explained, with the help of some slides, the nature of thunderstorms and the characteristic meteorological indications of their presence. Mr. Slater asked whether the hoops employed on chimneys were dangerous if not earthed, and was answered in the affirmative. Mr. Hall referred to the practice of bringing exhaust steam pipes part of the way up chimney shafts, and was told that these should also be earthed. Another speaker wished to know why a straight lightning conductor should be employed to lead away the lightning which, by the pictures shewn, appeared to prefer a wavy path. It was also elicited in the discussion that it was a dangerous practice for a man, with wet shoes, to lean against a lightning conductor during a thunderstorm.

COMPENSATION OF LINE DROP IN ALTERNATING CURRENT CIRCUITS.*

BY E. J. BERG.

To illustrate the practical application of the general equation (see footnote on next page) expressing the relation between currents and E.M.F. in an alternating-current system, assume a single-phase system in which it is desired to transmit 1,000 kw. at 60 cycles with 10,000 volts at the receiving end of the line. The length of transmission is 20 miles and the energy loss with non-inductive load about 10 per cent.; the load is, for simplicity's sake, assumed to be non-inductive. In order to determine the constants in such a system, the size of wire, the reactance, and capacity have to be calculated in the usual way. Since, however, with an overhead construction at 10,000 volts the capacity effect is very small, it can be neglected.

Line current = 1,000,000/10,000 = 100 amperes.

At 10 per cent. loss, $I^2R = 100{,}000$, thus $R = 100{,}000/10{,}000 = 10$ ohms. Therefore ohms per mile = 10/40 = 0·25, which corresponds to No. 0000 wire. This wire has 0·26 ohms per mile, therefore the resistance of transmission line is $40 \times 0{\cdot}26 = 10{\cdot}4$ ohms.

The reactance per 1,000ft. of wire is found from the following equation:—

$$x = 2\pi n \times 30{\cdot}5 \times 10^{-6}(2\log_\epsilon 2L/d + \tfrac{1}{2}),$$

where x = reactance per 1,000ft. of wire, m = frequency, L = distance between wires, d = diameter of wire expressed in same units as the distance. Assuming 18in. distance between wires, we get—

$$x = \frac{5{\cdot}28 \times 40 \times 2\pi 60}{10^6} \times 30{\cdot}5\left(2\log_\epsilon \frac{36}{0{\cdot}46} + \tfrac{1}{2}\right) = 22{\cdot}5 \text{ ohms.}$$

Impedance of line is $z = \sqrt{10{\cdot}4^2 + 22{\cdot}5^2} = 24{\cdot}8$ ohms.

* From the *Electrical World* of New York.

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The generator voltage at non-inductive load is obtained directly from equation (A), or

$$e_0 = \sqrt{(e+ir)^2+i^2x^2} = \sqrt{(100{,}000+100\times 10{\cdot}4)^2+100^2\times 22{\cdot}5^2}. \quad (D)$$

or the generator has 13 per cent. higher voltage than the receiving end of the line, with 10·4 per cent. energy loss and no compensation of line drop.

If it is desired that the generator voltage and the voltage at the receiving end shall be the same—that is, to compensate for the entire line drop—the value of i_3, the leading current, is obtained directly from equation (C) and is

$$i_3 = 10{,}000\times 22{\cdot}5 - \sqrt{\frac{(225{,}000)^2}{615} - 100^2 - \frac{2{,}000{,}000\times 10{\cdot}4}{615}}$$

$= 66$ amperes, or 66 per cent. of the full load energy current.

In other words, the condenser should be of such size that it will take 66 amperes when connected across the 10,000 volt mains, or be of 660 kw. capacity. Since a synchronous motor can be used as condenser by over-exciting its field, a synchronous motor can be substituted for this condenser. Such synchronous motor should have a current capacity of 66 amperes, and be wound for a potential of 10,000 volts—that is, it should also be of 660 kw. capacity. Its field should be so much over-excited that while running light—that is, carrying no load—its current should be 66 amperes.

If there is no margin in current capacity, it is possible to put any mechanical load on the motor and at the same time obtain this potential control. Were there, however, only a slight margin, considerable load could be carried. For instance, if the current capacity were 5 per cent. larger, or 69·3 amperes, the motor could carry a load corresponding to 21·2 amperes or 212 kw., as obtained from the diagram of Fig. 1. With 10 per cent. increase in current capacity a load of 303 kw. can be carried, and with 15 per cent. increase in current capacity a load of 375 kw. That is, with 5 per cent. increase in current over that necessary to obtain phase control a load of 31·6 per cent. of the synchronous motor rating can be carried; with 10 per cent. increase in current a load of 45 per cent., and with 15 per cent.

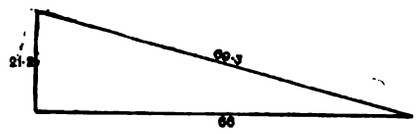

FIG. 1.—Relation of Currents.

a load of 56·6 per cent. of the synchronous motor rating can be carried. Or, vice versa, if a fully loaded synchronous motor is available in a system where phase control is desired, a compensation of lagging currents of 31·6 per cent., 45·8 per cent., and 56·6 per cent. respectively of the current capacity of the motor can be obtained by over-exciting the motor so as to take 5 per cent., 10 per cent., and 15 per cent. respectively more than full load current.

Such synchronous motor acts within a fair limit as an automatic compensator, since as the load increases the line drop increases—that is, the voltage at the motor terminals decreases—and therefore, if excited from a source of constant potential, and thus giving constant counter E.M.F., it takes more and more leading current, which is desirable. Since, however, this feature depends upon the armature reaction and magnetic condition—that is, the saturation of the motor—it is impossible to deal with it except in each particular case. As stated above, however, the control is often close enough without change of excitation of the motor: at the same time, if perfectly constant voltage is desired, the excitation has to be increased with the load.

If it is desired to have the synchronous motor over-excited so as to make the receiving voltage 5 per cent. higher than the generating voltage, the corresponding value of wattless current i_3 is obtained from the same equation (C) by substituting for $e_0 = 0{\cdot}95e$, as follows:—

$$i_3 = \frac{225{,}000}{615} - \sqrt{\frac{(225{,}000)^2}{615} - 100^2 - \frac{2{,}000{,}000\times 10{\cdot}4}{615} - \frac{10{,}000{,}000}{615}}$$

$= 95$ amperes.

That is, the wattless leading current is 95 per cent. of the full load energy current. In other words, a compensator or synchronous motor of 95 per cent. capacity of the load would be necessary to accomplish this.

The distribution of potential along the line in such a system can be obtained by considering the generator placed in the various points under consideration; in other words, by solving the equation by inserting proper values of r and x corresponding to distances between receiving station and the point of the line under consideration. Thus,

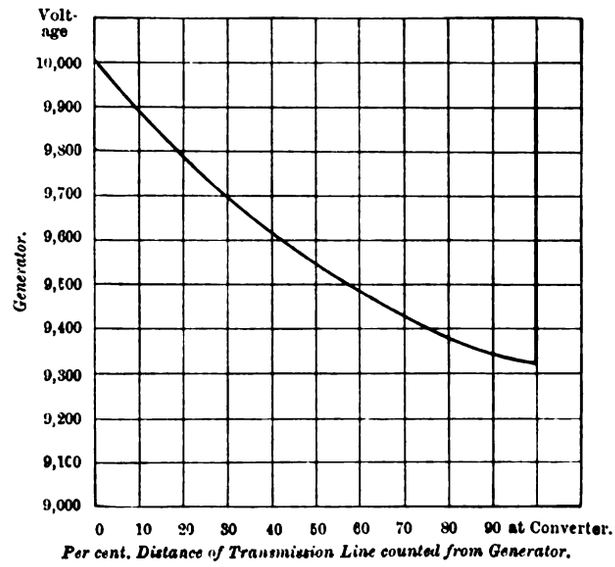

FIG. 2.—Distribution of Potential along a Line of 10·4 ohms resistance and 22·5 per cent. reactance with 15 per cent. additional reactance at Converter.

for instance, in the first case, when the voltage at generator and receiving end of the line is the same, at one-quarter of the distance counted from the receiving station, $r = 10{\cdot}4/4 = 2{\cdot}6$, $x = 22{\cdot}5/4 = 5{\cdot}62$.

$$e_0 = \sqrt{z^2(i_3^2+i^2) - 2e(i_3x - ir) + e^2} \quad \ldots\ldots\ldots \quad (E)$$

$$= \sqrt{38{\cdot}3(4{,}350+10{,}000) - 20{,}000(370-260) + 100{,}000{,}000}$$

$= 9{,}925$ volts.

In a similar way, by inserting other values for r and x, the following table has been calculated:—

Distance from receiving station.	e_0.	Distance from receiving station.	e_0.
0·1	10,000	0·6	9,880
0·2	9,930	0·7	9,900
0·3	9,900	0·8	9,920
0·4	9,880	0·9	9,950
0·5	9,880	Generator	10,000

It is of interest to note that the voltage all along the line is less than at the generator and at the receiving circuit; also that the percentage drop in voltage at any particular point is very small compared with the percentage line loss. In other words, for practical purposes the line has *practically* constant potential all over.

It is often advisable to instal special reactances in series with the line at the receiving end, in order to obtain more total reactance than that available in the line itself, and thereby to lower the wattless current necessary for phase or potential control. For instance, if reactive coils of 15 per cent. capacity of the load were installed, the wattless current under the condition given—the same voltage at

---

The general equation giving relation between currents and E.M.F.s in an alternating current system is expressed in complex quantities in equation (A):—

$$E_0 = E + (i+ji_1)(r-jx)$$

where

E_0 = generator voltage,
E = voltage at receiving end of transmission,
i = energy component of current,
i_1 = wattless component of current, which may in its turn be expressed as $i_2 - i_3$, where i_2 is the lagging component and i_3 the leading component;
r = resistance of transmission line,
x = reactance of transmission line.

This equation is essentially the same as in a direct-current circuit, and consists of three terms: The first, the E.M.F. generated; the second, the E.M.F. at the receiving end; and the third, the drop in voltage in the line. The only difference is that in an alternating-current circuit the drop is expressed as:—

$$(i+ji_1)(r-jx),$$

whereas in a direct-current circuit it is simply ir.

Solving equation (A) in reference to i_1, the wattless component of current, and substituting the real values of E_0 and E as e_0 and e we get

$$i_1 = \frac{-ex}{z^2} \pm \sqrt{\frac{e^2x^2}{z^4} - \frac{2eir}{z^2} + \frac{e_0^2 - e^2}{z^2}}. \quad \ldots\ldots \quad (B)$$

With non-inductive receiving circuit i_2 is zero and $i_1 = i_3$ thus represents the leading or condenser current.

$$\text{Thus } i_3 = \frac{ex}{z^2} - \sqrt{\frac{e^2x^2}{z^4} - i^2 - \frac{2eir}{z^2} + \frac{e_0^2 - e^2}{z^2}} \quad \ldots \quad (C)$$

neglecting the + sign for the square root since the value corresponding thereto is of no practical value.

This last equation enables us to calculate how much leading current is necessary in order to obtain any desired relation between the generator voltage and the voltage at the receiving end—that is, between e_0 e, in systems of non-inductive receiving circuit.

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the receiving end and the generating end—would be 54 amperes instead of 66 amperes, as can readily be obtained by inserting $r=10{\cdot}4$; but for $x=22{\cdot}5+15=37{\cdot}5$ ohms, as follows :—

$$i_3=\frac{375{,}000}{1{,}513}=\sqrt{\frac{(375{,}000)^2}{1{,}513}-10{,}000-\frac{2{,}000{,}000\times 10{\cdot}4}{1{,}513}}$$

$=54$ amperes,

which shows that by the introduction of 15 per cent. reactance the condenser current is decreased 18 per cent. in this case. In general, the more reactance the lesser condenser current, or the more reactance the smaller synchronous motor is required for controlling the voltage. The condenser current necessary to give 5 per cent. over-compounding is found by the same equation when substituting $e_0=9{,}500$, $e=10{,}000$. This gives $i=73$ amperes, or 23 per cent. less than when no additional reactance is used.

Before leaving this problem it is of interest to see directly the effect of reactance on the amount of condenser current. By substituting various values of x in equation (C), the corresponding values for i_3 are set out in the following table :—

x.	i.	x.	i.
10	133	50	54·5
20	72	60	59
30	57·5	70	66
40	54	80	80

This effect of reactance is clearly shown in Fig. 3.

Briefly, there is a certain most favourable amount of reactance which corresponding to minimum current and minimum size of

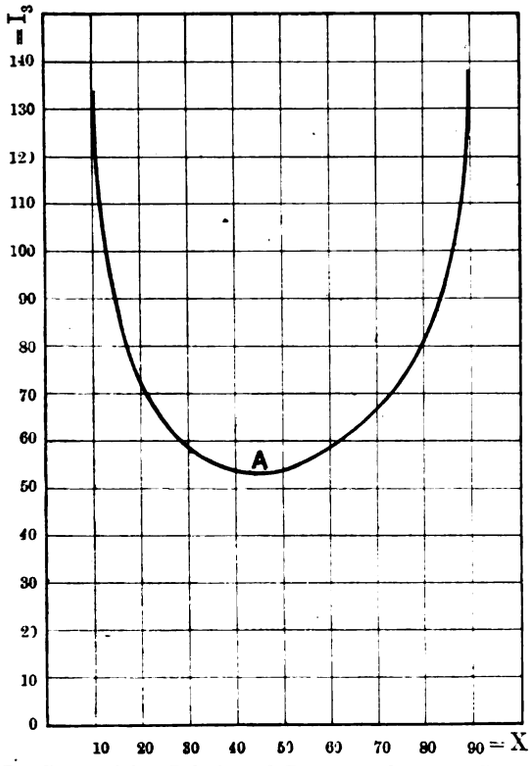

FIG. 3.—Curve giving Relation of Reactance between Generator and Receiving Circuit, and condenser current to give same potential at generator and receiving circuit in a system of 10·4 per cent. resistance loss at non-inductive load.

synchronous motor, and which gives minimum line loss. In general, when line drop is compensated for in systems of non-inductive receiving circuits, the line loss is increased. In this particular case, although with non-inductive load the loss is only 10·4 per cent., it is with various reactances as follows :—

Reactance.	Loss.	Reactance.	Loss.
10 per cent.	30 per cent.	50 per cent.	14 per cent.
20 do.	16 do.	60 do.	14·5 do.
30 do.	14 do.	70 do.	15·5 do.
40 do.	12 do.	80 do.	18 do.

It is frequently not advisable to insert too much reactance between the generator and synchronous motor, since the stability of the system is affected thereby. In these cases it may seem strange that so great an amount of reactance and leading current is necessary to compensate for 10 per cent. drop. The reason is that the maximum output of the line is approached. A much less amount would have been required if the generator was kept at 10 per cent. higher voltage at all loads—that is, if the potential at the generator had been 11,000 volts at all loads and that of the receiving end 10,000 volts. Such a condition could have been obtained by under-exciting the synchronous motor at no load. The distribution of potential along the line in such installations with reactive coils at the receiving circuit can be obtained in same manner as above by solving equation (A) with reference to e_0 as follows :—

$$e_0=\sqrt{z^2(i_3^2+i^2)-2e(i_3x-ir)+e^2}.$$

Fig. 2 is calculated by inserting for $e=10{,}000$, $i=100$, $i_2=51$, at generator $r=4$, $x=37{\cdot}5$.

Distance from generator.	r.	x.	Distance from generator.	r.	x.
0·1	9·36	35·3	0·9	1·04	17·2
0·2	8·32	33·0	Converter (line side of reactive coil)	0	15·0
0·3	7·30	30·8			
0·4	6·25	28·5			
0·5	5·2	26·3			
0·6	4·16	24·0	Converter (bet. reactive coil and collector)	0	0
0·7	3·12	21·75			
0·8	2·08	19·5			

From this curve it is seen that the voltage rises abruptly across the reactive coil; it is lower than the voltage at the receiving end and generating end all along the line; it gradually rises from the reactive coil up to the generating station, and rises at once across the reactance to the proper value. The drop in voltage in any point of the line is less than corresponds to the ohmic drop.

The real advantage of synchronous motor phase control is, however, first apparent in systems with inductive receiving circuits. Referring back to equation (B) and substituting for $i_1=i_2-i_3$, we get :—

$$i_3=i_2+\frac{ex}{z^2}-\sqrt{\frac{e^2x^2}{z^4}-z^2-\frac{2e\,ir}{z^2}+\frac{e_0^2-e^2}{z^2}} \quad . \quad . \quad . \quad (F)$$

In the above numerical instance assuming the power factor of the load to be 90 per cent., $i=100$, $i_1=\sqrt{114^2-100^2}=48$. The gen-

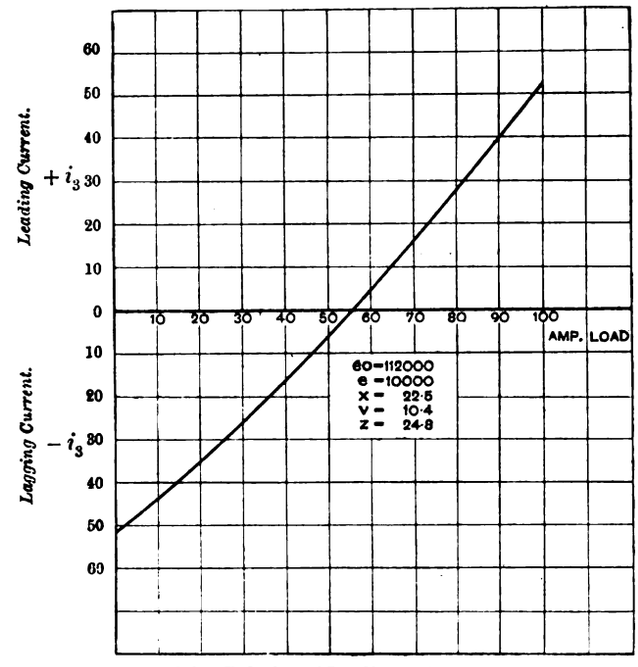

FIG. 4.—Curve giving Relation of Leading and Lagging Current, taken by synchronous motor as function of load of the receiving system. Generator voltage kept constant at 112,000 volts, voltage at receiving end of line 10,000 volts at all loads.

erator voltage is obtained by solving equation (A) with reference to e_0 as follows:—

$$e_0=\sqrt{(e+ir+i_1r)^2+(ix-i_1r)^2} \quad . \quad . \quad . \quad . \quad . \quad (G)$$

substituting for $e=10{,}0000$, $i=100$, $i_1=48$, $r=10{\cdot}4$, x $22{\cdot}5$, e_0 is found to be 12 200 volts. Or thus the generator voltage is 22 per cent. higher than the voltage at the receiving circuit. The energy loss in the line is $(100^2+48^2)\times 10\,4=128{,}000$ watts, or 12·8 per cent. of the delivered power. In such a system it would be well to keep the generator voltage about 10 per cent. higher than the voltage of the receiving end at all loads; in other words, to keep e_0 = about 11,000 and $e=10{,}000$ at all loads. Furthermore, the synchronous motor has to take lagging currents at light loads and leading currents at full load. Neglecting the small energy current necessary to run the synchronous motor light at non-inductive excitation, and assuming that the nature of the load remains the same at all loads—that is, its power factor remains the same—we have $i_2=0{\cdot}481$. Assuming further $e_0=11{,}200$ volts, $e=10{,}000$ volts, and substituting these values in equa-

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tion (G) and solving with reference to i, it is found that $i_2 = 52$ amperes, or at 52 per cent. of rated load no phase control is exerted. At no load the synchronous motor should take 52 amperes lagging current, and at full load 52 amperes leading current. In other words, the capacity of the synchronous motor is just about 50 per cent. of the load. The amount of current taken by the motor at all loads is shown in Fig. 4. As will be seen, the synchronous motor should run non-inductively at 54 per cent. of full load of the system. Without the use of a compensator the full load line current is 111 amperes, therefore the loss is $111^2 \times 10{\cdot}4 = 128{,}000$ watts, or 12·8 per cent. of the delivered power With the synchronous motor the line current is 100 amperes, and the loss therefore only 104,000 watts, or 10·4 per cent. The poorer the power factor of the load, the more advantageous it is to use this method of potential control.

In conclusion, it may be brought out once more that although a non-inductive receiving circuit has been considered chiefly in the present instance, this method of compensation of drop is not well suitable except in cases where the load is more or less inductive, or when it is desired to have the voltage constant and the same all along a line. It is hardly desirable to try to maintain the same generator voltage as the voltage at the receiving end, or to get a higher voltage at the receiving end than at the generator, unless there is no objection to large reactances and comparatively large wattless currents. It is, however, perfectly feasible to maintain the generators at a somewhat higher voltage than that at the receiving end at all loads; in other words, to lower the voltage by means of under-exciting the synchronous motors, which causes them to take lagging current at no load, and to run them under non-inductive condition at part of the load and with leading currents at full load. Under these conditions, the amount of reactance, leading current, and boosting the voltage can be comparatively closely approximated as follows: With 10 per cent. reactance and full load leading current 10 per cent. boosting of voltage is obtained. With 20 per cent. reactance and full leading current 20 per cent. boosting is obtained. With 10 per cent. reactance and one-half full load leading current 5 per cent. boosting is obtained. With 20 per cent. reactance and one-half full load leading current 10 per cent. boosting is obtained, &c. This rule holds comparatively good unless the maximum output of the line is approached, as is the case in the examples assumed. The chief advantage of the synchronous motor used as compensator is, however, to be found in systems of lagging currents, such as induction motor installations, where the drop in the line and the current in the line are larger than at non-inductive load. In such case not only is the efficiency of the system raised, but the line loss is lessened; whereas with non-inductive load the line loss is increased by the use of synchronous motors or potential control.

LEGAL INTELLIGENCE.

National Co. for the Distribution of Electricity, &c., Ltd. v. Gibbs and another.

In the Court of Appeal on Tuesday and Wednesday, before the Master of the Rolls and Lords Justices Rigby and Collins, this case was heard on appeal by defendant, H. O. Ruelle, from an order of Mr. Justice Cozens-Hardy. There was also a cross appeal by the plaintiff company from the same order.

Mr. EVE, Q.C., for the defendant, said the learned judge had dismissed both the action and counterclaim, and his client only appealed from that part of the order which dismissed the counterclaim. The action was brought claiming damages for breach of an agreement, and the counterclaim sought to enforce a judgment which had been obtained in France in an action between the same parties. The point which the learned judge decided was that the grant of letters patent in the ordinary form to two persons, their executors, administrators and assigns, constituted them joint tenants, and that the benefit of letters patent survived to the survivor, and accordingly that the legal personal representative of one of the joint grantees could not be sued in respect of the assignment of the patents, and could not herself sue in respect of royalties. The plaintiff company was in liquidation. It was incorporated in 1883 for the purpose of acquiring from Messrs. Gaulard and Gibbs the benefit of certain letters patent which they had obtained in respect of apparatus for the distribution of electricity by means of secondary generators. The agreement was dated May 25, 1883, and was between Lucien Gaulard and John Dixon Gibbs and the company. After reciting the consideration to be paid, Clause 7 of the agreement provided that the said vendors and all other necessary parties should, with the consent of the company, execute such assignments to the company or as they should direct, and such assignments respectively should contain a covenant by the said vendors that all the letters patent thereby assigned were valid and in nowise void or voidable. The action was brought upon these covenants, the case of the company being that the British patents were not valid, and that, so far as other countries, including the United States, were concerned, they were limited in their application. They consequently claimed damages to a large amount. As regarded the survivor Gibbs, the action was compromised, and it therefore went on against Madame Ruelle as the legal personal representative of the deceased grantor Gaulard. By way of counterclaim the defendant Ruelle set up a judgment of the Paris Court of Appeal, under which, after protracted litigation, the company were held liable to pay to her a sum of £2,600. By way of defence to the action the defendant alleged that all the matters in dispute had been determined in the French proceedings, and that the release of Gibbs *pendente lite* was a release for the deceased man.

After hearing the arguments on both sides,

The MASTER OF THE ROLLS said in this case he was unable to agree with the view adopted by the learned judge, but he doubted very much whether the practical result of the view they had adopted would be more beneficial to the parties. There were two patentees—Gaulard and Gibbs—who were entitled to certain patents for the distribution of electricity, and they agreed to sell them to the plaintiff company under an agreement dated May 25, 1883. The learned judge had treated this agreement as neither more nor less than a joint covenant by Gaulard and Gibbs to assign these patents with a covenant of title, and he decided the case upon the short ground that Gaulard being dead there was no remedy against his personal representative, and that the claim therefore of the company against her failed. If the company could therefore only look to Gibbs it followed that the defendant's counterclaim against the company also failed. By taking that short cut the learned judge dismissed both the action and counterclaim. He could not think that that view was correct, and what the Court proposed to do was to reverse the judgment, and declare that upon the true construction of the agreement the right of the plaintiff company for relief against Madame Ruelle was to be ascertained upon the footing that Gaulard and Gibbs had jointly covenanted to assign the patents mentioned in the agreement to the plaintiff company, and that such assignments should contain joint and several covenants that such patents were valid, and in no wise void or voidable. Then a declaration that the amount due from the company to Madame Ruelle on her counterclaim was to be ascertained upon the footing of the order made on the proceedings in the French Courts, and with these declarations to remit the action and counterclaim for trial. They proposed to reserve the question of the costs of the action and counterclaim and of the appeal, including the costs of the plaintiffs' cross appeal, to be dealt with by the judge at the trial. A point had been raised that the plaintiffs' appeal was out of time, and that it had reference to a separate and distinct cause of action, but the learned judge had so linked the action and counterclaim together that they did not think they ought to be debarred on that ground. He thought counsel would do well to advise their clients to see whether they could not settle their differences by compromise, and so avoid further litigation.

Kirby v. Lawson.

This case came before Mr. Justice Grantham and a special jury in the Queen's Bench Division on Tuesday, and was an action to recover £2,000 commission alleged to be due from Mr. Harry J. Lawson, a company promoter.

Mr. RUFUS ISAACS, Q.C., said that the plaintiff, Mr. Frederick Kirby, was a civil engineer and was associated in business with a Mr. Wells. In June last year, Mr. Lawson had some business in hand in connection with a then projected company, to be called the Electrical Tramways Construction Co., and he desired an introduction to an engineer of considerable eminence in the electrical world whose name could appear on the prospectus. In an earlier matter Mr. Kirby had introduced to the defendant Sir William Preece, for which service he received a commission. The subject was introduced to plaintiff and Mr. Wells by Mr. Tom Lawson, brother of defendant, and as a result, the three met Mr. H. J. Lawson. After some negotiation defendant promised verbally to pay £2,000 commission for the introduction to Mr. Thomas Parker, an electrical engineer of established reputation, who had been described by Lord Kelvin as the "Edison of Europe." The introduction was duly effected, and there was an agreement drawn up between Mr. Parker and the company. Mr. Lawson now denied having made any undertaking to pay the commission.

Mr. FREDERICK KIRBY, the plaintiff, said he had originally asked for £5,000 as commission for the introduction of Mr. Thomas Parker, but that finally £2,000 was agreed upon, and Mr. Parker, who was then waiting at the Hotel Cecil, was duly introduced to Mr. H. J. Lawson. He did not know Mr. Lawson had previously been introduced to Mr. Parker in connection with automobile business, and it was not the fact that the commission was only to be paid on Mr. Parker consenting to come into the business and to accept the post of consulting engineer to the Electrical Tramways Construction Co. at a salary of £1,000 per annum. He pointed out to Mr. H. J. Lawson that if he got hold of Mr. Parker the latter would doubtless obtain for the new company the order for the electrical equipment of the Metropolitan Railway, and influence the necessary financial assistance, and so make the business of the Electrical Tramways Construction Co. the finest in existence. Mr. Parker had, however, declined to execute an agreement with the Electrical Tramways Construction Co. unless the latter took over some part of the Wolverhampton business with which he was associated.

Mr. MARSHALL HALL, Q.C., said plaintiff and his colleagues originally wanted to get Mr. H. J. Lawson to take up Mr. Thomas Parker and his Wolverhampton business on a commission to them of £5,000, but that had been declined. It was proposed that the new company should start a factory for the purpose of making electrical tramway plant. Mr. Lawson was himself anxious to get a first-class scientific man like Mr. Thomas Parker at the head of it, and on the terms that Mr. Parker should come in at £1,000 a year salary, and bring his influence, he offered the present claimants £2,000 commission, as and when the company was formed, because they had represented that Mr. Kirby had influence with Mr. Parker, and could persuade him to join the company. It was idle to suggest that Mr. Lawson would pay £2,000 for merely bringing the people into one room. Mr. Parker had always refused the appointment with the Electrical Tramways Construction Co. unless his

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businesses were taken over, and for that reason the agreement had never been completed.

Mr. H. J. LAWSON was called, and said he was still engaged on the scheme for electrical tramways construction. Mr. Parker was known to him before this introduction. Mr. Kirby represented himself as an old personal friend who could persuade Mr. Parker to join in the scheme as consulting engineer and director, and give his influence to the company. At the interview the witness refused to give a commission note or to be bound in any way, telling the plaintiffs they must depend entirely on how he got on. That was the usual thing, and he always worked on those terms. He had not been able to make any agreement with Mr. Parker, but if Mr. Kirby would get that gentleman to execute the agreement now he would pay him the £2,000 claimed.

In the result the jury found for defendant, and judgment was entered accordingly.

Alleged Electricity Supply Failures.

At the Greenwich Police Court, on Tuesday, the London Electric Supply Corporation appeared to seven adjourned summonses at the instance of a publican (occupier of the Dover Castle public house, Deptford) for making default in supplying electric energy. Mr. Lawless, for complainant, said his client had spent £200 in having his premises wired and fitted, and the defendants, during the winter neglected to supply Deptford while they were supplying the West End, the result being his client's public house was left in darkness from 4 o'clock to 8.30. Mr. Bailhache, for the Corporation, admitted the failure, and quoted the Electric Lighting Orders Confirmation Act to show that the company was not responsible for failure due to inevitable accident or *force majeure*. The latter was foreign to English statute, and if the magistrates should be against him he must ask for a case.

The Managing Director, (Mr. R. Stewart Bain) detailed the difficulties the company had laboured under through the failure of contractors to supply boilers to time, as well as to explosions of tubes, which necessitated the withdrawal from use of five or six boilers. The coal supply had also been a cause of difficulty. Mr. Lawless argued that *force majeure* did not apply in this case, and the magistrate (Mr. Kennedy) said he would give his decision on May 4.

On the same day at Southwark the same company were summoned at the instance of the London County Council for failing to maintain a proper supply of electric current in their mains adjacent to 148, Borough High-street, the Weights and Measures Office, Union-road, and St. George's Public Library, Borough-road, on various dates in January and February, and further for making default in supplying current to the same premises. The magistrate (Mr. Paul Taylor) said that no evidence had been given to show negligence on the part of the company. Yet even if there was slight neglect it seemed, in the circumstances, to be covered by the term *force majeure*. If it was contended that want of foresight was negligence, how could it be said that the company could have foreseen the failure of contractors to provide boilers?; or, that the company could have foreseen that the South African war would cause a shortage in the supply of Welsh steam coal? He had decided to dismiss the summonses.

At Marylebone the Metropolitan Electric Supply Co. appeared before Mr. Plowden to answer six adjourned summonses, at the instance of the Marylebone Vestry and the Marylebone Guardians, for in December making default in the supply of electric energy. When the case was originally heard, Mr. Muir (for the company) pleaded guilty, and offered an explanation in mitigation. He said that measures had been taken to prevent a recurrence of the cause of complaint, and asked, as a test, that the case should be adjourned for three months. Mr. Neill (for the prosecutors) now stated that during January, February and March there had been 14 occasions on which the company had failed in its supply. Mr. Muir said that there had been no repetition of the original faults, and that the failures since had been beyond human foresight. The plant was tested every day. Mr. Plowden thought the explanation as to the failures this year exculpated the company. On the original summonses they would have to pay 5s. for each date (total £1 5s.), with costs.

FORTHCOMING LEGAL ACTIONS.

Causes with an electrical interest entered for hearing at the Royal Courts of Justice during the Easter Sittings, 1900, include the following:—

SUPREME COURT OF JUDICATURE.—COURT OF APPEAL.

From Chancery Division.

The Electric Construction Co. (Ltd.) *v.* Imperial Tramways Co. (Ltd.). (British Thomson-Houston Co. (Ltd.) third parties). (Appeal of plaintiffs from order of Mr. Justice Cozens-Hardy, dated Nov. 14, 1899.)

Heyl-Dia *v.* Edmunds. (Appeal of plaintiff from order of Mr. Justice Kekewich, dated November 11, 1899.)

British Motor Syndicate (Ltd.) *v.* John Taylor and Sons (Ltd.). (Appeal of defendants from order of Mr. Justice Stirling, dated Feb. 15, 1900.)

Rucker *v.* The London Electric Corporation (Ltd.). (Appeal of plaintiff from order of Mr. Justice Farwell, dated Feb. 12, 1900.)

QUEEN'S BENCH. Final Appeals.

The Mayor &c. of the Borough of Hyde, Oldham, and Ashton *v.* Hyde Electric Tramway (Ltd.), and others. (Appeal of Defendants from judgment of Mr. Justice Grantham, dated July 3, 1899; at trial without a jury.)

QUEEN'S BENCH DIVISION.—*Special Juries.*

A. Shanks and Son (Ltd.) *v.* the Globe Electrical Co. (Bill).

Stephens *v.* Mather and Platt. (Commission).

Revenue Paper.

ttorney-General *v.* National Telephone Co.

CHANCERY DIVISION.

Before Mr. Justice Stirling.

Cuba Submarine Telegraph Co. (Ltd.) *v.* the West India and Panama Telegraph Co. (Ltd)

Before Mr. Justice Farwell.

Chamberlain and Hookham *v.* Mayor, &c., of Bradford.

City of London Electric Lighting Co. *v.* Corporation of London (ordered to stand over till May 21.)

Jandus Arc Lamp and Electric Co. (Ltd.) *v.* Johnson (action and counterclaim).

MUNICIPAL, FOREIGN & GENERAL NOTES.

Alleged Incendiarism.—At the West Ham Police Court on Saturday an electrical wireman named Christian Maddock was charged with attempting to set fire to a building and its contents at the India Rubber, Gutta Percha and Telegraph Works Co.'s factory, Factory-road, Silvertown. Mr. F. Stern, who prosecuted, said a serious conflagration had apparently been escaped only by reason of the carefulness of an employé. There had been six fires at this factory during the last twelve months, and though it could not be suggested that prisoner was connected with them, in view of the charge now made against him the fact could only be regarded as remarkable. Alfred May, storekeeper at the factory, deposed that on the previous afternoon he was in the pattern shop in which were stored some 18,000 wood patterns. He had had two visits from the prisoner, and his conversations aroused witness's suspicions, and he concealed himself. Prisoner went to the spot where they had previously stood and took up a pattern—a disc-shaped piece of wood like a flower-pot saucer. He put the "saucer" by the side of a box and then left the room. Going to the spot witness found that the pattern contained about three-quarters of a pint of methylated spirit, and he then called Mr. Kennedy's and Mr. McNault's attention to the matter. Methylated spirit was not used in the store, which was lighted by electricity. No unmasked lights were used there. John Pattison, a foreman, deposed that he went to the pattern room after Mr. May had created an alarm. He put on a temporary electric light, and saw the box produced turned mouth downwards. Beneath the box he found a candle stuck in a bit of wood. The wood was partially covered with cotton-waste, and the cotton-waste was soaked with methylated spirit. Across the waste was a ginger beer bottle, which was uncorked and half filled with methylated spirit. The candle had been freshly trimmed and was ready for lighting, and a piece of its wax was lying close by. Around about the floor of the room was wet and smelt of spirit. Prisoner would use spirit and waste in his work. Constable Green deposed to arresting prisoner, who said: "Someone has made a big job of this for me; I did not think it would come to this. Will it be settled by a magistrate or go to the Old Bailey?"—Remanded.

Barrow-in-Furness.—The accounts for the electricity department for the year ended March 31 have been issued. The capital expenditure is nearly £33,000, the revenue for the year £2,600, and the annual expenditure £1,900, leaving a gross profit of £750. It has been decided to make a reduction in the charge for current.

Brussels-Antwerp Electric Railway.—A bill has been introduced in the Belgian Chamber of Deputies to authorise the construction of this railway. The concession for the line, which will be for 60 years, has not yet been granted. The Government reserve the right to acquire the line at ten years from date of opening, and, among the other conditions, the concessionaires will have to contribute one-half of the net loss in receipts which may arise on the existing State railway between Brussels and Antwerp.

Calcutta.—An electric lighting installation was recently erected at the Government House by Messrs. Balmer, Laurie and Co.

Cardiff.—At the meeting of the Lighting committee, on Friday, applications for the position of mains superintendent were considered, and Messrs. H. D. B. How, of London, E. Jones, of Cardiff, and W. H. Illingworth, of Halifax, were chosen, from whom a final selection will be made at the next meeting of the committee.

At the end of March the equivalent number of 8 c.p lamps connected was 27,463, compared with 21,782 last year, and there were 1,512 lamps awaiting connection. The number of units sold was 509,000, against 405,000 units in the preceding 12 months, an increase of 25 per cent. The increase in revenue was £1,500.

A special meeting of the Council was held on Monday to consider the supply of electric current for the projected system of electric tramways. The Tramways committee recommended the erection of a separate station for tramway purposes, but Ald. Carey, chairman of the Lighting committee, moved that the Council adopt a combined station. He said nearly all municipalities in this country which had considered this question had favoured combined stations, and contended that whatever could be done by the Tramway committee the Lighting committee could most successfully carry out. If the Corporation erected a separate station they must have extra land, extra buildings, and an additional staff, whereas the present lighting station,

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with certain alterations, could run a large portion of the trams in Cardiff. The Tramway committee had scheduled land for stations at Roath, Portmanmoor-road, Cathays, and Clare-road, which were most of them as far from the centre of the town as the lighting station. The Lighting committee had expended £85,000 upon their station, and had authority to spend an additional £12,000. The capacity of the station was 60,000 units per annum, and at present they supplied 30,000 units, and as new applications for 10,000 a year were coming in the committee would have to look out for another station during the next few years. They supplied current to the public arc lamps at £18 per annum, which worked out at 1·7d. per unit, although the cost of generation was 2·16d. per unit. They lost, therefore, ½d. per unit, which amounted to over £200 per annum. This charge of £18 per lamp at Cardiff compared with £32 at Bristol, and £20 at Edinburgh. The cost of generating had been reduced from 3·1d. per unit in 1895, to 2·16d. in 1898. The Lighting committee certainly deserved some consideration for the work they had done. Mr. T. Andrews, chairman of the Tramways committee, moved that a separate station be erected as a distinct undertaking. He quoted from the report of the Huddersfield borough engineer (Mr. Campbell) who favoured an independent station, and who had stated that on no consideration should sub-stations or accumulators be provided if tramway equipment was to consist of the best and most up-to-date plant. His committee wanted to know what price the Lighting committee would charge for current; that was the crux of the whole question. Altogether they would ultimately have to work 26¼ miles of tramway by electric traction. That was a large order, and the present lighting station was totally unsuitable for electric traction plant. If electric traction was to be a success they must have a separate station. The erection of a large power station would require the attention of a first-class electric traction engineer, a permanent official to design and superintend the erection of the station and advise the committee as to the machinery and plant necessary. This man should be engaged immediately and be held responsible. In towns where energy was purchased from the Lighting committee the charge was very much higher than it could be produced by the Tramway committee themselves. He pointed out that current for tramways would be required for 16 hours out of 24, whereas the lighting was only required for six hours per day, and he did not see why the greater should be subject to the smaller undertaking. He had hoped that Ald. Carey would have been able to put forward some alternative scheme that he would be able to offer power at, say, ¾d. per unit, but he had not done that. Eventually the debate was adjourned until May 7, and both committees are to submit additional information.

Dundee.—The Lighting committee have considered reports from the city electrical and gas engineers regarding the proposed extension of the electric lighting system. It was stated that the annual cost of lighting the tram routes by gas would be £348. 0s. 4d., and by electricity (lamps being placed in the centre and side of the streets) the initial cost would be £1,730, and the annual upkeep £1,138. 18s.

East London Electric Lighting Orders.—The Board of Trade have intimated to the Vestries of St. George's in the East and Mile End Old Town and the District Board of Works of Limehouse that they propose to grant the applications of these local authorities for provisional orders. The applications were opposed by the County of London Co., who already possess electric lighting powers for these districts, and particulars of the conference which took place at the Board of Trade in connection with the matter will be found in our issue of March 30.

At the meeting of the Mile End Old Town Vestry last week it was reported that amended plans and notices had been received from the County of London Co. giving notice of intention at the expiration of one month to commence the execution of works under their provisional order. The Electric Light committee reported they saw no objection to the plans submitted, but after discussion it was decided to refer the report back.

Edinburgh.—The Council have decided to erect 72 additional arc lamps for street lighting. At the Council meeting on Tuesday, the convener of the Electric Lighting Committee (Bailie Mackenzie) said he had received a report on the approximate cost per lamp from the electrical engineer as follows:—Carbons £1. 2s. 6d.; coal, £3. 5s. 0d.; stores, 6s.; trimmers' wages, £3.; maintenance, £1. 7s.; interest and sinking fund, £2. 17s.—total, £11. 17s. 6d. The rise in the price of coal for the coming year would represent £1. 1s., and for carbon, 7s. 6d.—making a total cost per lamp of £13. 6s. With the 72 lamps proposed, the total number of lamps would be 839, which, at 6s. per lamp, would mean a loss on the year of £251. 14s. They had, however, only made coal contracts for three months. Even supposing they made a loss of 6s. per arc lamp, he was in favour of going on with the extension, because the general community got the benefit of the light, and the public lighting was a good advertisement for the private lighting. The Electric Light committee has been requested to report upon the charge to be made for electric current for the year commencing May 15, and also on the expediency of the Corporation hiring out electric motors in order to increase the day load.

Fatal Accident.—An inquest was held at Blackpool last week into the death of J. A. Hopton, electrician, engaged on the local electric tramway. Hopton, it appeared, attempted to board a car from the front, and was crushed between the tram and the pole. It was stated in evidence that it was the custom of the electricians to ride upon the front of the car in order to be out of the way of passengers. The town clerk explained that a bye-law had been in force prohibiting anybody from entering the front of the car while in motion. A verdict of accidental death was returned.

Fire Prevention.—The British Fire Prevention committee, presided over by Mr. Edwin O. Sachs, is discussing the question of obtaining some international basis for tests with fire-resisting materials with a view to arriving at comparative results. Mr. Sachs has recently by invitation inspected the German Government's new fire-testing grounds at Berlin, and finds that here and elsewhere on the Continent research work in this branch is still carried on in an incomplete and primitive manner, making it difficult for any assimilation of the testing arrangements adopted in this country to those in vogue on the Continent.

Grays (Essex).—The Council have received sanction to a loan of £12,000 for electricity supply. A refuse destructor is also to be erected.

Great Yarmouth.—The Port and Haven Commission have sanctioned the application of the Corporation to lay three cables in the bed of the river near the Lower Ferry for supplying electric current in the Gorleston district. The trench for the cables is to be excavated to a depth of 21ft. below low water.

Hampstead (London).—The Vestry recently applied for a loan of £97,178 for electric lighting, but the London County Council intimated that they could only sanction the borrowing of £90,740. The Council have further intimated that as the Vestry had elected to spread the repayment of the whole of the initial cost of the installation over 42 years, the Council would decline to give its sanction to the raising of any loan to replace any of the plant and machinery which might be necessary during the currency of the loan, and would expect the Vestry to provide for all renewals required during that period out of a sinking fund or from maintenance account. The matter has been referred to the Finance committee.

The Vestry have decided to construct an artesian well, 400ft. deep, at the electricity station, capable of yielding 5,000 gallons per hour.

Infirmary Lighting.—The Fulham (London) Guardians have engaged Mr. F. H. Medhurst, at a fee of £21, to report upon the question of lighting their infirmary electrically.

Ipswich.—Prof. Kennedy's report on the electric lighting question has been received, and will shortly come before the Council for discussion.

Islington (London).—A recommendation by the Parliamentary and General Purposes committee to increase the salary of the electrical engineer (Mr. Albert Gay) from £500 to £600 per annum was considered by the Vestry at its meeting on Friday last. After a keen debate the proposal was rejected by 45 votes to 34.

Japanese Electric Railway.—It is stated by the *Electrical Review* of New York that a concession has been granted to the Tokio City Railway Co. to proceed to the construction of its proposed lines, which are to be some 200 miles in length. The capital of the company is to be 15,000,000 yen (about £1,440,000 sterling), to be spent in part as follows:—Track material, rails, &c., 3,525,000 yen; 600 electric cars, 2,140,000 yen; 6,000 H.P. power house, 1,500,000 yen; eight sub-stations, 1,000,000 yen. It is proposed to use 30 200 H.P. water-tube boilers, five 1,200 H.P. triple-expansion engines, and five three-phase, 3,500 volt, 800 kw. dynamos, direct coupled. The chief engineer of the works is Mr. Farichi Kain.

Light Railways.—The Board of Trade have, after modification, confirmed the Dudley and District Light Railways Extension Order (1900), the Mid-Suffolk Light Railway Order (1900), and the Rhyl and Prestatyn Light Railway Order (1900).

The Light Railway Commissioners propose to sanction the application of the Gloucester Tramways Co. for constructing the proposed Gloucester and District Light (Electric) Railway, subject to the Corporation waiving their right to purchase the existing tramways in the event of light railways being substituted therefor. The Corporation were recommended that, as they were expected to waive their right to purchase the existing tramways and any claim to wayleaves, and accept a right to purchase the proposed light railways within the city after 30 years, the company should be required to take electric energy at the rate of 2d. per unit for the first 200,000 units, 1¾d. per unit for the second 200,000, and 1½d. for the third 200,000; after 600,000 the price to be reduced one-tenth of a penny for every additional 50,000 units unless the price reached a minimum of 1d. per unit. The consideration of the matter has been deferred.

The adjourned inquiry of the Light Railway Commissioners into the joint application of the Middlesex County Council and the North Metropolitan Tramways Co. for permission to construct a system of light (electric) railways in Middlesex was resumed on Wednesday. Lord Jersey said they were prepared to sanction the line from

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Tottenham to Wood Green, thence through Bounds Green to Southgate, from Highgate to Whetstone, and from Kilburn to Edgware Church—the three main lines and the spurs on which the generating stations were to be constructed.

An inquiry was opened on Tuesday by the Light Railway Commissioners into the application of the London County Council to construct four lines of electric tramway—viz.: (1) Clapham-common to Kingston; (2) Deptford, by Shooter's-hill, to Woolwich; (3) New Cross, by Lewisham, to Eltham; and (4) Archway Tavern, Highgate, to the county boundary. The line from Deptford to Woolwich was first considered. Mr. Cripps, Q.C., for the Council, said the line was for local convenience. It would be worked on the slotted-conduit electric system, and the Council had met the wishes of the local authorities in regard to the method of constructing the line. Sir Alexander Binnie, engineer-in-chief of the County Council, said the Council had two existing tramways, connecting New Cross and Greenwich with Westminster and Blackfriars. The proposed extension would be 5½ miles long, and would be double throughout. The route presented no difficulty in regard to gradients. It was rather steep—1 in 10—at Shooter's-hill; but heavier gradients had been successfully dealt with at Halifax and Bradford. The total estimated cost was £178,637, which included electrical equipment. The line could not be carried out without widening some of the streets, but the Council were promoting a bill by which they sought to obtain powers to carry out this improvement at an estimated cost of £37,600. Most of the local authorities favoured the scheme, the only opposition coming from some of the thinly populated districts. It was true they took powers to carry goods, but they had not laid out any goods yard. They only intended to carry what might be called tramway parcels. Dr. A. B. W. Kennedy said he had prepared the plans and sections in connection with the proposed line. At no part would there be any interference with the ordinary traffic. The external appearance of the line would be exactly like that of the Brixton cable tramway, and no part of the conductors would be exposed. The conduit system was extensively used in New York and Washington, and in many European capitals. The cost would be £3,000 per mile more than the overhead system; but in view of the anticipated traffic he thought the increased cost could be borne without financial loss. The Council sought powers to construct the generating station in the Camberwell New-road, which was a desirable site. It was proposed to use the conduit system with an insulated return, thus avoiding any chance of electrolysis. The proceedings were adjourned until yesterday (Thursday). Further evidence was given yesterday (Thursday), and Mr. Balfour Browne, Q.C., urged the Commissioners to reject the applications, as a different procedure should have been adopted and the scheme should have been submitted to Parliament. The Council were seeking, by means of a light railway order to invade the legitimate powers of local authorities. Mr. Cripps contended that the Council had adopted the right method in bringing before the Commissioners the light railway portion and going to Parliament for power to make the street improvements. The chairman said it appeared that the Commissioners were of opinion that the proposal was incomplete because only a portion of it came before them at all, the schemes would therefore be rejected. Mr. Cripps then said that if the Improvements Bill were sanctioned the objection would not apply, and consequently they proposed to appeal to the Board of Trade on this point.

Liverpool.—Mr. A. P. Trotter officially inspected the Prince's Park electric tramway route on Tuesday.

Lymington.—The Council have invited tenders from Edmundson's Electricity Corporation and the local gas and coke company for lighting the district. Both tenders will be considered at the meeting on 10th prox.

Newcastle on-Tyne.—A Board of Trade enquiry will be held on 1st prox. into the application of the Corporation to borrow £120,560 for electric tramways.

The first rail of the new electric tramway system was laid by Mrs. W. Cail, wife of the chairman of the Tramways committee, on Thursday last. The total length of the system is about 20 miles, and all the lines are double.

Nuneaton.—The Local Government Board have intimated to the Council that, in respect to the application for sanction to a loan of £16,000 for the purchase of the Nuneaton Electric Co.'s undertaking, they are not satisfied that the purchase would not involve a charge upon the rates. If the Council retain the opinion that the purchase is advisable in the interests of the district, the board will not refuse to sanction the loan, provided the Council undertook to consult an expert as to future extensions, and be guided by his advice. The board have been informed that the Council think it desirable to purchase the undertaking, and that an expert will be consulted.

Pacific Cable.—In February last the Japanese House of Representatives passed a resolution in favour of Japanese participation in any scheme for the laying of a Pacific cable.

Personal.—Mr. W. J. Furze, head of the firm of W. J. Furze and Co., electrical engineers and contractors, Nottingham, has been unanimously appointed chairman of the Basford Board of Guardians, of which body he has been a member for ten years.

Perth.—An inquiry was held on Friday into the application of the Corporation to borrow £50,000 for electric lighting and £50,000 for gas extensions. Particulars of the electric lighting scheme were given by the consulting engineer (Mr. W. C. C. Hawtayne), and to this portion of the scheme there was no objection, but Bailie Taylor and Councillor Anderson objected to the proposed expenditure on gas works.

Portsmouth.—The charge for the supply of current to public buildings has been reduced from 4½d. to 4d. per unit.

Private Bill Legislation.—The promoters of the North Metropolitan Electric Power Supply Bill have introduced a clause into this measure to empower them to compulsorily acquire lands in Enfield for the erection of an electricity generating station.

The Salford Corporation desire to introduce an additional clause in their bill before Parliament empowering them to run omnibuses in connection with any tramways owned, leased or worked by the Corporation.

The City of London Electric Lighting and the Metropolitan District Railway Bills were read a second time in the House of Commons yesterday (Thursday). The London County Council Tramways (No. 2) Bill was considered and ordered for third reading.

Provisional Order Transfer.—The Garston District Council intend to transfer their electric lighting Order to the Garston and District Electric Supply Co. (Ltd.), receiving power to purchase at 21 years, or at the end of any year thereafter. The company agree to pay the expenses of obtaining the Order and transfer.

St. James' and Pall Mall Electric Light Co. (Ltd.)—The amount of electricity sold by this company for the quarter ended March 25 is returned at 1,599,768 units (estimated to produce £28,529), as against 1,161,987 units (which produced £20,964) for the corresponding period of 1899.

Sheffield.—The Eccleshall electric tramway route has been passed by the Board of Trade.

Telephone Wayleaves.—At Southwark (London) Police Court on Monday Mr. J. A. Johnson, clerk to the Vestry of St. George the Martyr, applied for a summons against the National Telephone Co. for breaking up the roadway in Marshalsea-road, Borough, on the early morning of April 1. Mr. Johnson stated that the application was under Sec. 109 of the Metropolis Local Management Act, and was made on the strength of advice given by the judge in the case "Battersea Vestry *v.* County of London and Brush Provincial Electric Lighting Co." In that case the judge refused an application for an injunction to remove conduits which had been laid, but suggested that if a summons had been taken out under Sec. 109 of the Metropolis Local Management Act the result would have been different. In the present instance the company did not give three clear days' notice of intention to break up the road, although they had been negotiating for years for permission. The Vestry had however withheld their consent except upon certain conditions. The summons was granted.

Theft of Electrical Fittings.—At the Hull Quarter Sessions last week, before Mr. J. Forbes, Q.C., some singular evidence was given during a charge of theft. Charles Monkman, electrician; M. McElwee, labourer; and J. H. Nicholson, electrician, were indicted for stealing a quantity of electrical fittings from Messrs. Reames, Wokes and Co. The prosecutors had undertaken a contract with the Sculcoates Guardians for wiring the Beverley-road workhouse. McElwee was in their employ, and it was alleged that he purloined a quantity of fittings and sold them to the other prisoners, who fitted them into various shops in the city. Defendant Monkman gave evidence in his own behalf and said he had been in the electrical business in Hull for 16 years, and always stipulated with his employers that he should be allowed to do private work. McElwee borrowed 3s. 6d. from him, and subsequently he took to him a coil of wire and six lamp holders, and asked him to buy them. He did so, and gave him 7s. 6d. for the lot. He did not know the articles were stolen. Afterwards he sold the wire and holders to Nicholson for 10s. Nicholson said that he did private electrical work in his own time. He had no idea the things he purchased from Monkman were stolen. He paid him about two-thirds the value of them, but did not take a receipt. He knew he was getting the goods cheap. He took a ceiling rose and some holders from his employer (Mr. Hyde) without his knowledge, but had paid for them after the other two men had been taken into custody, and after Mr. Hyde had been round and seen the different shops which he (Nicholson) had fitted up. He was still in Mr. Hyde's employ, and had continued to purchase things from him. He had nearly paid Mr. Hyde for all he had taken. The Recorder said he had never heard of such a state of things in his life. Mr. Hyde said he was satisfied Nicholson was an honest, straightforward man. He took the things without his knowledge,

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it was true, but he had done it before, and paid for them in the usual way. Nicholson was found not guilty, and was discharged. The other prisoners were found guilty, and McElwee was committed for one week, making 12 weeks in all, as he had been 11 weeks in custody. Monkman was sentenced to 11 weeks' imprisonment in the second division.

"The Journal."—Part No. 144 of the *Journal of the Institution of Electrical Engineers* is now ready, price 3s. 6d. Particulars of the contents are given in an advertisement elsewhere.

Workhouse Lighting.—The Preston Guardians have decided to light the Fulwood workhouse electrically.

On Monday the chairman of the Croydon Union Infirmary committee (Mr. G. J. Shirley) formally switched on the electric current in the presence of a number of visitors. The installation was erected by Messrs. W. J. Bishop and Co., to the specification of Mr. A. W. Sclater, the consulting engineer. There are about 800 lamps in the infirmary, totalling in the aggregate to 13,000 c.p.

Works Lighting.—At the recent meeting of Dr. Tibble's Vi-Cocoa (Ltd.) the chairman announced that their new extensive factory at Watford was being fitted up with a complete electric lighting plant.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date) a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made quite complete. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is the most complete and correct book of its kind ever published in any language.

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Armature Winding of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"Temperature Coefficients of 'Conductivity' Copper." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 84·9°F. Printed on strong cardboard, 6d. net.

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IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade.

"Primary Batteries: Their Construction and Use."—By W. R. Cooper.

"Practical Telephony."—By Dane Sinclair and F. C. Raphael.

"'The Electrician' Wireman's Pocket-book."—Edited by F. C. Raphael. *Nearly ready.*

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

The *Heywood* Corporation require tenders for the supply and erection of electricity generating plant, particulars of which are set out in an advertisement. Copies of specification, &c, may be obtained from the offices of the town clerk (Mr. J. H. Baldwick) after 30th inst.; and specifications and plans may also be obtained from the consulting engineer (Mr. W. P. Adams), 35, Queen Victoria-street, London, E.C., from whom further information can be obtained. Tenders addressed to the town clerk, Municipal Buildings, Heywood, Lancs., must be delivered before noon on May 14.

The Commissioners of the Royal Burgh of *Perth* invite tenders for the supply and erection of 45 enclosed arc lamps and ornamental cast-iron and steel pillars, with switch gear, &c. An advertisement contains additional particulars, and specifications may be obtained at the offices of the clerk (Mr. John Begg), City Chambers, Perth. Plans can be seen and further information obtained at the offices of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., and Central Chambers, 93, Hope-street, Glasgow. Tenders must be delivered before noon on May 7.

The *Salford* Electric Light committee require tenders for two miles of low tension single cable, lead covered, and a battery of accumulators. An advertisement contains further particulars, and specifications, &c., may be obtained from the electrical engineer (Mr. Chas. L. Turner), Walness-road, Broughton. Tenders (addressed chairman of committee) must be delivered at the offices of the town clerk (Mr. L. C. Evans), Town Hall, Salford, before 10 a.m. of May 7.

The Streets committee of the Corporation of *London* invite tenders for the supply on hire of electrically-driven dust carts. An advertisement contains further particulars, and tenders must be sent to the town clerk (Sir John B. Monckton), Public Health Department, Guildhall, E.C., by June 1.

The *Manchester* Tramways committee invite tenders for 150 car trucks, tramway bonds and special track work and points and crossings. Specifications may be obtained from the general manager (Mr. J. M. McElroy), Tramway Department, Town Hall, Manchester, and tenders (addressed Chairman of committee) must be in by May 7. An advertisement gives further particulars.

The *Paddington* (London) Vestry invite tenders for carrying out certain work in connection with proposed alteration to the existing electric lighting at the public baths. Copies of specification can be obtained from the surveyor (Mr. George Weston), and tenders must be delivered to the vestry clerk (Mr. Frank Dethridge), Vestry Hall, Harrow-road, London, W., by noon of May 14. An advertisement gives further particulars.

The Guardians of the *West Ham* Union invite tenders for the erection of works detailed in an advertisement elsewhere. It will be seen that the tenders are to include maintenance of the installation for 12 months from the date of completion of the whole of the works. The advertisement contains further important particulars of the conditions, and tenders have to be sent in to Mr. Fred. E. Hilleary, clerk to the Guardians, Union-road, Leytonstone, E., by Wednesday, May 16.

The *Burnley* Corporation invite tenders for laying about 2,000yds. of cable. Tenders to Mr. A. Steele Sheldon, town clerk, by May 14. See advertisement.

The *King's Lynn* Corporation invite tenders for the supply of steam dynamos, boiler, switchboard and cables. Tenders by May 17.

The *Birkenhead* Corporation invite tenders for steam pipe work, &c. Tenders by May 15.

The *Wimbledon* District Council require tenders for erecting additions to the electricity station building. Tenders to clerk by May 15.

The *Keighley* Corporation require tenders for steel roofs and girders for the electricity works. Tenders by May 1 to electrical engineer.

The *Central Electric Supply Co. (Ltd.)* invite tenders for the supply, delivery and erection of electricity generating plant. Specifications from general manager (Mr. F. J. Walker), 19, Carnaby-street, Golden-square, London, W., to whom tenders by 10 a.m. of May 22.

The *Rhyl* District Council invite tenders for the supply and erection of electricity generating plant. Tenders to Clerk by 2 p.m. of May 14.

The *Great Eastern Railway Co.* require tenders for stores, including telegraph materials, bolts, screws, tools, &c. Tenders to secretary (Mr. W. H. Peppercorne) by 10 a.m. on May 8.

The *Glasgow* Corporation require tenders for opening trenches and supplying and laying underground conduits for telephone purposes, &c. Tenders to town clerk (Sir J. D. Marwick) by 30th inst.

The *Glasgow* Corporation also invite tenders for electricity meters. Tenders to Town Clerk before May 5.

The *Plymouth* Corporation invite tenders for overhead line construction, &c. Tenders to borough electrical engineer (Mr. John H. Rider) by May 2.

The *Southampton* Corporation invite tenders for a 300 kw. continuous-current generator. Tenders to Town Clerk by May 1.

The *Brighton* Corporation invite tenders for the supply of incandescent lamps for 12 months from July 1 next. Tenders to Town Clerk by June 11.

Tenders are invited until May 3 by the *Bienrerida* Municipal Council (Badajoz), Spain, for the concession for electric lighting for two years. Tenders to el Secretario del Ayuntmiento.

The *Swedish* Government invite tenders until May 3 for the supply of telephone cables, as follows:—2,000 metres (204 wires) underground cable; 10,000 metres (28 wire) overhead cable; 10,000 metres (14 wire) overhead cable.

The *Aarhus* (Denmark) Council invite tenders for delivering and laying down network for distribution of electricity. Tenders by 20th inst., to Aarhus Gas Works.

TENDERS RECEIVED AND ACCEPTED.

A short time back tenders were invited privately for wiring and installation work at King's College, London, and five tenders were submitted. It will be seen from the list below that a higher tender than the lowest has been accepted, and one of the tendering firms, whose offer was much below that of the accepted tender, complains that its offer was rejected. As, however, the specification contained the usual clause that the Council of King's College did not bind themselves to accept the lowest or any tender, there can be little real cause for complaint. We understand that the committee of King's College who considered the tenders were unable to come to a decision at a first meeting, and consequently held a second to discuss the whole question in consultation with their engineer. The dissatisfaction expressed over this contract points to the unwisdom of seeking tenders by other means than public advertisement:—

	Iron tubing.	Wood casing.
Tamplin and Makovski (*accepted*)	£1,656 0 6	£1,444 5 9
Alliance Electrical Co.	1,722 0 0	1,644 10 0
Drake and Gorham	1,343 0 0	1,209 15 0
National Electric Wiring Co.	£1,173 8 4	
J. O. Grant	1,160 0 0	

The Keighley Corporation have accepted the tender of Messrs. G. H. Woods and Co. for wiring the new municipal offices at £220.

The tender of the National Electric Wiring Co. has been accepted for wiring the Gloucester Library and municipal schools at £372. 13s.

The Bedford Corporation have accepted the tender of Messrs. W. Courte and Son for the supply and erection of two Lancashire boilers at £1,322. Eight tenders varying in amount from that accepted to £1,750 were submitted.

APPOINTMENTS VACANT AND FILLED.

A chief assistant to the superintendent engineer is required for the Bradford Corporation electricity department. An advertisement contains further particulars, and applications to the city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford, must be in by May 2.

The States of Guernsey require a local manager for their telephone exchange. Applications to Mr. A. R. Bennett, City Chambers, Glasgow. An advertisement contains additional particulars.

A chief assistant is required for an alternating current electricity station. See advertisement.

A shift engineer is required for the Taunton electricity works. Applications to the Borough electrical engineer (Mr. Ed. B. Thornhill) by May 5. See advertisement.

A junior assistant engineer is required by the Dover Electricity Supply Co. (Ltd.). See advertisement.

Thirty-one tenders have been received for the electric lighting of the Northumberland County Lunatic Asylum, and the report of Mr. A. A. Campbell Swinton upon these tenders is to be considered at the meeting of the Visiting Committee on 21st May.

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The Brighton Corporation require a resident electrical engineer to act under the consulting engineer (Mr. Arthur Wright). Applications town clerk (Mr. F. J. Tillstone) by 10 a.m. of 30th inst.

A chief clerk and book-keeper is required for the Shoreditch electric lighting department. Applications to vestry clerk by May 9.

The Manchester Tramways committee require a foreman platelayer, a foreman pavior, and a yard foreman. Applications (addressed to chairman of committee) to Town Clerk by 30th inst.

A second assistant engineer is required at the York electricity works. Applications to the city electrical engineer (Mr. C. A. Midgley) by May 7.

BANKRUPTCIES, LIQUIDATIONS, &c.

The discharge of E. L. Joseph, electrical engineer, 109, Brondesbury Villas, Brondesbury, and Northampton Works, Northampton-grove, Canonbury, London, is suspended for three years because, (1) the assets are not equal to 10s. in the £, and (2) debtor had contracted debts without reasonable expectation of being able to pay them, and had incurred unjustifiable expense by bringing a frivolous or vexatious action.

In the bankruptcy of Edwin Bates, electrician (now or lately trading at 4, Hopwood-avenue, Manchester, with W. H. Walley, as E. Bates and Co.), the first meeting of creditors will take place on May 2 at the O.R.'s, Byrom-street, Manchester, and the public examination on May 28 at the Court House, Manchester.

The Perfect Arc Lamp and Accessories Co. (Ltd.) is to be wound up voluntarily, and Mr. S. H. Lee, 185, Gracechurch-street, E.C., is liquidator.

Claims against Cuttriss, Wallis and Co. (Ltd.) must be sent by June 6 to the liquidator, Mr. J. W. Close, Greek-street Chambers, Leeds.

Plant for Sale.—The National Telephone Co., Royal Exchange, Glasgow, have for sale a motor generator by Mavor and Coulson and a Crocker-Wheeler motor. See advertisement.

A complete private electric lighting plant is advertised for sale in another column. Applications to Mr. Thomas J. Barratt, Bell Moor House, Upper Heath, Hampstead, London, N.W.

Telegraph Stores for Sale.—Tenders are invited for the purchase of old telegraph stores, particulars of which are set out in an advertisement. Forms of tender can be obtained from the controller of stores (Mr. Chas. E. Stuart), G. P. O. West, London, E.C, and tenders must be in by 10 a.m., May 9.

Parsons Steam Turbine.—Messrs. Brown, Boveri and Co. and the Parsons Foreign Patents Co. have entered into an agreement for the manufacture and sale, for electrical purposes, of the well-known Parsons steam turbine in France, Germany, Russia, Switzerland and Italy, and a company styled the Aktien-Gesellschaft für Dampf-Turbinen (System Brown-Boveri-Parsons), has been registered in Switzerland, with head office at Baden, for the purpose of carrying on the business. The combination is an important one in view of the position Messrs. Brown, Boveri and Co. hold on the Continent as manufacturers of electric generating plant.

Electrical Inkless Printing.—Some time back we received a circular from the Electrical Inkless Printing Syndicate (Limited), in which reference was made to a pamphlet on "Picturesque Dovercourt," stated to have been recently issued by the syndicate as an example of the printing work produced by the syndicate's machinery and patented method of production. In the printing trade it is pretty generally thought that the sensitiveness of the chemically-prepared paper used in the syndicate's process becomes exhausted when one side of the paper has been printed upon. This, however, the syndicate denies, and claims that paper has been printed on one side only and laid by for a lengthened period, and when again put through the machine for printing on the reverse side has at once responded to the electric current. These statements and claims are interesting not only to the printer but to the electrician, and it would be distinctly in the syndicate's interest from every point of view to clearly and publicly demonstrate their truth or falsehood. The syndicate does not readily respond to the efforts made by the technical press to obtain particulars of its process.

French Patents and the Paris Exhibition.—Messrs. J. C. Chapman and Co., 70, Chancery-lane, W.C., write to point out that in connection with the International Exhibition at Paris this year, a short law was enacted in December, 1899, by which "any person who shall have exhibited at the Universal Exhibition of 1900 an article similar to that covered by his patent, shall be considered, so far as is necessary, as having worked his discovery or invention in France during the course of the Exhibition." The French law provides two years' delay for working any patented invention, and by default of such working forfeiture is incurred, but by the above law, patented inventions exhibited and "worked" during the exhibition, the period of delay will recommence either from the date of the official closing of the exhibition, or from the date of an earlier order by the authorities for removal of the article. The exhibition of a patented article therefore constitutes sufficient compliance with the working provisions of the French Patent Law. It is advisable for those who exhibit patented articles to obtain a sufficient certificate or proof thereof, as in the case of ordinary working, for subsequent use should the validity of their patents be attacked.

Accumulator Plates.—An advertisement on p. 22 announces that Mr. O. R. Schulz, patent agent, 171, Leipzigerstrasse, Berlin, W., is prepared to grant manufacturing licences for what is claimed to be a good and rapid process for producing electrodes of any kind with large surfaces, without injurious chemical constituents. Or the process may be purchased outright.

"Buffoline" Noiseless Gearing.—The Buffoline Noiseless Gear Co., of Chapel-street, Levenshulme, near Manchester, forward particulars of special types of gearing manufactured by the company on spur, bevel, single or double helical, with machine cut teeth, for motors, pumps, cranes, motor cars, and for general machinery. These wheels are claimed to have been tested to be more than twice the strength of cast iron. The company undertake to cut spur wheels up to 11ft. diameter.

Interior Conduit Systems.—Messrs. Pryke and Palmer have issued an illustrated list of interior conduit fittings. This firm claims that its system was placed before the trade some years ago and was the original conduit wiring system.

British Westinghouse Plant.—Circular No. 1,026, issued by the British Westinghouse Co., is entitled "Compensators for A.C. Circuits," and illustrates and describes Westinghouse compensators of the E and F types.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 13 to April 24, with the ports of destination:—

Africa—Alexandria, £24; Cape Town, £71; Chinde, £866 (including £854 telegraph material); Durban, £979 (including £832 telegraph material); East London, £75; Port Elizabeth, £164. *Argentina*—Buenos Ayres, £331 (including £244 telegraph material). *Australasia*—Adelaide, £14; Auckland, £101; Canterbury, £11; Christchurch, £28; Freemantle £42 (including £17 telegraph material); Launceston, £200; Melbourne, £271 (including £50 telegraph material); Port Chalmers, £58; Sydney, £1,180; Townsville, £763; Wellington, £706. *Belgium*—Brussels, £34; Ostend, £105. *Ceylon*—Colombo, £295. *Channel Islands*, £115. *China*—Shanghai, £310; Tientain, £76 (telegraph material). *Denmark*—Copenhagen, £121 (telegraph material). *France*—Havre, £100. *Germany*—Hamburg, £985 (including £900 telegraph material); Stettin, £60. *Gibraltar*, £11 (telegraph material). *Holland*—Amsterdam, £135; Flushing, £78; Rotterdam, £100 (telegraph material). *Hong Kong*, £510. *India*—Bombay, £476 (including £83 telegraph material); Calcutta, £2,742 (including £655 telegraph material); Madras, £131. *Malta*, £140. *Mauritius*, £75. *Peru*—Callao, £15,000 (telegraph cable). *Russia*—Odessa, £80 (telegraph material). *St. Vincent*, £163,000 (telegraph cable). *Straits Settlements*—Singapore, £434 (telegraph material). Total (for 12 days) £191,047, against £35,575 for one week last year (April 19 to 25).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 24, 1900.

5,561. R. Rougé and G. Faget. London. Transformer of alternating currents into continuous currents of equal or different tension. (Date applied for under Patents, &c., Act, 1883, sec. 103, Sept. 27, 1899, being date of application in France.)

5,562. R. Rougé and G. Faget. London. Improvements in apparatus for transforming single and multiphase alternating currents into continuous currents and inversely. (Date applied for under Patents, &c., Act, 1883, sec. 103, Nov. 14, 1899, being date of application in France.)

5,567. E. Andreas. London. Improvements in or relating to plug contacts.

5,569. W. P. Thompson. Liverpool. Improvements in or connected with electric storage batteries. (E. A. Sperry, United States.)*

5,585. R. Arno. London. Improvements relating to the measurement of electric power and energy in three-phase alternating-current systems. (Date applied for under Patents, &c., Act, 1883, sec. 103, Aug. 26, 1899, being date of application in Italy.)

5,593. A. Wright and The Reason Manufacturing Co. (Ltd.) London. Improvements in electricity meters.

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March 26, 1900.

5,609. T. Tomlinson. Dublin. An improvement in electrical (static) transformers and in the arrangement of sub-stations containing them.
5,637. H. R. von Kralik. London. Improvements in the manufacture of globes or shades for incandescent lamps.
5,649. S. G. Brown. London. Improvements in and relating to telegraphic apparatus.
5,650. W. P. Thompson. Liverpool. Improved method and apparatus for determining the size and position of bodies by means of Röntgen rays. (The Voltohm Electrical Co., Germany.)

March 27, 1900.

5,693. M. C. Mengis and F. S. Christensen. Manchester. Improvements in and relating to telephonic systems.*
5,698. J. Langton. Manchester. Improvements in the method of and means for protecting electrical connections.*
5,707. S. Wolf. London. Improvements in means for carrying or supporting electric leads or conductors.
5,710. P. J. S. Tiddeman. Manchester. Improved indicator for storage batteries.
5,727. J. A. G. Trudeau. London. Improvements in the electric heating of liquids and apparatus therefor.*
5,751. E. A. Sperry. Liverpool. Improvements in or connected with storage batteries.*
5,755. C. Jung, A. Brecher, and A. Kittel. London. Improvements in the manufacture of electrical insulating materials.*
5,764. C. A. Lindstrom. London. Means for retaining the field magnet coils of electric motors and dynamos in position. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 16, 1899, being date of application in United States.)*
5,767. E. Stanley. London. Improved construction of carrier for globes or glasses of electric gas or oil lamps.

March 28, 1900.

5,773. A. G. New. Woking. Improvements in automatic and safety subsidiary devices for controlling electrically propelled vehicles and the like.
5,786. G. H. Nisbett. Liverpool. Improvements in electric cables.
5,806. The British Thomson-Houston Co. (Ltd.) London. Improvements in the regulation of dynamo-electric machines. (C. P. Steinmetz, United States.)*
5,833, G. A. Mower. London. Improvements in and relating to starting, regulating and reversing switches for electric motors.
5841. M. C. Clutterbuck. London. Improvements in electricity meters.

March 29, 1900.

5,848. M. H. Smith. London. Improvements in conduits for electric tramways.*
5,860. W. H. Scott. Norwich. Improvements in electrical apparatus for hoisting or other intermittent work.
5,900. C. B. Callow and H. J. Eck. London. A method of securing intermittent motion in electric switches and other devices.
5,925. J. G. Childs. London. An electric lift controller.

March 30, 1900.

5,928. W. Aitken. London. Improvements in telelephone divided multiple-board systems.
5,944. B. J. Day. London. Improvements in train lighting by electricity.
5,961. W. McAulay, G. A. Clark, and J. A. McLaren. Glasgow. Improvements in and relating to the rendering water-tight the attachment of fittings used in electric wiring to branch cables.
5,980. H. Bevis and F. W. M. Chapman. Upton Park. An improved plug and socket fitting for electrical circuits.

March 31, 1900.

6,023. The British Electric Works Co. (Ltd.) and B. Brander. Birmingham. Improvements in electric bells.*
6,028. E. W. Mix. London. Improvements in brush-holders for dynamo-electric machines.*
6,054. H. C. Jobson. London. Improvements in telegraph poles.
6,069. R. Lundell. London. Improvements relating to the generation of direct electrical currents and to apparatus therefor.*

April 2, 1900.

6,101. H. Oppenheimer. London. Improvements in and connected with microtelephones. (Actiengesellschaft, Mix, and Genest, Germany.)
6,103. R. O'Brien. Manchester. Improvements in and relating to shade rings for use in connection with electrical and other lamp-holders.
6,129. R. von Grätzel. London. Improvements in and connected with the production of paste carriers for collectors of electricity.
6,138. A. F. Spooner. London. Improvements in and relating to synchronous motors, more especially applicable to combined cinematographic and phonographic apparatus. (H. Joly, France.)
6,141. A. F. Evans. London. Improvements in magneto-electric generators for electric ignition purposes.
6,153. P. M. Justice. London. Improvements in and connected with electrically propelled motor vehicles. (Columbia and Electric Vehicle Co., United States.)*

April 3, 1900.

6,165. J. Swinurne. London. Improvements in incandescent lamps.
6,188. J. B. Boutillier and W. B. Hunter. Glasgow. Improvements in armoured conduits for electric wires.*
6,204. H. C. Longsdon and S. Dale. Keighley. Improvements in and appertaining to switches for electro-motors.
6,209. G. Brewer. London. Improvements in electric bonds for street-mains. (A. A. Knudson, United States.)
6,217. P. H. Rosenbach. London. An improved compound or material for bearings, valves, cells for storage batteries and similar purposes.*
6,218. C. L. Coffin. London. Improvements in machines for electrically heating, welding, or working metals.*
6,237. J. Schwarzenbach. London. Improved electrical gas igniting apparatus.
6,244. L. David. London. Improvements in and apparatus for manufacturing plates for secondary electric batteries.
6,261. C. W. Atkinson. London. Improvements in electric switches and resistances.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

5,100. Cooper and Ridley. Methods for charging and discharging accumulators.
5,104. Braun. Reinforcement of electrical waves and avoidance of loss by straying reflection and the like by means of a condenser.
5,211. Miller. Electric incandescent lamps.
5,468. Wise (Thowless). Incandescent bodies for electric incandescent lamps.
5,543. Cohen and Cole. Multiplex selective systems of wireless telegraphy.
5,734. Vitali. Hydrocarbon engines for driving dynamo-electric machines and dynamo-electric machines driven thereby.
5,797. Rhodes. Alternating-current induction motors.
6,032. Loubery, Francois and Kunkelmann. Electricity registers or meters.
6,054. Berditschewsky-Apostoloff. Electric lamps.
6,690. Lamme. Method of and means for varying the speed of direct current motors. (Date applied for under International Convention, Sept. 3, 1898.)
6,691. Lamme. Systems of electrical distribution and regulation. (Date applied for under International Convention September, 28, 1898.)
6,712. G. Aboilard et Cie. Lines, circuits and apparatus for telephonic intercommunication. (Date applied for under International Convention, August 30, 1898.)
6,873. Prestwich. Accumulators or secondary batteries.
6,947. Wydts and Weissmann. Method of and apparatus for transforming continuous electric currents into continuous or alternating currents of different voltage.
7,415. Cary and Delevy. Electrical cooking apparatus.
7,594. Bowley. Phonographs and the like.
7,856. Royal. Coin-freed gramophones or the like.
7,641. Cole and Cohen. Hertzian wave telegraphy to enable signals to be transmitted to any distance by means of intermediate relay stations.
8,340. Berry and Wallis-Jones. Electric welding or metal working apparatus.
8,522. Welford. Storage batteries.
8,949. Belfield (Perkins). Starting mechanism for electric motors.
8,957. Reason and Mutual Electric Trust (Ltd.) Connecting devices for electric conductors.
8,961. Poulsen. Method of and apparatus for effecting the storing up of speech or signals by magnetically influencing magnetisable bodies.
9,101. Pennycuick and Barrett. Globes or protectors for electric and other lighting apparatus.
9,278. Statter. Dynamo electric or electrodynamic machines.
9,351. Strecker. Manufacture and production of elements for secondary batteries or electric accumulators.
9,414. Leitner. Controlling electric motors and apparatus for that purpose.
9,456. Niblatt and Sutherland. Electric storage or secondary batteries.
9,512. Abel (Soc. d'Etude des Piles Electriques). Voltaic batteries.
8,518. Veyey. Automatic telephonic switches.
9,523. Lamme. Distribution of electric currents. (Date applied for under International Convention, Oct. 6, 1898.)
9,690. Denayrouze. Incandescence lamps. (Date applied for under International Convention, October 19, 1898.)
9,966. Boult (Jungbluth). Manufacture of protecting casings or tubular structures for electric cables.
10,163. Lake (Scott). Electric circuit breakers.
10,228. Boult (von Zweigbergk). Electric controllers.
11,424. Marino. Accumulator batteries.
11,552. Voigt and Haeffner. Electric tumbler switch.
11,880. Croneau. Portable electric drilling machine.
13,733. Abel (Soc. Anon. pour la transmission de la Force par l'Electricité). Apparatus for exciting alternating current dynamos.
15,019. Gillmore. Telephone switches and switchboards.
16,494. Groome. Automatic cut-off devices principally designed for controlling the flow of fluids and of electric currents.
16,650. Petersen. Conduits suitable for electric mains.
18,350. Marino. Electrolytes.
20,328. Robison. Dynamo electric generators or transformers.
21,378. Halsey. Combined maximum and integrating electric meter. (Date applied for under International Convention, March 27, 1899.)
21,777. Szanka and Ganz and Co. Eisengiesserei und Maschinen-Fabriks Actien-Gesellschaft. Electric condurting sheaths or coverings for articles of ceramic or pulverulent materials.
22,081. Schiff. Micro telephones.

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23,219. BOULT (Cumont). Electric signal alarm and safety devices for railways.
23,540. HART. Graphophone reproducers.
24,614. RIES. Telephone systems and apparatus.
24,673. BUTCHER. Electric clocks.
24,739. ELY. Electric switches.
25,491. MARINO. Accumulator batteries.

1900.

547. PAYNE. Process of and apparatus for magnetic separation.
1,276. BOULT. (Soc. E. Giraud et Cie.) Electric chain-link welding machines.
1,309. EARLE. Manufacture of compound metal tubes suitable for gas and electrical conductors.
2,077. CHEVAL and LINDEMAN. Accumulator battery.
2,271. BOULT. (Soc. Anon. des Moteurs et Voitures "Aigle.") Electric ignition devices for explosion engines.
2,357. SIEMENS BROS. AND CO. (LTD.) (Siemens and Halske Aktien Gesellschaft.) Electro-magnetic bell signalling apparatus.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia and China Telegraph Co. (Ltd.).

The fifty-third half-yearly general meeting of this Company was held on Wednesday at Winchester House, London, under the presidency of the MARQUIS OF TWEEDDALE, K.T.

The MANAGER and SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and the minutes of the previous meeting, which were duly confirmed and signed by the Chairman, after which

The CHAIRMAN said: Gentlemen, I think that you will consider the report and accounts satisfactory. (Hear, hear.) The gross revenue for the half-year under review has amounted to £339,450, against £290,431 for the correeponding period of 1893, showing an increase of £49,019. About one-half of this increase is derived from Australasian traffic, the remainder being spread over the rest of the system, but more particularly the Manila, Japan, and China sections. The working and other expenses have amounted to £116,935, against £100,085 for the corresponding period of 1898, showing an increase of £16,850, which, as will be seen from the printed accounts, is almost entirely due to the "Expenses attending the maintenance of cables" being considerably heavier than in 1898. The balance of increase is attributable to the special payments made to the Philippines staff to recoup losses, &c., during the insurrection and war in those islands, and also, to a smaller extent, to expenses connected with negotiations with foreign and other Governments. Comparing the figures for the whole year, the results are as follows: Gross receipts, £663,811, against £567,713 for the year 1898, or an increase of £96,098, while the expenses for the past year amounted to £224,201, against £202,958 for the year 1898, showing an increase of £21,243, accounted for as already explained. The usual interim dividends have been distributed during the past year, making with the final dividend proposed to be paid to-morrow a total payment of 5 per cent. for 1899. A bonus of 4s. per share, or 2 per cent. will also be paid, making a total distribution for the year of 7 per cent. The revenue balance of £86,582 has been carried to the general reserve fund, which now stands at £967,581, after having charged against the fund £58,901 for cable renewals, &c., carried out during the June half of 1899. It will also be observed from the printed report and accounts that the subsidy of £32,400 per annum, payable by certain of the Australasian Governments in respect of the duplicate cable between Penang and Australia, ceased on Oct. 31 last. The original debenture debt amounted to £640,000, which will be entirely extinguished when the 333 debentures now outstanding are paid off on July 2 next. The Tariff Guarantee Agreements entered into several years ago with the Australasian Governments will also come to an end during the next few days; but, on the other hand, a new agreement has recently been concluded with the Governments of South Australia, Western Australia, and Tasmania for immediately reducing the tariffs between the contracting Colonies and Europe (varying between 4s. 9d. and 5s. 1d. per word) to an uniform rate of 4s. per word, with proportionate reductions for Government and press telegrams. Should the "standard revenue" fixed by the agreement be maintained, a further reduction—to 3s. 6d. per word—will take place on January 1 next, to 3s. on January 1, 1902, and to 2s. 6d. on January 1, 1903. The agreement, moreover, provides for the extension by this Company, in conjunction with the Eastern Telegraph Co., of the third cable recently laid by the latter company to South Africa—by laying a direct cable from Durban to Perth and Adelaide, via Mauritius, Rodriguez and Cocos Islands; and when this cable is opened for traffic, the tariff between the Contracting Colonies and South Africa will be reduced from 7s. 1d. per word to about 2s. 6d. The Company have not asked for any subsidy or guarantee in return for the reduced rates and improved communication which the new cable will secure, but only for the right to have their own land wires and offices in the capitals of the contracting Colonies when the proposed Government Pacific, or other competing cable is laid. At present the Company's cables are landed more than 2,000 miles away from the principal capitals in Australia, and the traffic is consequently dependent on the good working of the long Government landlines across the Australian Continent—which landlines might not be so efficiently maintained as they are at present when the Governments owning them are federated, and in competition with the Company for the international traffic. (Hear, hear.) On the other hand, the new cable will terminate in the heart of Australia, and with the right to deal direct with the public and transmit their own traffic from end to end, the Company will be placed on terms of equality with their opponents; and on that basis they do not fear the result should competition arise. (Cheers.) Strange to say, grave concern has been evinced in Canada, New Zealand, Queensland and elsewhere at the prospect of the Company enjoying in Australia the right so readily accorded in this country and in Canada itself, both to foreign and British cable companies, of direct dealings with the public; and not only have the Company's motives and intentions been misinterpreted in those Colonies, but strong protests have been made by the Governments of Canada, New Zealand, and Queensland against the Australasian Governments granting any such privilege to the Company. Nevertheless, as I have already mentioned, three of the Australasian Governments have agreed to grant the privilege; and the Governments of New South Wales and Victoria having accepted the agreement in principle, are expected to join in the arrangement very shortly. (Applause.) The protest to which I have alluded is based on the ground that if the privilege is granted it will make the Government Pacific Cable a financial failure; but the real objection appears to be that the prospects of the Company will, in all probability, and at no very distant date, lead to a reduction of the tariff to 2s. 6d. per word; an objection, however, scarcely consistent with the ostensible objects of the Pacific scheme—namely, the breaking up of the Company's so-called monopoly and the cheapening of the cable rates to Australasia. It would almost seem that the promoters of the Pacific cable are not averse to creating a Government monopoly and the consequent discouragement of all private enterprise, if by those means a tariff can be maintained sufficiently high to make the Government Pacific cable a paying concern. However that may be, the danger has been averted by the action of the three Australasian Governments with whom we have concluded our agreement—an agreement which I believe will be approved by everyone present. (Hear, hear.) We have a fair field now before us, and no favour; and we have no doubt we shall be able to hold our own against all comers from whatever quarter proceeding. (Cheers). You will have learned from the report that it is proposed to add to the Directorate by electing Sir John Wolfe Barry, K.C.B., to a seat at the Board; and accordingly to increase the remuneration of the Directors to £4,500 per annum. Although the Directors have power, as you are aware, to fill up casual vacancies in the directorate, yet—having regard to the intimation given to the shareholders when the last vacancy occurred, that it was not then proposed to fill it up—your Directors desire to have the concurrence of the shareholders in the election of an additional Director. Moreover, it has been thought undesirable that the number of Directors should remain at the minimum fixed by the Articles of Association, as in case of a casual vacancy occurring, it might lead to some inconvenience, notwithstanding the resolution passed at a recent general meeting giving the Directors power to carry on the business of the Company during the casual vacancy. Sir John Wolfe Barry is, as you are doubtless aware, a Director of the Eastern Telegraph Co., and your Directors have much pleasure in proposing his election as a Director of this Company. He is well known as an engineer of the highest eminence, and the Company, I think, may be deemed very fortunate in securing his services as a Director. With these observations, I beg to propose—

"*That the Report and Accounts of the Directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share together with a bonus of 4s. per share, both free of income tax, payable on the 26th inst., making with the previous distributions a total payment of 7 per cent. for the year 1899.*"

Mr. FRANCIS A. BEVAN seconded the resolution.

The CHAIRMAN invited discussion, but no one rising to address the meeting, he put the resolution, and it was carried unanimously.

Mr. BEVAN afterwards proposed the re-election as a Director of the Marquis of Tweeddale, remarking that no words of his were required to put the resolution before the shareholders in the most favourable manner.

Mr. JOHN DENISON-PENDER seconded the motion, which was carried unanimously.

The CHAIRMAN: I beg to thank you very warmly, gentlemen, for your renewed confidence. Continuing, the Chairman proposed the re-election as a Director of Mr. Bevan.

The Hon. GEORGE PEEL seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed the election as a Director of Sir John Wolfe Barry, K.C.B.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the resolution, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. CLEMENT S. COLVIN, C.S.I., the following resolution was afterwards carried unanimously:—

"*That the minimum annual renumeration of the Directors be increased from £4,000 to £4,500, such sum to be divided between the Directors as they may from time to time determine.*"

The retiring auditors, Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Welton, Jones and Co., were afterwards re-elected.

Mr. JOHN NEWTON then proposed a vote of thanks to the Chairman and Directors for their services. He remarked that the past year had not been an ordinary one for the holders of telegraph stocks. Many rumours had been going about, and they were accused of being the most gigantic and pernicious monopoly ever known in the world. This was because they were paying a dividend of 7 per cent., but those who knew what the enterprise was at the outset would not consider 7 per cent. an extraordinary return even in these days. The Directors had struggled in the most successful manner, and had achieved an excellent position for the Company. (Applause.)

Mr. W. T. ANSELL seconded the resolution, which was carried unanimously.

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The CHAIRMAN: I beg to thank you, on the part of my colleagues and myself, for the handsome way in which this motion has been proposed and seconded and received by you. I think it is two years ago since I said with respect to the Pacific cable that we should successfully look after your interests, and I think that we have done so. (Cheers.)

The proceedings then terminated.

Dudley, Stourbridge, and District Electric Traction Co. (Ltd.).

The eighteenth ordinary general meeting was held on Tuesday, Mr. EMILE GARCKE presiding.

The SECRETARY (Mr. H. S. Hodgson) having read the notice calling the meeting,

The CHAIRMAN (in moving the adoption of the report and accounts) said: Gentlemen, this is practically the first meeting that has been held since the conversion of the line from steam working to electric traction. As as 1880, and the undertaking has for many years been worked by steam power. Some few years ago the British Electric Traction Co. acquired the majority of the shares of the company with a view to introducing electric traction. They commenced negotiations with the various local authorities, which proved rather a slow process. Nevertheless, arrangements satisfactory to all parties were made, with the result that the tenure was so extended as to permit of the expenditure of the additional capital requisite for reconstructing the permanent way, erecting power houses, providing new cars, and electrical equipment generally. Under the Tramways Act, of course, the local authorities were entitled to purchase the tramways on the expiration of a period of 21 years from the date of the order, which would be in 1902, and obviously the period remaining was too short to justify the large outlay which electric traction made necessary; and it therefore became absolutely incumbent on the Directors to make the fresh agreements with the local authorities to which I have referred. These agreements are not the same throughout the district. They vary according to circumstances, but, speaking generally, we have an extension of life for our lines ranging from 21 to 35 years, according to the different sections. In addition to making these agreements which have enabled us to convert the old lines from steam to electric traction, we have obtained powers for extensions in the district which we believe will very materially improve the results of working on the main line from Dudley to Stourbridge. These extensions have been promoted under the Light Railways Act, and the powers obtained under two separate orders. The first of these orders was confirmed by the Board of Trade in 1898, and the lines authorised by that order have been in course of construction for some little time, and I am glad to say that they are now nearing completion. We shall lose no time with the construction and equipment of these light railway extensions, and when they have been completed we shall have upwards of 16½ miles worked electrically by this company, as compared with the original line of about 5½ miles which the company was working by steam before the British Electric Traction Co. obtained control of the undertaking. It is obvious, therefore, that the whole aspect of the company's undertaking will have undergone a considerable change by the time these new lines are completed. The capital necessary for the electrical conversion of the line has so far been provided by the British Electric Traction Co. A few years ago the tramways of the Dudley and Stourbridge Co., 5½ miles long, were isolated from the other tramways in the district, yet by means of the various powers which the British Electric Traction Co. has obtained, these tramways now form part of a very important network of tramways and light railways traversing the whole of South Staffordshire and parts of the adjoining counties. A very important undertaking has been authorised under the Kinver Light Railways Order. That will join the Dudley-Stourbridge lines at two points, and will bring that very popular holiday resort into direct communication not only with Stourbridge, Brierley Hill, and Dudley, which are served by this company's lines, but also with other and more distant centres of population in what is known as the Black Country. Then, by means of one of the Light Railway Orders I have referred to, this company's lines have been connected with the tramways of the Dudley and Wolverhampton Co, which formerly were independent and completely isolated, being separated from the other tramways in South Staffordshire in the same way as the tramways of this company were. Then the fact that the British Electric Traction Co. have very large interests in the South Staffordshire Tramways Co., and have recently acquired the controlling interest in the Birmingham and Midland tramways, will make it possible, we hope, to arrange for mutual running powers over the other lines, in a way which will enable passengers on any part of this company's system to reach any other tramways in the very large and important district of South Staffordshire. Instead, therefore, of being a comparatively short line of 5½ miles, this company's system will form in a measure the centre of a very much larger system, and the traffic is almost certain to be very much greater per mile than it has been in the past. The existing tramways were opened for electric traction in July last year, and since then a very satisfactory service of electric cars has been provided over that route, but in view of the fact that the whole of our organisation—the character of the cars, the power-house, the car depôts—has been made with a view of providing for a larger service than is being run on the 5½ miles, it is difficult, if not impossible, to accurately gauge the results of the past few months' working as affording any indication of what will be the conditions of working in the future, when the other lines authorised by the Light Railways Orders have been completed. Nevertheless, it will be of interest to shareholders that I should state that, not only the number of passengers carried, but also the receipts, have increased by more than 50 per cent. as compared with the time when the lines were worked by steam. We propose to work, on behalf of the British Electric Traction Company, the Kinver Light Railways as soon as they are completed. With regard to the appropriation of the balance to the credit of profit and loss account, the amount is £4,309, exclusive of the sum brought forward from the previous year, and the Directors propose, after paying the preference dividend, that a dividend should be paid on the ordinary shares at the rate of 3 per cent. per annum for the past year, that £1,000 should be placed to depreciation fund, and that the relatively large balance of £2,313 should be carried forward. It would have been possible to pay a very much larger dividend than is proposed, but in view of the fact that a large amount is owing to the British Electric Traction Co. for construction works, which at present does not figure in the capital account, the directors deemed it more prudent that the dividend on this occasion should be at no higher rate than that which has been paid during the last few years, and that as large a balance as possible should be carried forward until the capital account had been adjusted in a way which would provide for the liabilities of the company, and until the other lines had been opened and had been working some time it was not advisable, in the opinion of the board, that the dividend should be largely increased. I conclude by moving the resolution.

The resolution was carried unanimously. The retiring directors and auditors were re-elected, and the proceedings terminated.

Kidderminster and District Electric Lighting and Traction Co. (Ltd.)

The second ordinary general meeting of this Company was held on Wednesday, Mr. J. S. RAWORTH, M.Inst.C.E. (chairman of the Company), presiding.

The SECRETARY (Mr. H. S. Hodgson) having read the notice calling the meeting,

The CHAIRMAN, in moving the adoption of the report and accounts, said: Gentlemen, this is the first meeting of the shareholders which has been called for any specific purpose. I would remind the shareholders that this Company was formed for combining, as far as might be found practicable, the tramway service and the electric lighting of Kidderminster and district. You are aware that there is a company called the Kidderminster and Stourport Electric Tramway Co. That company possess a line of tramways between Stourport and Kidderminster, and it is in contemplation to make an extension of it to Bewdley. I am glad to say that we are on extremely friendly terms with the Corporation of Kidderminster, who, although they have not seen their way to support our proposition exactly in the form in which we put it before them, yet have come to an agreement with us whereby they will withdraw all opposition, so far as they are concerned, to the granting of the requisite Order. This Company made an arrangement whereby they took over the electric lighting Order granted to the Corporation of Kidderminster, and in order to work the whole undertaking economically the two enterprises—the tramway service and the lighting—have been combined as far as possible. You will notice by the accounts that this Company hold 5,600 shares of £10 each of the Kidderminster and Stourport Electric Tramway Co. out of the 5,720 shares issued, and had paid up, on Dec. 31, £22,400 on account of calls due on those shares. Other money has been spent on capital to the extent of £6,676 in connection with buildings and plant for electric lighting, and I may add that there is every prospect that the supply of current will be commenced in the course of the coming summer. The revenue account shows, you will see, that the revenue of the Company (£1,558) is almost entirely derived from the dividend receivable from the Kidderminster and Stourport Electric Tramways Co., and, on the other side, you will notice that we carry forward a balance to net revenue of £1,448. The only amounts which have been spent by way of management expenses are £32 odd for stationery and printing, and £52 odd for general establishment charges, so that the total expenses of managing the business during the past eight months have been just over £84, apart from a special outlay of £16 for obtaining a Stock Exchange quotation. There remains a net profit of £1,458, which the Directors propose should be applied as follows: To dividend on cumulative preference shares £312, and to be carried forward to the next account £1,145. Although we are not individual shareholders in the Kidderminster and Stourport Electric Tramway Co., our company hold the great bulk of the shares, and therefore it has been decided, in order to more clearly show the manner in which that property has been managed, to enclose with the Directors' report and the accounts of this company a copy of the balance-sheet and the profit and loss account of that company. There is only one item in those accounts which calls for comment, and that is sundry creditors, £34,423. This sum is a large one, but it was dealt with fully in the prospectus on which the capital of this Company was raised, and I may say that the whole of the amount, with the exception of £7,000, has now been wiped out. Turning to the profit and loss account of the Kidderminster and Stourport Co., the traffic receipts amount to £5,335, which, with advertising and sundry receipts, brings the total up to £5,537. The power and running expenses were £2,688, repairs and maintenance £341, and administration and general expenses £341, leaving a net balance of £2,165. The Directors regard this result, considering the circumstances of that undertaking, as highly favourable, and they believe that when the Bewdley line is added, thereby considerably reducing the average rate of expenses over the whole system, a very much improved profit will be shown. I now move the resolution.

Mr. C. SHIRREFF B. HILTON seconded the resolution, which was carried unanimously.

On the motion of Mr. STEVENS, seconded by Mr. HOWARD SMITH, the retiring Directors, Mr. Emile, Garcke and Mr. Hilton, were re-elected. and the auditors, Messrs. Walter J. Kershaw and Co., were also re-elected.

The proceedings concluded with a vote of thanks to the chairman.

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Oriental Telephone and Electric Co. (Ltd.).

The sixth ordinary general meeting of this company was held on Wednesday, Sir AUCKLAND COLVIN, K.C.S.I., presiding.

The SECRETARY (Mr. Alexander B. Chalmers) read the notice convening the meeting, and the report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, it gives the Directors great pleasure to meet the shareholders again with so satisfactory a report. Increases all round have been attained both in the numbers of subscribers at the different centres and in the receipts, whilst the expenses are but in proportion to the heavier work entailed. After providing for the usual dividend of 5 per cent., there is therefore a balance to be dealt with of £4,507. 16s. 10d., as compared with £3,344. 8s. the year before. The board hope that their proposal to add a larger amount to the reserve fund than on previous occasions will commend itself to the shareholders. Much re construction of an expensive nature, necessitated by the increase of business, is now taking place in the localities where the company's operations are carried on. During the present year the old reserve fund, now available only for capital expenditure, will have to be drawn upon to a considerable extent, and it is therefore desirable that the new reserve fund should be brought up to a fair strength so as to become available again for all and any purposes whenever necessary, such as was the case in former years. Whilst the Directors believe that the best interests of the company are served by this policy, they are pleased to add that should the steady development of the company's business render it desirable, an increased dividend might possibly be recommended at a later date, when this question again comes up for consideration. The closing of the Shanghai exchange is a matter of regret. The Municipal Council imposed on the China Co. conditions which would have involved an expenditure of fresh capital to the extent of from £15,000 to £20,000. This sum would have had to be provided by this company, but we have come to the conclusion that better and safer employment can be found for so large an amount in our exchanges nearer home, especially in Egypt. The Hong-Kong branch, on the other hand, is prospering, and is sufficiently provided with funds for a considerable time to come. Indeed, we hope that that branch will be in a position next year to contribute to our annual dividend. I now move the adoption of the report and accounts.

Mr. THOMAS LLOYD seconded the motion, which was unanimously agreed to.

Resolutions approving the dividend of 8d. per share, free of tax (making 5 per cent. for the year 1899), and re-electing the retiring Directors and auditors were passed, and a vote of thanks to the Chairman and Directors terminated the proceedings,

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BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)—Mr. J. B. Concanon presided at the annual meeting of this Company last week. The accounts represented a mixture of horse and electric traction, and it was next to impossible to separate the profits of each section. Up to Feb. 16 last year only one section of the new line (Retiro Station to Palermo Park gates) was being worked electrically, but upon that date the line was continued from the Retiro Station to the Plaza, and on April 22 following the line was open from Palermo Park outwards to Belgrano, the inner loop in Belgrano being opened on July 4. The receipts per mile (9¼d.) were on the whole satisfactory, but, on the other hand, the expenses were for an electric line abnormally high. They made the initial mistake of running far too generous a service on some of the sections, and therefore at the commencement of the year they reduced it, and that caused a considerable saving in the expenses for wages, electric current, &c. The consumption of current, which they took under contract from a local company, was unusually high, due to the fact that the cables for feeding the overhead wires were in an incompleted state. The average consumption of current per mile run for 1899 was 1·3 of a unit. This figure they had already got down to 1·2, and when the feeder system was in full operation they hoped to get it down to about one unit per mile run, and having regard to the high rate of speed at which the cars travel, this might be regarded as a fair average. They were allowed to run at something like 15 miles an hour between the various points. The debit of £3,300, balance of 1898 power account, was occasioned by the contract entered into by Mr. C. Bright with the electricity supply company, whereby he guaranteed a minimum consumption of current, and their requirements having fallen short of that minimum, they were compelled to pay the sum in question. On Jan. 21 last they started running electric cars over the old lines from Belgrano, as far as the Park Gates, and on the 14th ult. a further section, as far as Centro America was similarly worked by electric cars. They were pushing on with the work of completing the conversion of the remaining and the most profitable portion of the old lines within the city, and they had reason to hope that the lines throughout their system would be open for traffic by July.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—An extraordinary meeting was held on Tuesday to pass resolutions increasing the capital of the company to £800,000 by the creation of 30,000 new ordinary and 60,000 new cumulative 4½ per cent. preference shares, both of £5 each. Mr. W. F. Fladgate presided, and explained that the increase of capital represented the largest amount the directors considered, under any circumstances, would be required for the purposes of the company, whether for its old districts or for the city. On Dec. 31 last they had in their old districts the equivalent of 19,000 8 c.p. lamps connected and had capacity to supply was, therefore, necessary that they should provide a new station or possibly two, and increase their generating plant and apparatus at their existing stations, where they had facilities for so doing. The company anticipated having to spend, between now and the next five years, not less than £250,000 to enable them to cope with their business. They had expended in round figures £500,000, and required £250,000 further expenditure on stations and works, and they propose to expend in the city about £200,000, making in all £950,000. They were already lighting 1,300 8 c.p. lamps within the city area, which he thought was a good beginning. They proposed to register a new company to lay mains, and to provide the installation for the City, and to that company they would loan the necessary moneys, and would take shares in the company to the extent of the money so advanced. He had no doubt whatever that they would reap a rich harvest from their City business. The new shares would be issued to the present shareholders *pro rata*, at a premium slightly under the present market value. The resolutions submitted to the meeting were approved unanimously.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRAZELESS JOINT CO. (LTD.)—This company was registered on April 12, with a capital of £20,000, in £1 shares, to carry on the business of electricians, electrical and general engineers, machinists, &c.

JOHNSON-LUNDELL ELECTRIC TRACTION CO. (LTD.)—This company was registered on April 17, with a capital of £300,000, in £5 shares, to acquire any patents and rights relating to the generation, storage, and use of electricity, and in particular to acquire from Messrs. E. H. Johnson and R. Lundell certain patents for improvements in dynamos, electric motors and apparatus for controlling electric currents, electric railways, &c. The subscribers are L. W. Holmes, electrical engineer; E. H. Johnson, electrical engineer; T. M. Winstanley-Wallis, electrical engineer; A. Holmes, electrical engineer; J. H. Holmes, electrical engineer; A. Laing, and S. E. Robson. The first directors are G. B. Hunter, A. Laing, L. W. Holmes, E. H. Johnson, and H. Webb.

SMITH BROTHERS AND EASTWOOD (LTD.)—This company was registered on April 21st, with a capital of £35.000 in £1 shares (32,000 preferred ordinary and 3,000 deferred ordinary), to acquire the business carried on by Smith Brothers and Eastwood, and to carry on the business of mechanical, electrical, and general engineers, &c.

W. F. STANLEY AND CO. (LTD.)—This company was registered on April 10, with a capital of £120,000 in £5 shares, to enter into an agreement with Mr. W. F. Stanley for the acquisition of the business of manufacturers of and dealers in optical, geodetic, surveying, mathematical, drawing, and philosophical instruments carried on by Mr. Stanley, at Great Turnstile, Holborn, W.C., Railway Approach, London Bridge, S.E., and Victoria-street, S.W., and the factories at Great Turnstile and 8 and 9, Tichborne-street, W.C., and the optical works at South Norwood, with goodwill, stock-in-trade, trade marks, machinery, fixtures, utensils, copyrights, letters patent, secret processes, drawings, designs, models, contracts, &c., to develop and extend the said business, and generally to carry on the businesses of workers of and in, merchants and contractors for, articles made of metal, wood, ivory, glass, or other materials, &c. The signatories are W. F. Stanley (1,000 shares), G. I. Gray (50 shares), T. S. Walker (20 shares), O. G. Winzar (20 shares), H. T. Tallock (50 shares), J. Austin (10 shares), and A. G. Bennett (5 shares). The first directors are J. Stanley, W. F. Stanley, G. I. Gray, and W. W. Cobbett.

BARCELONA TRAMWAYS (LTD.)—The annual return to April 4th has been filed. The capital is £300,000 in 20,000 ordinary and 10,000 preference shares of £10 each, all of which have been taken up and paid for in full.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The annual return to March 29th gives the capital as £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each, of which 40,000 preference and 60,000 ordinary have been taken up. £10 has been called up on each share and £1,000,000 has been received.

ELECTRIC SIGN AND GENERAL ADVERTISING CO. (LTD.)—The annual return to February 23rd has been filed. The capital is £5,000 in £1 shares, 2,000 of which have been taken up. £1 has been paid on 1,000 shares, the remaining 1,000 being considered as fully-paid.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The annual return to March 27th has been filed. The capital is £1,000,000 in £10 shares, 85,000 of which have been taken up. £10 has been called up on 82,968 and £829,680 has been received, 2,032 shares are considered as fully-paid.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LTD.)—The annual return to March 22nd gives the capital as £80,000 in 4,000 ordinary and 4,000 preference shares of £10 each, all of which have been taken up and paid for in full.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—In the annual return to April 2nd, the capital is given as £400,000 in 20,000 preference and 20,000 ordinary shares of £10 each, all of which have been taken up. £10 per share has been called up on 20,000 preference and 13,334 ordinary shares, and £333,340 has been received, 6,666 shares are considered as fully-paid.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—According to the annual return to March 5th, the capital is £50,000 in £10 shares, all of which have been taken up, and £9 per share called.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LTD.)—The directors have issued a circular to the shareholders regretting that the delay in the arrival of the balance-sheet relative to the suspension of Dumbell's Bank has placed the company in an extremely difficult position, rendering it necessary to call in Messrs. Turquand and Youngs to prepare a statement of the affairs of the company.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 7/16d. per oz. (April 26). Consols (2¾ per cent.) 100⅝—100⅞ for money, 100⅝—100⅞ for account; 2½ per cent. 97¾—98¼ (April 26). Stock Exchange Settling Day: Consols, May 4; Stocks and Shares Continuation Days, May 14 and 26; Ticket Day May 15; Pay Days, April 27 and May 16; Mining Share Carry-over Days, May 11 and 28.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The ninth drawing of this company's 4 per cent. mortgage debentures (140 in number) will take place at the offices of the company, Winchester House, Old Broad-street, E.C., at noon of May 1.

AMERICAN WIRELESS TELEPHONE AND TELEGRAPH CO.—This company has recently been formed in Philadelphia, U.S.A., with a capital of $5,000,000 in $100 shares. Prof. H. P. Davis is electrical engineer to the company, which it is believed will develop the Dolbear patents.

GENERAL ELECTRIC CO. (U.S.A.)—The earnings of this company for the year ended January amounted to $22,379,000 gross, increase $5,118,000, $3,452,000 net; total income $5,479,000, balance after charges $5,197,000, surplus after dividends $4,196,000, amount written off $2,000,000.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors recommend a dividend on the ordinary shares at the rate of 6 per cent. per annum, tax free, for the half-year ended Dec. 31.

JOHNSON-LUNDELL ELECTRIC TRACTION CO. (LTD.)—This company, which has a share capital of £300,000 in £5 shares, has invited subscriptions for 40,000 shares. The list closed on Wednesday.

SIEMENS AND HALSKE AKTIENGESELLSCHAFT.—An extraordinary meeting of this company was held at Berlin last week, when resolutions were passed increasing the capital from 45,000,000 to 54,500,000 marks (from £2,250,000 to £2,725,000), and appointing Mr. J. Dreyfus-Brodsky and Mr. Karl Klönne new members of the Board.

W. F. STANLEY AND CO. (LTD.)—The well-known mathematical and philosophical instrument business of Mr. W. F. Stanley has been converted into a limited liability undertaking. Particulars of the registration are given in another column, and subscriptions are being invited for 10,000 £5 per cent. cumulative preference shares of £5 each.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has been asked to appoint a special settling day in the further issue of 7,582 £3 fully-paid ordinary shares (Nos. 46,419 to 54,000) of *Crompton and Co. (Ltd.)*, and to allow the $3,333,300 additional capital stock of the *Commercial Cable Co.* to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Apl. 21	5,001	+ 882	15	64,769	+ 3,476
Blackpool Corporation...	„ 19	913	+ 708	3	1,270	+ 291
Blackpool and Fleetwood	„ 21	757	+ 456	16	3,525	− 122
Bradford Corporation...	„ 22	532	+ 242	3	1,458	+ 246
Brisbane Trams	Mar. 7	1,777	+ 471	23	46,984	+14,280
*Bristol Trams & Carriage	Apl. 20	3,900	+1,281	16	43,018	+ 1,892
*Buenos Ayres & Belgrano	Mar. 25	2,206	− 25	12	28,043	+ 5,331
City & South London Ry.	Apl. 22	1,211	+ 186	16	19,688	+ 2,398
Dover Corporation	„ 21	247	+ 87	3	618	+ 43
Dublin United	„ 20	4,312	+1,447	16	50,092	+9750
Dublin Southern Dist....	„ 20	1,506	+ 637	16	12,089	
*Glasgow Corporation ...	„ 21	9,725	+ 961	...	...	...
*Liverpool Corporation...	„ 14	7,520	+1,658	15	101,326	+12,419
Liverpool Overhead Rly.	„ 22	1,665	+ 313	16	22,470	+ 1,015
*Sheffield Tramways	„ 22	2,543	+1,298	16	30,126	+ 9,914
*South Staffs. Trams.....	„ 20	1,067	+ 460	16	10,243	+ 433

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, April 18.	Price Wednesday, April 25.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 25. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July	...	...
25,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	63 66	63 66	5 9 9	Feb., May, Aug., Nov.	...	...
£3,062,240	Stock	30/0	Do. Preferred	115 116	115 116	5 3 6	„ „	116	115
£3,062,240	Stock	27/0	Do. Deferred	14⅛ 15	14¼ 14⅜	9 3 5	...	14⅜	14⅜
$10,000,000	$100	$1¼	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	102 104	3 17 0	„ „	103½	103
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11¾ 12¼	11¾ 12¼	5 14 3	Jan., Apr., July, Oct.	12	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100 103	100 103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	151 156	150 155	4 10 4	Jan., Apr., July, Oct.	155	151½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	98⅜	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115 120	115 120	3 7 8	May and November	116½	115
250,000	10	2/6	Eastern Extension	16 16½	16 16½	4 4 10	Jan., Apr., July, Oct.	16⅝	16½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115 120	115 120	3 6 8	February and August	117½	...
£6,700	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.)	100 103	100 103	4 17 1	January and July	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 18 5	February and August	100½	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)	101% 104%	101% 104%	3 16 10	May and November	101½	...
180,227	10	1/9	Globe Telegraph and Trust	11½ 12	11⅝ 12	4 7 6	Jan., Apr., July, Oct.	11⅝	11½
180,042	10	3/0	Do. 6 per Cent. Preference	15½ 16	15½ 16	3 15 0	„ „	15⅝	15 9/16
150,000	10	5/0	Great Northern of Copenhagen	33 35	33 35	3 11 5	January and July	...	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)	100 103	100 103	4 8 0	...	...	...
17,000	25	12/6	Indo-European	54 58	54 58	4 6 2	May and November	54	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	7¼	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124 129	124 129	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	97 100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 13 7	January and July	...	...
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	...	May and November	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9¾	9½ 9¾	6 3 1	„ „	9⅝	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	100 104	100 104	3 16 11	June and December	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15	14½ 15	4 13 4	Mar., June, Oct., Dec.	14⅝	14 3/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105 108	105 108	4 13 10	June and December	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ⅜	¼ ⅜	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ¾	½ ¾	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	½ 1	½ 1	5 0 0	„	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5½	5 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5¼ 5½	5¼ 5½	4 10 11	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December	98⅞	97½
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	1⅜	...
58,000	5	2/6	United River Plate	4¾ 5¼	4¾ 5¼	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, April 18.	Price Wednesday, April 25.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 25. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅜ ⅝	⅜ ⅝	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,681	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7 7½	7 7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9½ 10½	9 10	4 10 0	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6	5½ 5¾	3 19 3	" "	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6½ 7½	6½ 7½	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	108 111	4 2 2	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	10 11	9½ 10½	3 16 2	February and August	10½	10
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	13	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	127	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½ 10½	9½ 10½	3 16 2	...	10	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12½ 13½	12½ 13½	4 8 11	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109 112	109 112	4 0 11	...	111½	110
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	7 7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1½ 2	1½ 2	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	4½ 4¾	4½ 4¾	6 6 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 103	100 103	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½ 14½	13½ 14½	3 9 0	April and October	14	13¾
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December	...	...
£125,000	Stock	24/3	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	98 98	3 11 10	...	97½	97½
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½ 7	6½ 7	3 11 5	"	...	...
300,000	1	8%	Rand Electric	⅛ ¼	⅛ ¼	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	170 190	170 190	4 4 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103 105	103 105	4 5 9	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15½	14¾
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2½ 3½	2½ 3½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 93	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4 4½	4 4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	15 16	14½ 15½	4 8 10	March and September	15½	15
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜ ½	⅜ ½	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	¾ 1	⅞ 1⅛	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	...	...
100,000	5	...	British Westinghouse 6% Preference	4½ 5½	4½ 5½	...	...	5½	5⅛
90,060	2	1/3½	Brush Electrical Engineering	1½ 2	1½ 2	4 0 0	September	1½	...
90,000	2	1/3½	Do. 6 per Cent. Pref. Non-Cum.	2½ 2¾	2 2½	5 6 8	"	2½	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 113	109 113	3 19 8	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½ 15½	14½ 15½	4 16 9	" "	15⅛	15
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	5½	5⅛
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 18 5	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99 103	99 103	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅜ ½	⅜ ½	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅜ ½	⅜ ½	5 6 8	...	...	...
32,098	3	1/9½	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	3¹³/₁₆	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 103	4 19 3	" "	101½	101
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	5 6 8	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2 2½	2 2½	7 3 9	February and August	2⅛	...
17,189	5	2/9½	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4½ 5½	4½ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	...	101 104	...	...	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2½ 2¾	2½ 2¾	4 16 0	January and July	2½	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½ 3½	2½ 3½	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	103 106	3 16 2	January and July	104	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ½	⅜ ½	...	...	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½ 14½	13½ 14½	3 15 10	February and August	14½	13½
30,000	5	1/6	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	" "	5⅝	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	" "	111½	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	" "	2	21½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 101	3 17 6	March and September	100½	100
37,350	12	24/0	Telegraph Construction and Maintenance	36 40	35 39	4 13 4	March and July	38	36
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	10 11	10 11	3 3 7	...	10⅞	10½
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	12 13	12 13	3 9 3	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7½ 7¾	7½ 7¾	3 17 5	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 3	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	102 104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½ 23½	22½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£3 paid)	8½ 8¾	8½ 8¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 8 5	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10 10½	10 10½	...	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17 18	17 18	3 6 8	...	17⅛	17½
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16½ 17½	16½ 17½	...	...	16¼	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12½ 13½	12½ 13½	4 10 7	...	13¼	12½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	125½	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5 5½	5 5½	5 14 4	...	...	...
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	4½	4⅜
320,000	Stock	5%	Do. 5 per Cent. Debentures	103 108	105 108	4 12 7	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk Prov. Certs. (£57½% to be p l.)	37 40	37 40	...	...	...	...
213,553	10	3/0	Central London Ordinary	10½ 10¾	10½ 10¾	2 16 10	June and December	10¾	10½
£956,000	Stock	1½%	City and South London Railway Con. Ordinary	67 70	67 70	2 13 11	January and July	68	...
37,500	10	...	Do. (Nos. 23,501 to 60,000) (£5. 10s. paid)	6 7	6 7	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	132 137	132 137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½ 23½	22½ 23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10 10½	9½ 10½	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8½ 8¾	8½ 8¾	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13¾	13½ 13¾	3 14 1	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 15 4	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4½	3¾ 4½	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5½ 5⅞	5 4 4	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 19	16 18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½ 10¾	10½ 10¾	4 13 0	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	9½ 10½	4 15 3	...	9¾	...
£340,000	Stock	3%	Waterloo and City Ordinary	101 104	100 103	2 18 8	June and December	102	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

-THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,146. [Vol. No. 2. XLV.] FRIDAY, MAY 4, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 15 cents, or 2R/r., or 70pf.

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NOTES.

AMONG the electrical bills now before Parliament, that of the Baker-street and Waterloo Railway Co. deserves notice. By this bill powers are sought to extend the railway underground from the Marylebone terminus of the Great Central Railway to the Paddington terminus of the Great Western Railway, and at the other end of the underground line to extend from Waterloo to the Elephant and Castle. These additions to the originally proposed length of the line involve about 2¼ miles of additional route. Subways would, of course, be constructed connecting with the main railway termini mentioned. Sanction is also sought to erect the power station on the site of the school belonging to the trustees of the Indigent Blind in St. George's, Southwark, and no local opposition, it appears, has been raised to the erection of a generating station on this spot. The additional capital to be raised by shares is £1,000,000, with further borrowing powers of £333,000. In view of the great facilities thus afforded by the railway, as now proposed, for passenger communication between several London railway termini, as well as on account of the relief it would afford to street traffic, it seems highly desirable that these powers should be granted by Parliament without delay.

IN the debate on the telephone question in the House of Commons last Friday, two separate questions were raised. One was whether the Post Office was acting rightly in laying inter-exchange cables for the National Telephone Co. in Glasgow in accordance with the agreement made at the time of the cession of the trunk wires—even if the Glasgow Corporation desired that the Department should ignore this agreement. The second question was with regard to the way-leave controversy in London, referred to in our last two issues. In spite of Mr. HANBURY's repeated assertions last year that he desired to act with absolute fairness and impartiality to the company, he supports the London County Council in its unreasonable demands.

IT is, we believe, without precedent in the annals of the Institution of Electrical Engineers that a writer, in acknowledging the source from which a large part of his Paper is taken, impugns the accuracy of that source in the same sentence. Prof. GEORGE FORBES has taken the first part of his Paper, which will be found elsewhere in this issue, from the technical journals, which, he says, "are always liable to mislead, especially as to the satisfactory nature of the supposed uninterrupted supply of power." Our readers need not to be told that such statements are not borne out by fact—at all events, so far as our columns are concerned; but, for Prof. FORBES's benefit, we may refer as specific examples to two of the plants mentioned in his Paper. Our description of the Paderno-Milan power transmission was not taken from a French journal, as was Prof. FORBES's, but was written by the engineer who designed and erected the station. For details of the Rheinfelden plant, Prof. FORBES refers to a book describing the original scheme before the plant was completed, but since the publication of this volume the scheme was considerably modified, and in *The Electrician* he would have found a detailed description of the plant written by our correspondent, who had examined and discussed almost every detail of it with the engineer responsible for its erection and subsequent maintenance. Among the descriptions of the Niagara plant published in all the electrical journals, was a Paper by Prof. FORBES himself, who, we believe, takes credit for its design and erection. This, indeed, was "liable to mislead," as it was merely a description of plans and specifications. As to interruptions of supply after plants have been in operation—to which the Professor seems to attach such importance—our columns contain particulars of these whenever they are of technical interest.

NO ONE will deny that there is room for improvement in the British patent system, especially in the direction of reforming and rendering less costly the methods of settling disputes, and

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in amending the procedure by means of which the patents themselves are "amended." But although reforms are needed, we should be sorry to see such sweeping ones as are recommended by Mr. IVAN LEVINSTEIN in a pamphlet lying before us, which has been "approved and adopted by the Board of Directors of the Manchester Chamber of Commerce." It is surprising to find so important a body as the Manchester Chamber of Commerce identifying itself not only with Mr. LEVINSTEIN'S extreme views, but with a polemic in which the present patent system is criticised and its drawbacks magnified in no impartial spirit.

THE criticism is chiefly devoted to the absence of preliminary examination by the Patent Office as to novelty, when an inventor desires to patent an invention. First, we are introduced to the "poor inventor, who may have deprived himself of the necessaries of life in order to scrape together the money needed for paying the fees demanded by the Government . . . ,"—fees which, Mr. LEVINSTEIN forgets to add, would be higher if the Government were called upon to make a preliminary examination. "He (the inventor) presently finds out that what may have been the dream of his life may have been patented 10 or 20 years before by probably 50 other poor inventors." But is it not reasonable to expect the poor inventor to devote a few hours of the lifetime, which would otherwise have been wasted in dreaming, to examining the records of the Patent Office—an examination which has been recently greatly facilitated by additional indexing—and ascertaining for himself whether he has not been anticipated? Next, the writer of the pamphlet refers to "the injury suffered by really meritorious inventors, and the trading interests of the country alike" by inventions existing on paper only. To illustrate this, he alludes to the fact that in organic chemistry "you may by theoretical deduction fix the potential existence of a large and almost unlimited number of substances, which may never have been seen or made by anyone," and instances a certain patent covering "thousands of possible colouring matters," which "it will take an expert chemist in his laboratory several years to produce." But surely this patent would not be valid, for, according to existing patent law, an inventor has to give explicit instructions in his patent to enable any person of ordinary skill in the art to construct the apparatus or material for which protection is desired. Again, it is more than a slight exaggeration to say that "A British patent is only considered of value after having passed through the ordeal of a most expensive law-suit."

IT is tedious to be constantly told that we must remodel all our institutions to conform with the German pattern; and we will not allow that Germany is so immeasurably our superior in the case of patent law as Mr. LEVINSTEIN maintains. In holding up the American patent procedure as being less free from abuse than our own, however, Mr. LEVINSTEIN must be under a misapprehension.

IN commenting on the report of the "Committee on Copper Conductors," in our issue of December 22nd last, we expressed surprise that a value for "MATTHIESSEN'S Standard" of the resistance of pure annealed copper wire should have been chosen differing from that generally accepted. Prof. J. D. EVERETT writes in our "Correspondence" columns this week that he has been unsuccessful in finding the Committee's standard in any of Matthiessen's own Papers or reports. In reply, Mr. A. H. HOWARD gives chapter and verse for the standard chosen; but on looking up the reference we find, not a report of Dr. MATTHIESSEN or of Prof. FLEEMING JENKIN, but a table reprinted in a report of some Cantor lectures on submarine telegraphy delivered by the latter gentleman in 1866. The table is headed "Specific Resistance in B.A. units of Metals and Alloys at 0° Centigrade, from Dr. MATTHIESSEN'S Experiments," and bears the footnote:—"This table has been considerably modified, both on account of some clerical errors, and on account of the use of different specific gravities," so that it is evidently not MATTHIESSEN'S actual figures that are given. Mr. HOWARD'S reference to the varying values given for the specific gravity of copper only emphasises the arbitrary nature of the report, for the committee has chosen the value 8·912 merely because it is the equivalent to 555lbs. per cubic foot.

Obituary.—The death is announced of Prof. Silas W. Holman, Emeritus Professor of Physics at the Massachusetts Institute of Technology.

The American Association for the Advancement of Science.—The annual meeting of this Association will be held at Columbia University, New York, from June 25 to 30 inclusive.

Electrical Organ Blowing.—A new Hope-Jones organ in the Burton parish church was dedicated last week. The organ-blower is driven by an alternating-current motor connected to the public supply mains.

Fire.—A small fire at Lord Battersea's house in London, last Friday, is attributed to a defective new installation of electric light in one of the rooms, which was apparently switched on without being properly tested beforehand.

Importation of Electrical Apparatus into Turkey.—A Reuter's Constantinople telegram, on Monday last, stated that the Sultan has issued an Iradé prohibiting the importation into Turkey of all electrical apparatus, "including electric bells."

Little Scheidegg-Männlichen Electric Railway.—The Jungfrau Railway Co. intends to build a branch line from the Little Scheidegg to the top of the Männlichen. This line will be 2·6 miles long, and its estimated cost will be £16,000. The elevation of the Little Schiedegg is 6,770ft. above the level of the sea, and that of the top of the Männlichen 7,700ft., the maximum gradient being 6 per cent.

The Ottawa Fire.—According to the Ottawa correspondent of the *Standard*, new electric plant has been installed in Ottawa. The cars were running and buildings and residences were lighted up on the day after the fire, *i.e.*, on Friday last. This fact is all the more remarkable that the readers of the newspaper accounts of this disastrous fire will remember the Ottawa power-house is stated to have been burnt down.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Para—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Trinidad—Demerara	Mar. 30, 1900
Manila—Iloilo	April 9, 1900

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Electric Railway to Oberammergau.—The line between Murnau and Oberammergau has been opened, but owing to the bad weather the erection of the electrical equipment has been delayed, and the trains are at present being drawn by steam locomotives. It is hoped, however, that the electric installation will be ready before the Passion Play takes place. The line, which is being built by Messrs. Kummer, of Dresden, is 15 miles long, and has several gradients, the largest of which is 3 per cent., extending over a length of nearly four miles.

Technical Education Board Scholarships.—The Technical Education Board of the London County Council will shortly award five senior county scholarships of the annual value of £60, with free tuition fees up to £80 a year. Candidates must not be more than 22 years of age, and their parents' incomes must not exceed £400 a year. The scholarships are tenable at some university or technical college of university rank. Application forms may be obtained from the secretary of the Technical Education Board, 116, St. Martin's-place, W.C.

Electroplating from Non-Aqueous Solutions.—In a recent Paper before the Chicago Electrical Association, Mr. C. F. Burgess referred to the desirability of a bath containing no water, which would obviate difficulties experienced with certain metals owing to the liberation of hydrogen from the water. It is possible to dissolve certain metallic compounds in certain organic substances containing no water, and such solutions may act as electrolytes. Dr. Kahlenberg, of the University of Wisconsin, has succeeded in obtaining good deposits of lithium by such a method, and lithium is, in ordinary circumstances, more difficult to deposit than aluminium or magnesium. His method consisted in dissolving lithium chloride in pyridine, and electrolysing in the ordinary way.

An American Pacific Cable Bill Passed.—The *Electrical World* of America says that on April 11, the Senate passed a bill appropriating a sum of $3,000,000 for the construction and laying of a cable between San Francisco and Honolulu, the work to be done under the supervision of the Navy department, who have surveyed the routes. The bill provides that any ships, American or foreign, may be used in the laying of the cables. In the event of the Navy department deciding to accept tenders from other contractors for the complete work, a clause in the bill provides that the cable, wires and other necessary instruments, materials, appliances and appurtenances shall be manufactured in America, provided that the cost do not exceed by more than 12 per cent. the cost of same in any foreign market. Americans are surely paying a high price for their independence!

The Telephonograph.—This instrument, which is a modification of the phonograph, was recently inspected and tested by the German Postmaster-General and several engineers. Its inventor, Herr Paulsen, a Dane, has replaced the wax cylinder of the Edison phonograph by a steel band, and the style by a magnet energised by a telephone. Currents transmitted by the telephone pass through the electromagnet and create consequent poles on the steel band, and more or less the converse operation is employed for reproducing the sound. A long line can, of course, intervene between the transmitting telephone and the phonograph itself, and it is suggested that a telephone subscriber on leaving his office can set such a telephonograph to receive telephoned messages during his absence. Even if the efficiency of the instrument is only twice that of the average office boy, it should find many purchasers. We understand that the apparatus will be shown in operation at the Paris Exhibition.

A New Typewriting Telegraph.—A new typewriting telegraph, the invention of Mr. W. S. Steljes, formerly an electrical mechanician in the Post Office, is about to be put on the market by the Typewriter Telegraph Corporation (Ltd.), the prospectus of which will shortly be issued to the public. The capital of this new company is fixed at £100,000, the chairman being Sir James Ferguson, Mr. C. E. Spagnoletti acting as consulting engineer. The instrument, which is of simple construction, requires no battery power, the electrical energy being generated by a magneto-instrument, as in the Wheatstone A B C transmitter. In working the instrument a record is made at both ends of the line in the form of a printed copy of the message sent, and, as it can be used in conjunction with telephone lines, both verbal and printed messages can be sent. It is stated that the instrument, which can be worked on single lines of great length, is safeguarded against the possibility of tapping for intercepting messages.

Institution of Electrical Engineers.—At the meeting of the Institution, on April 26th, the President (Dr. S. P. Thompson) in announcing the list of nominations for President and Council for 1900-1901 (published in our last issue) read Article 45 of the Articles of Association, which provides that the Council shall, at least 28 days before the annual general meeting, announce the names of members whom they propose as officers and Council for the ensuing year. Alternative names may be proposed by any two members, supported by eight other members; but the proposal, together with the written consent of the new candidates, must be sent in to the Secretary within seven days of the Council's announcement. If no other candidates are put forward, those proposed by the Council are considered duly elected. Dr. Thompson also drew attention to the fact that M. E. Mascart, who is on the list of nominations for a Vice-Presidency, is to be President of the International Congress of Electricians, which will be held at the Paris Exhibition in August.

Canadian Water Power Development.—The Ontario Power Co. have definitely agreed, says the *Electrical World* of New York, with the Commissioners of the Queen Victoria Niagara Falls Park for the development of power on the Canadian side of the Niagara River. The company's plans contemplate the immediate development of from 30,000 H.P. to 60,000 H.P., which can be readily increased up to 300,000 H.P. The cost of the development of 30,000 H.P. is estimated at $2,000,000. It is proposed to bring the water from the Welland River at the point where it enters the Niagara River, by a canal to a bluff below the Dufferin Islands, where the first 60,000 H.P. will be developed. The water will be carried thence by an open canal through the park to a point just below Table Rock, where, under a head of 160ft., 240,000 H.P. will be available. The company expects to deliver the first power in about 18 months, and it will be used for electrolytic work and other industries, including a large steel plant, all of which will be located on the company's grounds, which comprise about 2,000 acres. It is stated that applications have already been filed for 60,000 H.P.

Underground Telephone Subways in Chicago.—The Illinois Telephone and Telegraph Co., in the underground system they are laying, are making a radical departure from the usual telephone practice. In Paris the telephone and telegraph cables are laid in troughs or suspended on hooks from the walls of the existing sewers, but this company is building special tunnels for the accommodation of its cables. The tunnels, described in a recent issue of the *Western Electrician* of Chicago, are of horse-shoe section, 8ft. in height with a maximum width of 6ft., and their floor is 38ft. below the centre of the roadway. No manholes are being made in the roadway, and communication with the tunnel is made by laterals running to the sidewalk, through which also the distributing wires are carried. Five shafts have been sunk and the excavations are being carried out under an air lock. The cables will be held on racks on the sides of the tunnel. The tunnels are lighted by means of 110 volt incandescent lamps, strung at 25ft. or 30ft. intervals along the top of the drifts, the current being derived from a generator in the basement. All the work at the heads of the drifts is done by the aid of electric lights, no torches being used, as they would be liable to cause explosions in gas pockets. The company is making experiments with an automatic telephone switchboard, and the precise nature of the exchange equipments has not yet been decided upon.

A Mercury Jet Interrupter.—In our issue of March 9, we described a new form of mercury jet interrupter recently brought out by Messrs. Isenthal, Potzler and Co. In a recent issue of *Nature*, Prof. S. M. Kintner, described another form

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of such interrupter, giving a high frequency of interruption which could be accurately measured. His description is as follows:—

An iron vessel, arranged as a Mariotte flask to maintain a constant head, holding about a pint of mercury, formed one terminal and a metallic plate the other. The plate was arranged below the vessel, and the mercury fell upon it, completing the circuit. In the bottom of the flask was a row of 10 holes, arranged around in a circle, with nozzles fitted into them. On a vertical shaft, concentric with the row of nozzles, a series of mica sectors were arranged, so that, when revolving, they would cut the mercury jets falling from the vessel above. These strips were placed with the line of their edges parallel to the axis of the shaft. Thus they would break the circuit in several places at the same instant, giving a very sharp break. It was found better to break the circuit by interposing an insulator than to break by opening the circuit with a conductor, as the wear at the spark tended to keep them all equal, so they automatically adjusted themselves to the best positions. The object of the row of jets was to get a more rapid interruption. To break a single jet in five or six places simultaneously, and at the same time with a satisfactory frequency, was found to require too great a head and velocity of jet to be practicable, so by adopting a row of ten the frequency could be increased that many times. These jets are all in parallel, and when the mica strips are revolving the head is so adjusted, by the Mariotte flask arrangement and screws on the sides of the reservoir, that at the instant of interruption of one jet, all the others are in a state of interruption; but the one directly in front of the mica strips will be the first to make the circuit. Thus it continues to break at a rapid rate. Greater rapidity of break can easily be obtained by increasing the speed, by increasing the number of nozzles, by increasing the number of sets of mica strips, or by any combination of the three. This form of interrupter will be found quite useful to any one desiring a known rate, high frequency interrupter.

Relative Popularity of the Toll System of Telephone Charges.—From a German contemporary we learn that the larger proportion of telephone subscribers in Berlin have preferred the old tariff system of a fixed sum per year, and only about one-fifth (8,000 subscribers) have elected to be charged according to number of conversations. The latter class of subscribers include chiefly the small offices and shops, and it is considered that the attraction to them of this system of charging is that they are entitled to loan their telephones at the rate of 5pf. ($\frac{3}{5}$d.) per conversation. Doctors, lawyers, and private persons who have the telephone chiefly to enable others to call them up have naturally preferred this system also. The fixed rate system has been preferred by the owners of larger restaurants, hotels, cigar shops, &c. The Bavarian and Würtemburg post offices have followed the example set by the Imperial post office, and have also made the toll system optional. In Munich 516 out of 5,500 subscribers have chosen it, in Nuremberg 390 out of 2,800, in Augsburg 101 out of 580, in Würzburg 120 out of 580, in Fürth 88 out of 540, in Bamberg 43 out of 230, in Regensburg 81 out of 280, and in Landshut 2 out of 55.

German Meter Statistics.—Some interesting statistics as to the employment of electricity meters in Germany have been collected by the Physikalisch-Technische Reichsanstalt, and are published in the *Electrotechnische Zeitshrift* of April 5. Circulars requesting information were sent to nine firms of meter manufacturers and 950 central stations and private stations using meters. The makers estimated that on July 1, 1899, 126,000 meters were in use, while the central station and private station returns only totalled about 60,000—the difference probably being due to the number of meters in stock and not yet put into use, also those employed for various testing purposes, and those exported. During the year 1898 alone, no less than 20,000 meters were supplied by the various manufacturers. In some of the returns the size of the meters was specified, and from these, out of 30,000 continuous-current meters 70 per cent. were for currents up to 20 amperes, 28 per cent. from 20 to 100 amperes, 1 per cent. over 100 amperes and 1 per cent. for tramway systems. Out of 8,500 alternating-current meters (both single and polyphase) 68 per cent. were for loads up to 5 kw., 22 per cent. from 5 kw. to 10 kw., and 15 per cent. over 10 kw. In their replies to a question as to the permissible error, the makers and the larger supply stations were in agreement, but smaller works considered a greater degree of accuracy desirable and one that is not attained in practice. Of course, in all circumstances, the electricity meter is more accurate than the gas meter. According to the new law settling electrical units, the Physikalisch-Technische Reichsanstalt is empowered to frame rules for the official testing of meters, and in the circulars it requested the central station representatives to say how soon, in their opinion, such regulations should come into force. Of the 950 stations, only 175 answered this question. Forty-one (representing 15,100 meters) thought that the official testing would be too difficult to introduce, or that the meters or the testing offices had first to be improved upon, while only twelve works (representing 900 meters) replied "soon." Fifty-five works (with a total of 9,000 meters) suggested the year 1902, and the majority of the replies—from fifty-seven stations, owning between them 22,300 meters—named dates from 1903 to 1910.

Interruption of the Hull Tramway Service.—An unfortunate interruption of the electric tramway service in Hull, due to a breakdown of the generating machinery, took place on Friday last. It will be remembered that the plant, which was described in *The Electrician*, Vol. XLIII., p. 482, consists of two 300 kw. Belliss-Siemens two-pole direct-driven sets. There is also one spare armature in the station, and one similar set is completed, but has not yet been delivered from the maker's works. None of the three dynamos, however, nor even the spare armature, have as yet been accepted by the Corporation as fulfilling the conditions of the specification, although the plant has been running since last July. On Friday one of the sets was running from 4 a.m. to 6 p.m., when the two dynamo bearings seized, the white metal ran, and the armature was slightly damaged from cutting on the pole pieces. The load was immediately transferred, without trouble, to the other set, which ran till shortly after nine o'clock, when its armature blew out and stopped the service. Meantime the fitters were at work getting out the armature of the first machine to repair the bearings. On the second machine breaking down, however, the armature was changed as speedily as possible for the spare armature, but, owing to the latter being quite new, the bolt holes in the coupling had to be broached out by hand, and it was 11.30 p.m. before this had been finished and supply resumed. During the day the Tramways Committee held a meeting and deputed three members, with the Town Clerk and electrical engineer, to see the contractors, Messrs. Siemens Bros. and Co. at once, with a view to obtaining the delivery of the third engine and dynamo to guard against a repetition of the accident, and pending the settlement of the question of the final acceptance by the Corporation of the three machines. On Saturday evening another unfortunate stoppage for about an hour-and-a-half took place, owing to the insulation of a field coil breaking down. It is only just to Messrs. Siemens Bros., to say that their engineers worked hard and ungrudgingly to repair the damage as quickly as possible.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

MONDAY, May 7th.

SOCIETY OF ENGINEERS.

7.30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "The Economical Disposal of Town Refuse," by B. D. Healey.

THURSDAY, May 10th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Society of Arts. Paper to be read: "A Frictionless Motor Meter," by S. Evershed.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III.: "A Century of Chemistry in the Royal Institution," by Prof. Dewar, F.R.S.

FRIDAY, May 11th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) Discussion of Prof. Lodge's Paper, "On the Controversy concerning Volta's Contact Force"; (2) "The Heat of Formation of Alloys, by J. B. Tayler; (3) "On the Want of Uniformity in the Action of Copper-Zinc Alloys on Nitric Acid," by Dr. Gladstone, F.R.S; (4) An Electro-magnetic Experiment and Experiments illustrating the Aberration called Coma, by Prof. S. P. Thompson, F.R.S.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Actinium.—By treating pitch blende with the reagents used for the extraction of metals of the iron group, and more especially of titanium and thorium, A. Debierne has succeeded in discovering a new radio-active substance, which has the general characteristics of thorium, but does not follow that metal through all its reactions. If a barium or bismuth salt is added to a solution of the new substance, the salt added may be eliminated by means of ammonia or sulphuretted hydrogen, without thereby eliminating the radio-activity. This proves that the latter is not due to either radium or polonium. The author calls the new substance "actinium." It produces the same phenomena of fluorescence, photographic action, and ionisation, as radium and polonium. All the experiments of magnetic deflection made by Giesel, Meyer, Schweidler, and Becquerel may be repeated with actinium. It also produces, to a slight extent, the permanent induced radio-activity described by Curie. It is known that the salts of thorium are feebly radio-active. The author suggests that their radio-activity may be due to traces of actinium, and that the latter is, in fact, the active principle of thorium radiation.

[A. Debierne, *Comptes Rendus*, April 20, 1900.]

Magnetised Coherers.—In the course of some experiments in wireless telegraphy made between Brest and Ouessant, C. Tissot hit upon a device which considerably increased the sensitiveness of the nickel or steel coherer used, and at the same time made it work with greater regularity and certainty. The device consists in placing the coherer in a magnetic field whose lines of force are parallel to the axis of the tube. The latter should contain some kind of magnetic filings, steel, nickel, or cobalt. The electrodes should preferably be non-magnetic, and the tube may be placed between the polepieces of an electromagnet feebly excited. The first result observed is that the terminals may be drawn very much further apart without annulling the action. The distance may, in fact, be increased from 1mm. to 6mm. Both the current traversing the coherer and the magnetic field controlling it should be feeble, as otherwise the decohering action is interfered with. One of the most striking results was the exchange of signals with the warship "Massena," over a distance of 18 nautical miles, with signalling masts only 100ft. high. The action of the magnetic field appears to be purely mechanical. It is important on account of the ease of regulation which it introduces, even in the case of sealed tubes, whose sensitiveness can easily be brought to the point required. When the field is suddenly withdrawn, a very slight shock suffices to decohere the apparatus. This suggests the possibility of working the magnet by a relay, and thus securing automatic decoherence.

[C. Tissot, *Comptes Rendus*, April 2, 1900.]

Electric Lines of Force.—A good photographic tracing of electric lines of force may, according to W. Schaffers, be obtained in full daylight by the action of the secondary circuit of an induction coil upon a sensitive plate. Two needles form the terminals of the circuit. One of them is placed in contact with the sensitive film of a silver bromide or (better) lactate plate, while the other is held about half a millimetre above the surface some distance off. The former should be made the positive, and the latter the negative terminal. If both points are in contact with the plate, the wandering globules discovered by Leduc interfere with the tracing. The lines of force begin to trace themselves by a great number of small black lines resembling arrows, which point from the positive to the negative pole, and which under the microscope resolve themselves into a mass of ramifications. The traces are not dissolved by "hypo," and hence the plant may be made transparent and used as a negative. No developer is required as the traces appear at once in black. Quicker action may be obtained by diminishing the proportion of gelatine in the film. The formation of the traces commences with the fusion of the silver salt, and the blackening is due to the carbonisation of the gelatine. After a while, the bromide is reduced also. Gold iodide gives brown continuous tracings communicating with each other by numerous branches. Sometimes their formation is almost instantaneous. But these traces cannot be fixed.

[W. Schaffers, *Comptes Rendus*, April 2, 1900.]

Electric Waves between Bitumen.—C. Gutton has examined the question as to whether electromagnetic waves, when propagated through a medium whose dielectric constant is different from unity, have the same velocity when they are propagated freely through it, and when they are guided by a wire. For the experiments, he used the same apparatus as for his experiments on electric wire-waves (see *The Electrician*, Vol. XLIII., p. 864). A block of bitumen, 1m. long, was balanced against another of exactly the same size, but having a wire embedded in it through which the waves in the second circuit were propagated. The waves of the first circuit were sent through the free block by means of cylindrical parabolic mirrors. When the rates of propagation are the same, the two wave systems interfere with each other and produce no effect on the coherer which bridges the two circuits at a distant point. Such was actually the case, and the speed of propagation must, therefore, be regarded as independent of the presence of the wire. The same arrangement allows of the determination of the refractive index of the material for Hertzian waves. Compared with air, the refractive index of bitumen comes out as 1·870 without the wire, and 1·885 with the wire. The author considers that the small discrepancy here indicated is probably due to a lack of perfect identity of structure in the two specimens of bitumen, though it would, of course, be more satisfactory to have this made evident by further experiments on different specimens.

[C. Gutton, *Comptes Rendus*, April 2, 1900.]

A New Source of Error.—While determining index corrections of the compass declinometers belonging to the United States Coast and Geodetic Survey, G. R. Putnam observed motions of the magnetic needles of such a nature as to leave no doubt that the glass covers of these instruments carried strong electrostatic charges, caused by atmospheric conditions, which at the time were especially favourable, the weather being dry and cold. In two of the declinometers, in which the glass covers were replaced by brass plates, with only small pieces of glass covering the openings through which to observe the points of the needles, no erratic movements were noticed, and repeated determinations of their index corrections agreed with each other within the error of observation; while before, nearly all observers using these instruments reported occasional discrepancies in their results which could not be accounted for. In reporting upon this source of error, E. G. Fischer raises the question as what may be the effect of the same phenomenon upon the magnetic needle in other instruments. The theodolite magnetometers do not seem to be sensibly affected, but in the dip-circle, the manner of housing the magnet is such as to immediately raise the question whether the frequent want of accord between the results obtained may not be due to electrostatic disturbance. As a remedy, both sides of the magnet case should be of brass, and should be so arranged that they can be rotated about the axis of the needle, in order to bring the openings opposite the points. In any case, wherever glass must be used in magnetic instruments, it should contain a large percentage of lead.

[E. G. Fischer, *Terr. Magnetism*, March, 1900.]

Combination of Large American Electrical Companies.—According to the *Western Electrician* of Chicago an arrangement has recently been concluded whereby the Siemens and Halske Electric Co. of America is in future to be controlled by the General Electric Co. of New York. It is understood that, for a time at least, the former company will be worked independently. The merging of these two interests leaves but two companies in America manufacturing machines of the largest size—say of 1,500 kw. and over.

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A MODERN GERMAN CENTRAL STATION.

BY JOHN R. DICK, B.SC.

German practice in public electricity supply has developed in somewhat different fashion from that which prevails in England. The great majority of the earlier undertakings were controlled by private companies, who obtained concessions of the rights of supply on more or less favourable conditions. Of recent years, however, after the profitable nature of these enterprises was recognised, the corporations of many towns are establishing municipal electricity supply works.

An admirable example of these municipal stations is that at Dortmund, which the writer has had the opportunity of inspecting closely. It presents many points of interest and

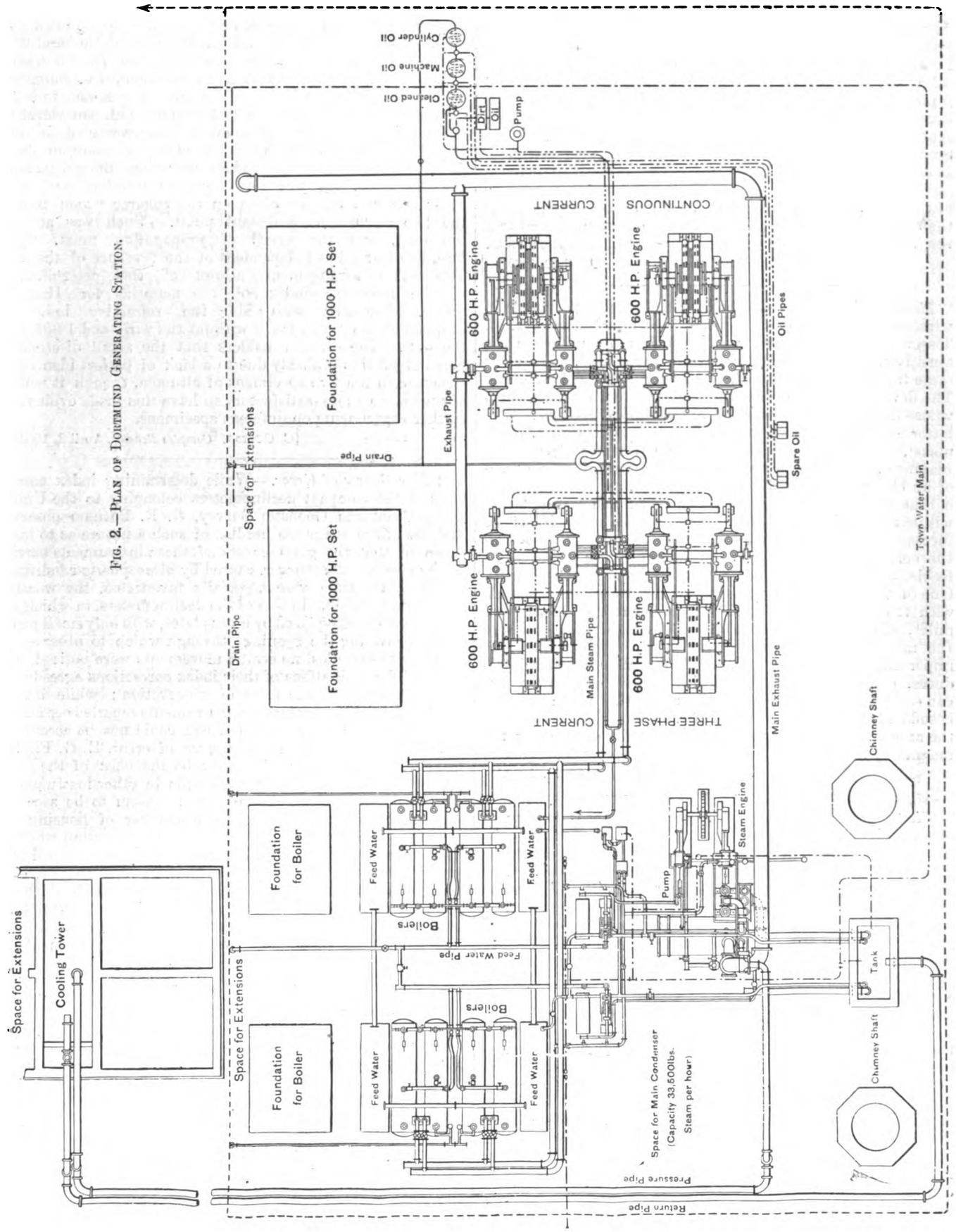

FIG. 2.—PLAN OF DORTMUND GENERATING STATION.

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novelty in its design, as well as in the successful results it has achieved commercially. The town itself, with a population of 140,000, is situated in the highly industrial province of Westphalia, in close proximity to some of the best coal fields in Germany. It consists of two parts—a densely populated central area, and a series of scattered suburbs devoted to engineering and various manufactures. Perhaps the town is best known by its excellent Dortmunder beer, deservedly renowned all over Germany. In the urban area electricity is supplied by continuous current, while in the outer zone three-phase distribution is used both for light and power. The general methods of distribution with battery sub-stations, numerous short feeders, bare neutral distributors with bare neutral wires in the houses, are well worth consideration, as they differ so widely from English practice. The very general employment of motors and the large amount of electricity supplied for motive power are also noteworthy. The whole of the works were designed by the present manager, Herr Döpke, and built under his supervision.

The works at Dortmund were built in a remarkably short time. From the commencement of the work till the supply to 80 installations was turned on, there intervened a period of only nine months, yet the idea of having works on a large and commercial scale adapted to any reasonable future developments was not lost sight of. It was found from the statistics of 50 electricity works in operation in Germany that the output for light and power increased more than 20 per cent. yearly. Costly extensions were, therefore, very soon required. Bearing these facts in mind, the engineer at Dortmund decided to arrange for extensions of buildings and plant on a consistent and definite plan to meet the probable demand of the next 25 years. Arrangements have been made for doubling, or even trebling, the present capacity of the works without any alterations to the buildings. Of course in such a case the initial capital costs for this item are rather high; but, considering that additional plant will so soon be necessary, there is no doubt that the interest and sinking fund will be less than the additional cost of subsequent alterations to buildings. Some

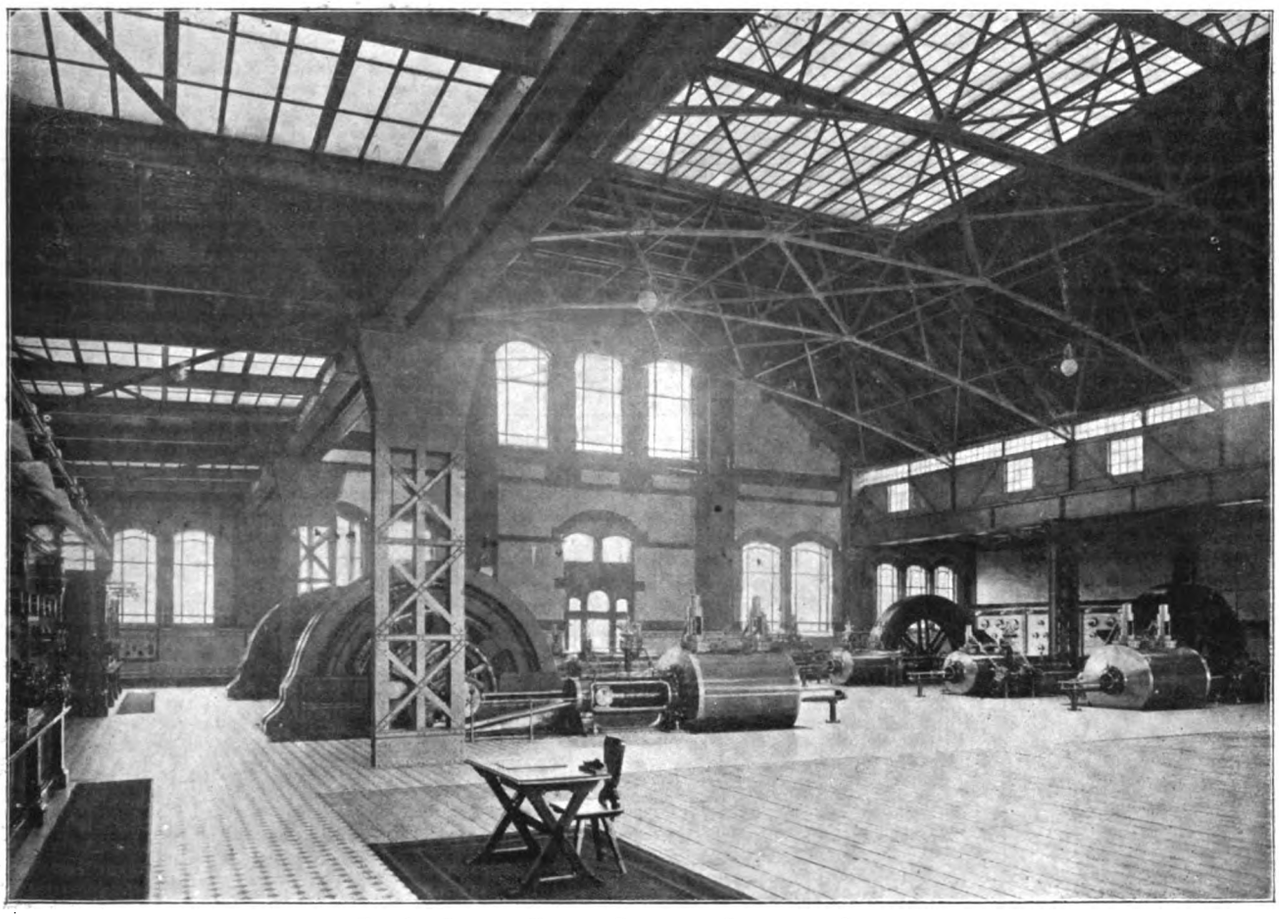

Fig. 1.—General View of Dortmund Generating Station.

A consulting engineer in Germany is more or less of a *rara avis*, as most of the stations are designed and equipped by the great manufacturing and financial companies, or, as in this instance, by the engineer who subsequently manages the business of supply. Under such conditions the municipality is likely to put more confidence in the recommendations of its engineer, and not to allow excessive caution or parsimonious ideas of initial cost to curtail the usefulness of a newly-started station. Municipalities in Germany do not make the mistake of imagining they are venturing on a precarious experiment in establishing electricity works. On the contrary they are regarded as solid and permanent undertakings that are certain to pay with good management. Accordingly they are designed on liberal lines, with ample buildings, and mains of sufficient section, so that the engineer is not continually preparing plans for niggardly extensions, to the exclusion of other duties. He has abundant opportunities for acquiring profitable business and for extending the use of electricity in the town.

engineers, when their works are barely completed, boast that their undertaking has been so successful that immediate extensions are required. This is a state of things entirely to be deplored instead of applauded, as it proves how, with a little foresight, a large expenditure might be saved. Extensions to buildings while running the station endanger the continuity of supply, occasion serious inconvenience, and are comparatively more costly.

The spacious engine room shown in the illustration (Fig. 1), with its ample provision for additional units, is a proof that such a short-sighted policy has not been followed at Dortmund. The steam plant consists of four engines of 600 H.P. each, of the horizontal, compound type, which run at 90 revs. per min. The two engines on the side next the boiler house are direct-coupled to three phase generators, while the two engines on the side nearest the battery room drive the continuous-current dynamos. When working at 500 I.H.P. they have a steam consumption of 14·3lb. per horse-power hour. The speed may be varied directly from the switch-

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board by means of a motor acting on the governor of the engine, in addition to the usual methods.

The continuous current dynamos are of the twin type, the armatures being supported in the middle of the shaft between the high-pressure and low-pressure cylinders. The field magnet of each dynamo has 30 poles, and the two armatures are entirely distinct from each other electrically. They are built by the Elektricitäts A.G., Frankfort, formerly Lahmeyer and Co. Each half of the twin machine has a capacity of 200 kw., with a voltage that can be varied from 220 to 370 volts. Each half can be used quite independently, or the two halves may be coupled in parallel to feed the outers of the 3-wire system, or to charge the batteries. When the electric trams are supplied by the Municipality the two armatures can be coupled in series, to furnish a pressure of 440 to 740 volts. Such a type of machine is of somewhat unusual construction, but it seems to overcome the difficulty of using the same plant for electric traction or lighting. In England the problem has been solved in another way, as we have arrived at 500 volts distribution on a 3-wire system, but in Germany anything like this pressure is extremely rare. The mechanical construction of the machine makes it a simple matter to examine the armature at any time. The field magnets can be very easily shifted apart along the shaft, and thus the necessity of lifting any heavy weight is avoided. The machines give 92·5 per cent. efficiency at full load, with 260 volts pressure, and 90 per cent. with 370 volts pressure. The three-phase generators have a capacity of 400 kw. at 2,600 volts, with a periodicity of 50. The fields are excited from the continuous current 'bus bars; the machines have an

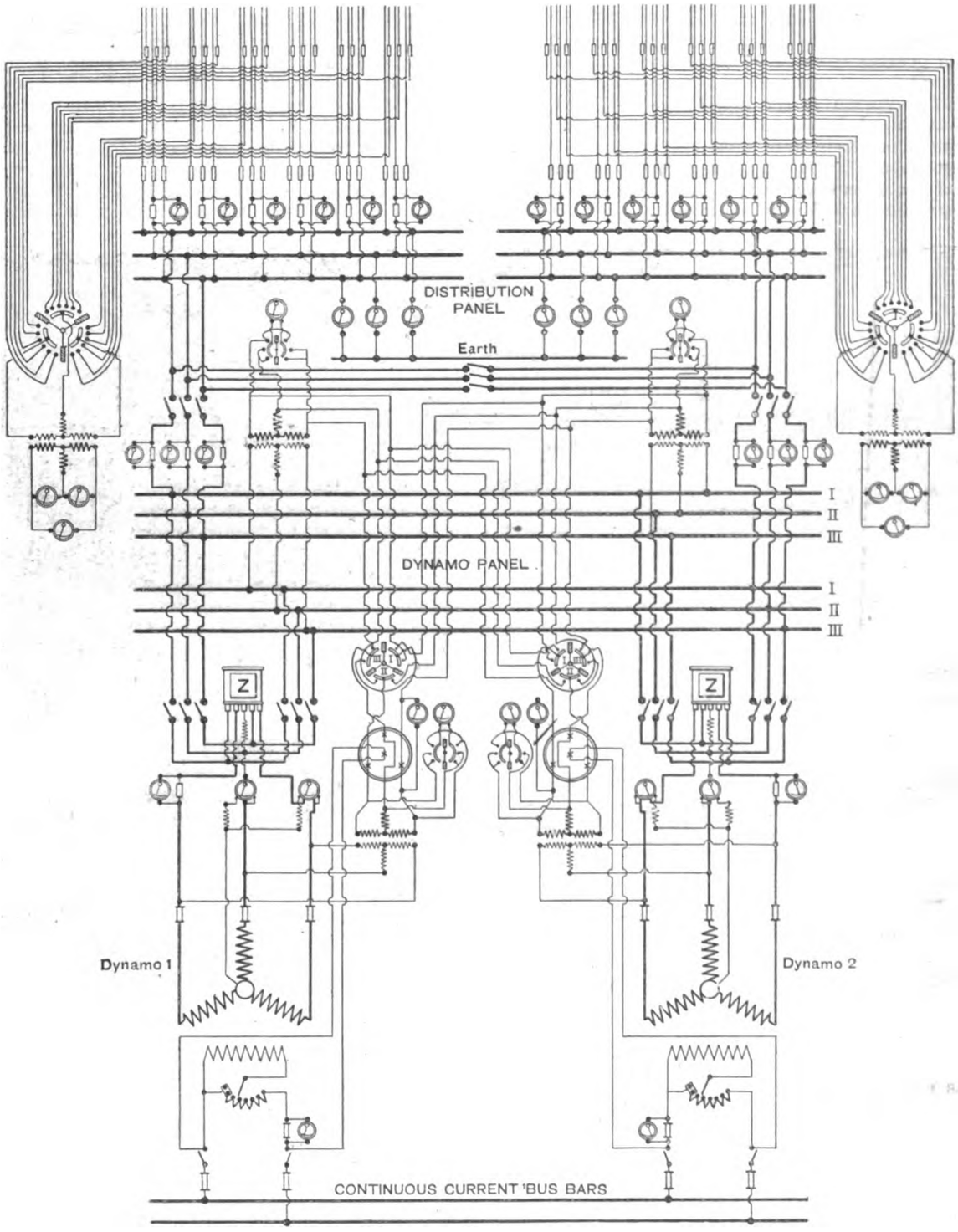

FIG. 3.—DIAGRAM OF CONNECTIONS ON THE THREE-PHASE SWITCHBOARD.

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efficiency of 93 per cent. at full load and 88 per cent. at half-load.

The steam generating plant has no very striking peculiarities. The general arrangement is illustrated in Fig. 2. The boilers are of the water-tube type, working at 170lb. per square inch, and are fitted with superheaters. There is an ample firing space between the two batteries of boilers, and there is a separate shaft for each battery. When working at 140lb. pressure and 27°F., superheating and burning good steam coal, they have an efficiency of 70 per cent. The live steam piping is arranged on the usual ring main system, and is mounted on rollers to allow of expansion. An exhaust pipe of 3ft. diameter, laid under ground, leads from the engines to a central condenser. This central condenser has a capacity of 33,500lb. of steam per hour. There is a cooling tower, 84ft. in height, for the condensing water. This appears to be very efficient, as, when working with 83 per cent. vacuum, the amount of cooling water required is just equal to that of the steam condensed, which then possesses a temperature of about 140°F. The switchboard at the central station is divided into two parts, one for continuous current and one for three-phase, each being erected on the side of the engine room next the corresponding machines. The three-phase currents are distributed directly to the various parts of the town from the main switchboard, the connections of which are shown in Fig. 8. The continuous-current board has connected to it only the leads for charging the sub-stations and the mains from the dynamos. Each section of the switchboard is divided into a dynamo panel and a distribution panel. The whole is constructed of polished marble.

The accumulator sub-stations play an important part in the distribution scheme. These are three in number, one forming a part of the main-station building, and the two others being distant about 2,000 yards and 1,800 yards respectively from the central station. There are 132 cells in each station, but provision is made for 140, so as to be able to allow for a greater drop in the feeders in the future. The capacity of sub station No. I. is 3,536 ampere hours, the maximum discharge current being 833 amperes, and the maximum charging current 720. The two other sub-stations are of half this capacity, and the joint output of all three, when running at full load, is equal to 370 kw. The accumulators are of the system Gottfried Hagen of Cologne, and the capital cost per kilowatt is only £11. The efficiency of the batteries is 90 per cent. reckoning in ampere hours, and 80 per cent. in kilowatt hours. All the batteries are charged directly from the central station without the intervention of boosters or rotary transformers; space, however, is left for the installation of such apparatus should the necessity arise in the future. In each sub-station there is a connection to the three-phase network to permit of the installation of converters. As far as can be judged at the present moment, however, it will be a long time before such complicated methods of charging the cells will be required.

(To be concluded.)

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

BY C. E. GROVE.

(Continued from page 14.)

Gun and Torpedo Work.—Electricity is an indispensable adjunct to the armament of a man-of-war, being invariably used for discharging torpedoes and for firing modern breech-loading guns of all sizes.

While all other circuits in the ship are twin-wired, gun and torpedo circuits are now universally single-wired. The following are the arrangements used in connection with Elswick equipments.

Torpedo-Firing Circuits.—Two batteries, one (A) of low, and one (B) of high resistance, are connected with their positive poles towards one another as shown in Fig. 21. The firing key and detector are fitted in the conning tower, from which the discharge of the torpedo is controlled. The torpedo is placed in the tube, the sluice-valve at the outer aperture of the tube being closed. The valve being closed, the firing circuit is open. The circuit is then "proved" by inserting a primer in the firing breech, when current flows from battery B, causing the sounder in the torpedo room to start buzzing, thus indicating that all is right. The primer is then removed and the sluice-valve opened, thus making contact at F, and completing the circuit through E, B, F, A, E, the two batteries being in opposition. The detector needle in the conning tower deflects to the left, indicating "valve open." The firing charge is inserted in the discharge chamber, the primer restored and the breech locked. Current from battery A through the high-resistance detector then flows in unison with that from battery B in the circuit E, A, F, P, E, reversing the deflection of the detector and indicating "ready." The officer in the conning tower at the proper movement depresses his

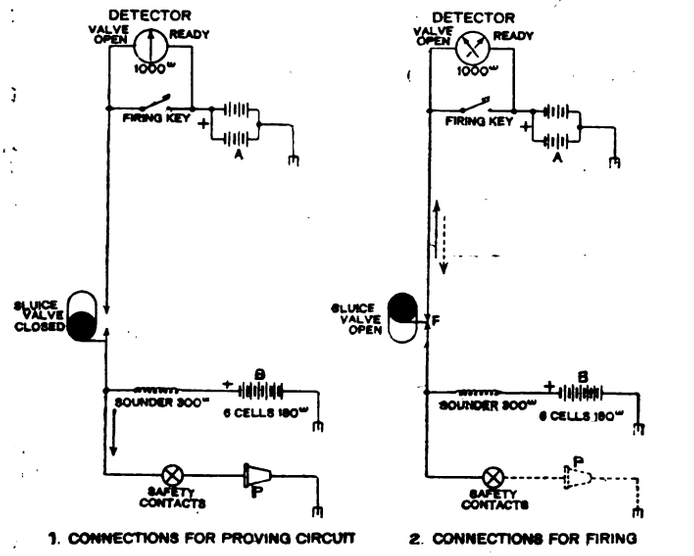

FIG. 21.—Torpedo Firing Circuit.

firing key, the two batteries send their full volume of current through the firing circuit in parallel, the fuse is ignited and the torpedo discharged.

Gun-Firing Circuits—A few years ago involved a formidable amount of wiring, as the circuits from all the barbette and casemate guns were looped into the conning tower, where the firing keys were situated. The practice now is to fire all guns on short local circuits, the batteries, switches, keys, &c., being carried on the gun mountings. Fig. 22 shows the connections for a pair of Armstrong barbette guns.

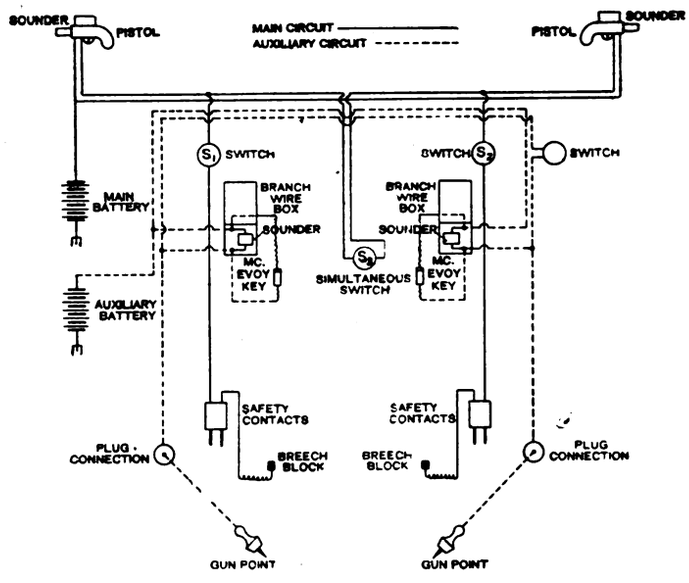

FIG. 22.—Gun Firing Circuit.

Following out the main (full line) circuit, it will be seen that if switches S_1, S_2 are closed and S_3 open, the left-hand pistol will fire the left gun and the right-hand pistol the right gun. If switch S_1 is open and S_2, S_3 closed, the left pistol fires the right gun; while if S_2 is open and S_1, S_3 closed, the right pistol fires the left gun. Finally, if all the switches are closed, both guns can be fired simultaneously from either side. An auxiliary circuit, shown in dotted lines, is fitted up as a stand-by to the main firing circuit. The latter is completed only when the gun is "right out"; he auxiliary circuit can fire with the gun in any position. The use

* Paper read before the Institution of Electrical Engineers, April 5th.

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of the sounders will be evident, as they buzz all the time the circuit is made. Whereas the firing pistols are usually fixed at the firing platform, the McEvoy keys, connected by flexible connections, enable the gunner to fire from any position.

Range Finders.—These are sometimes electrical. That used by the United States Navy, invented by Lieut. Fiske, is based upon the Wheatstone bridge principle. Two telescopes (Fig. 23) are mounted so as to move over graduated arcs. In gear with the trains of movement are cylinders wound with resistance wire. When the telescopes are parallel, these resistances form

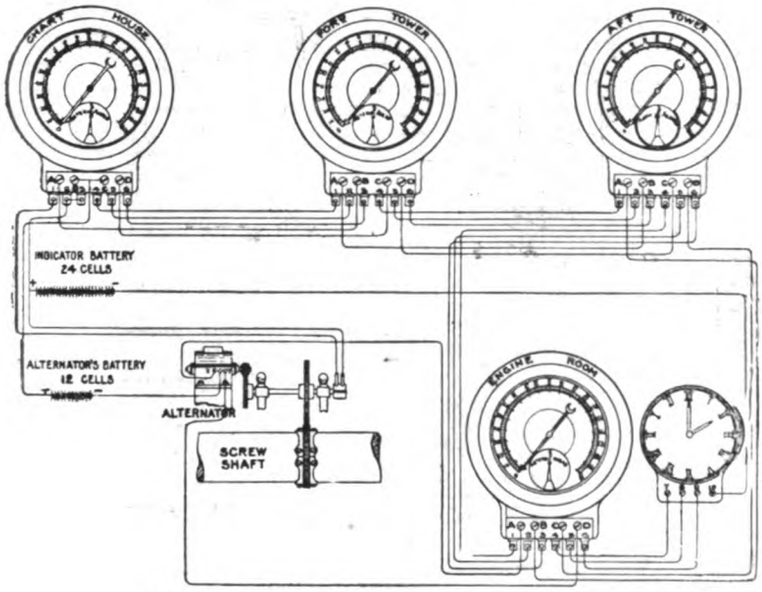

FIG. 28.—Molinari's Engine Revolution Indicators

balanced arms of a Wheatstone bridge. When the telescopes are trained so as to bring a distant object into the field of both simultaneously, the electrical balance is upset and current flows in the galvanometer to an extent depending upon the arc of training, which is a trigonometrical function of the distance of the object from the centre of the base line connecting the two telescopes. The base line should be as long as possible, whence one instrument is usually mounted on the forward bridge and one aft, the galvanometer being in the conning tower where the firing keys are placed. It is necessary to know this base line with great accuracy, or errors creep into the range. Further, three observers are necessary, who must be connected with each other by telephone. The method is a delicate one, and the difficulty of making the necessary adjustments, taken in conjunction with the difficulty of using the telephones during gun-firing, led, it is said, to the abandonment of the apparatus by the vessels engaged in the war with Spain, who found it easier to get the ranges by trial shots.

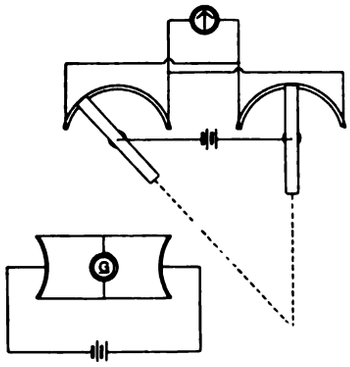

FIG. 23.—Diagram, "Fiske" Range Finder.

The range-finder used in the British Navy, and which has also been supplied to most foreign navies, is that of Barr and Stroud. It is designed for use by a single observer, but being a purely optical instrument does not call for detailed description here.* The ranges having been found, the next step is to transmit them to the various gun-stations. For this purpose Drs. Barr and Stroud have invented a system of *range and order telegraphs* for indicating simultaneously at any number of stations the range of a given object, together with information as to the guns which can be brought to bear upon it,

* Described in the *Proc. Inst. Mech. Eng.*, January, 1896

and orders as to firing. Figs. 24 and 25 show the general appearance of a set of such instruments supplied to the Japanese, who are adopting them generally. The British Admiralty have them on trial. As fitted in the ship, a single transmitter near the range-finder position gives the range upon a receiver in the conning tower.

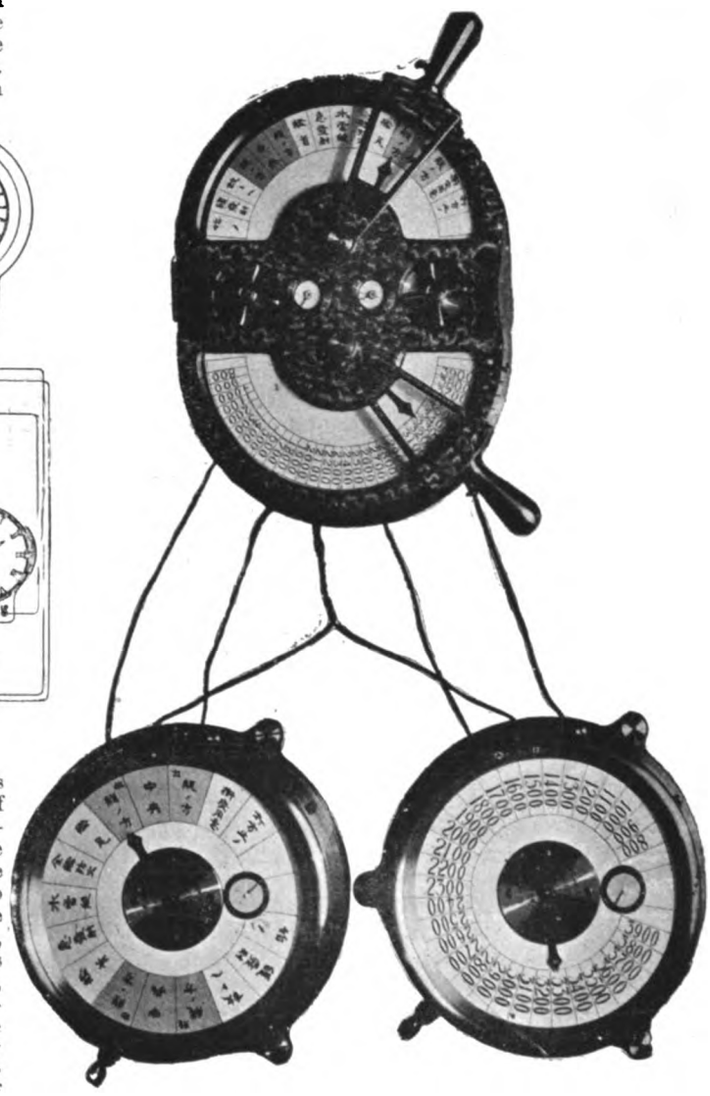

FIG. 24.—Barr and Stroud's Range and Order Telegraphs.

Adjacent to this receiver are two double transmitters for sending orders and ranges to the several casemates or to the barbettes, the receivers at which stations are grouped upon two main circuits, with bells which ring at every fresh signal received. The transmitters and receivers consist of clockwork mechanisms actuating, under electrical control, the movements of pointers over dial faces, on which figures representing ranges and symbols indicating orders are

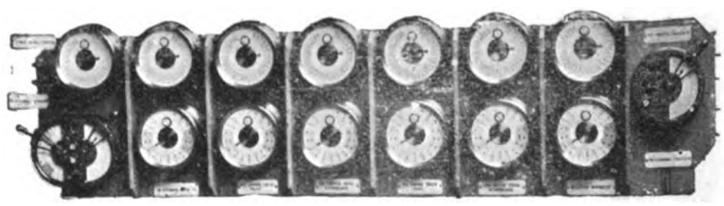

FIG. 25.—A Group of Range and Order Telegraph Instruments

inscribed. The transmitter has an outside handle moving about the centre of the instrument. To transmit an order, this handle is moved until its index pointer is over the required symbol. On moving, it puts current obtained by transformation from the lighting mains, into a small apparatus which starts an inside pointer following the outside index pointer. While this is moving, currents are being transmitted to the receivers at the distant stations, and the whole of the pointers are set in motion. They all stop together over the symbol under the index pointer of the transmitter. Being clockwork, the instruments have, of course, to be wound up periodically.

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Navigation Instruments.

1. *Engine-room Telegraphs and Helm Indicators.*—An electric system of engine-room reply telegraphs worked out by Messrs. Richards and Evershed was fitted in H.M.S. "Howe" and "Narcissus" in 1893, to H.M.S. "Royal Sovereign" in 1896, and since then in other British war vessels. The indicating instruments have the appearance common to mechanical telegraphs, the dials being marked to show the usual direction orders, "Stop," "Slow," "Half," and "Full," "Ahead" or "Stern." The revolution of the indicating hand is effected by the combined operation of two electro-magnets (see Fig. 26) placed at right angles to one another, and producing between them a cross magnetic field, within which lies a magnet with which the indicating needle is geared. The position of the needle depends solely on the relative strength of these two field components, and this depends on the ratio of the current in the two coils. This ratio is controlled by the "transmitter," which consists of a multiple contact switch, through which the ordinary 80 volt electric light circuit is connected to a pair of ratio arms included in the same circuit as the coils of the indicator; the movement of the transmitter switches resistance out of one arm into the other, thus altering the relative value of the current strength in them, and controlling the movements of the indicator. An important detail is that the action does not depend on the absolute value of the currents in the indicator coils, but only upon their relative value, so that a constant voltage is unnecessary. A similar indicating instrument, graduated in degrees, is used for showing, at the several navigating

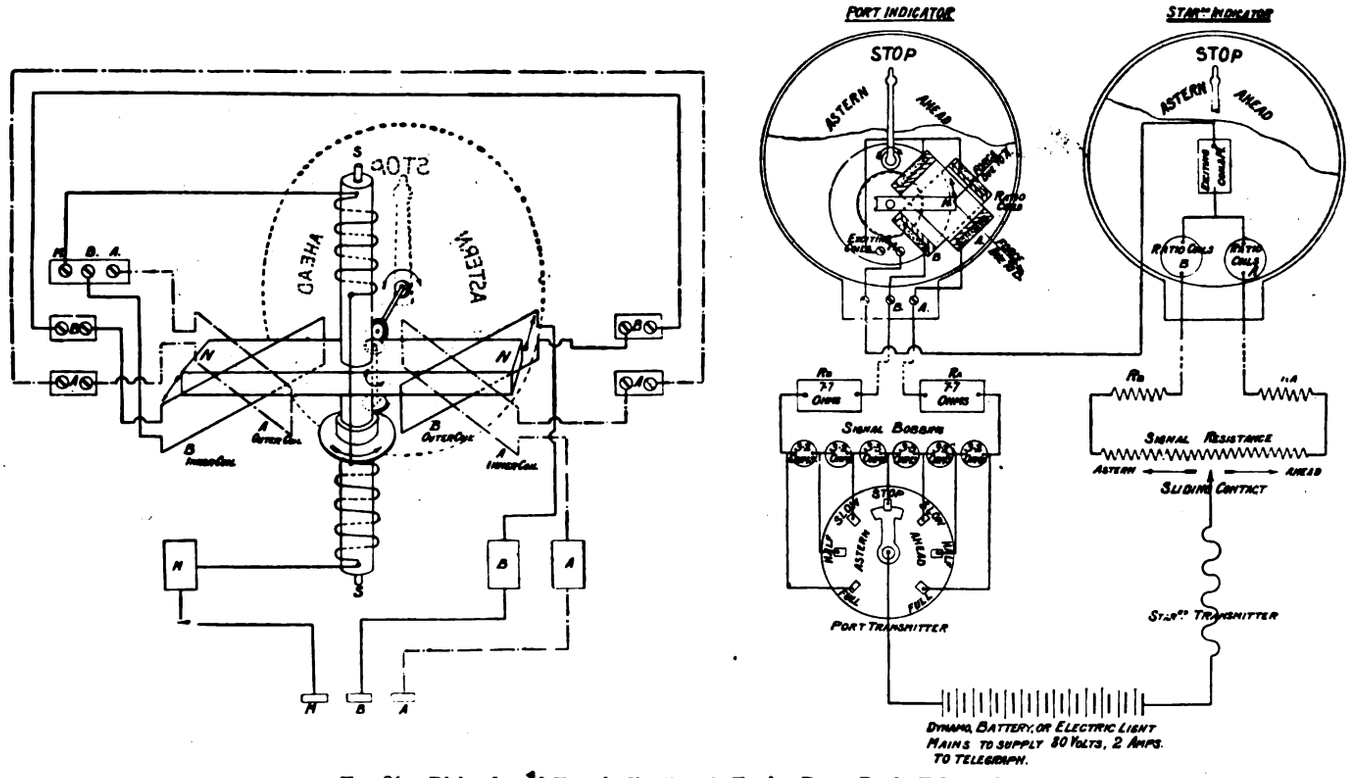

Fig. 26.—Richards and Evershed's Electric Engine Room Reply Telegraphs.

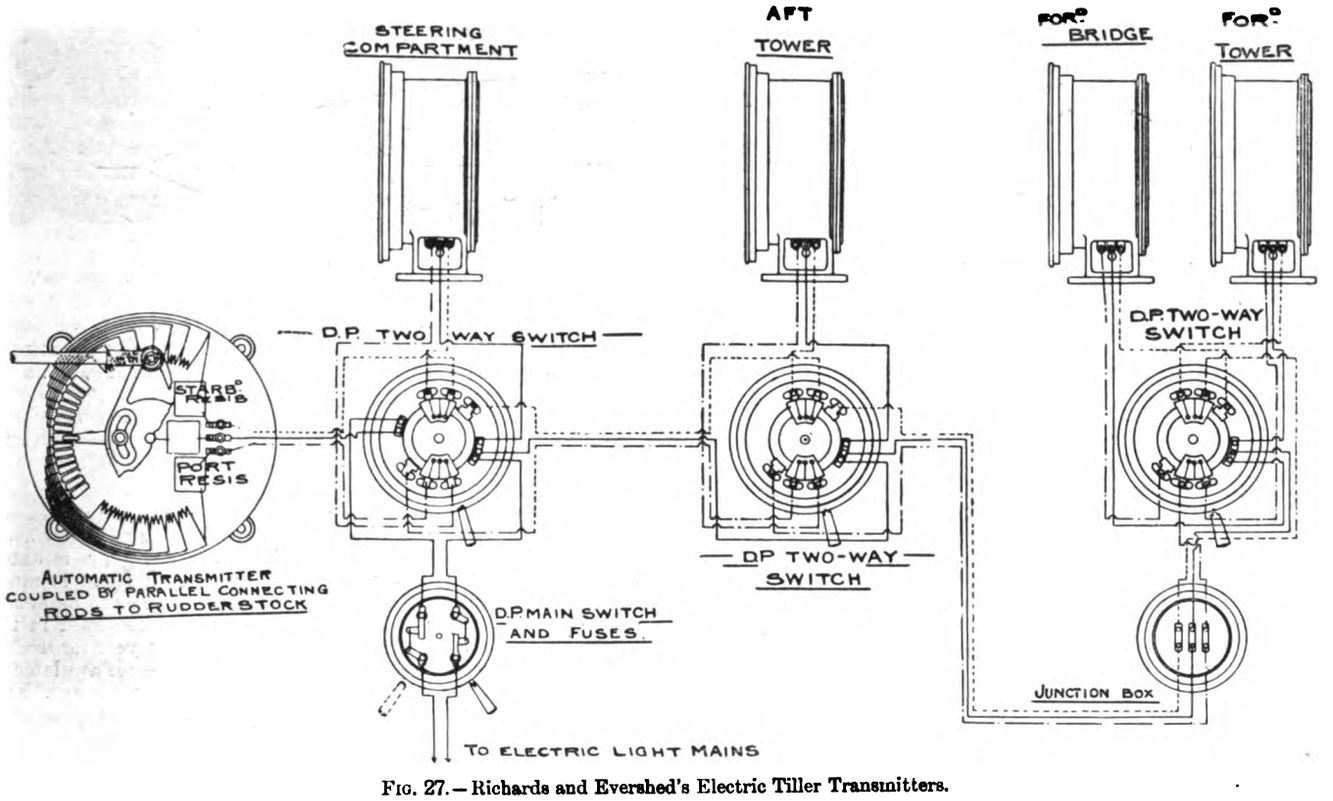

Fig. 27.—Richards and Evershed's Electric Tiller Transmitters.

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stations, the angle made by the rudder, the transmitter switch in this case being automatically worked from the rudder crosshead (Fig. 27). By means of switches these telegraphs can be arranged to signal from any of several working positions—bridges and conning towers to wit. Transmitters send orders from any of these stations to a common receiving instrument in the steerage flat.

2. *Engine-room Indicators.*—A system for showing simultaneously in the bridge positions, conning towers, and other navigating stations, the revolutions of each set of engines, and for indicating in each engine-room the revolutions made not only by the set of engines in that room, but also by the set in the other room, is of great value. Such a system has been worked out by Signor P. Molinari, and has been adopted throughout the Italian navy, and is also used on warships of other countries. The indicating instruments (Fig. 28) are direct reading in revs. per min. They are clockwork instruments, kept in synchronism by a standard clock. This standard clock has a commutator within it which sends current for 20 sec. into the coils of an electromagnet in the indicating instruments, then breaks it for 4 sec, re establishes it for another 20 sec., and so on. While this current is on, the electromagnet holds a detent which allows an escapement motion to drive the indicating hand over the dial. Correcting currents sent by a revolving contact-maker driven by a friction wheel from the propeller shaft of the engine at the rate of three per revolution are received in separate electromagnet coils in the instrument, and while the main current, controlled by the standard clock, is disturbed for the 4-second interval mentioned, the correcting currents drive the indicating needle forward or pull it backward according as the average rate of revolution of the engines has been less or greater than that shown at the moment on the dial of the instrument. A galvanometer tell-tale for indicating "ahead" or "astern" is fixed in the bottom of the indicator case, and receives current from what is called by the inventor an "alternator," driven from the shaft in one direction or the other according as the ship is going ahead or astern. When no current passes at all the needle takes the mid position and indicates "stop."

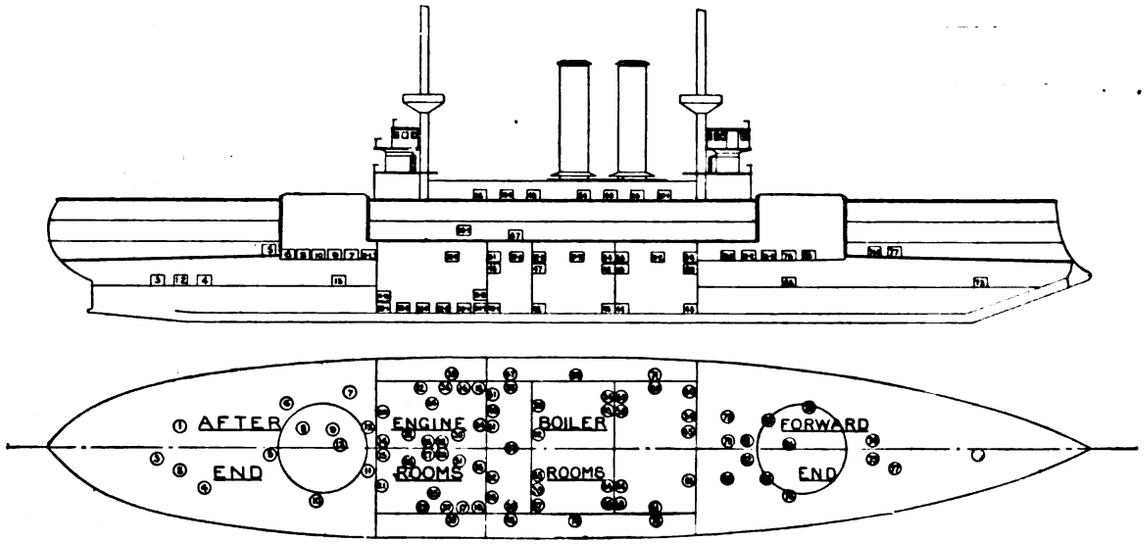
(*b*) *Auxiliary Machinery.*—This general title covers a variety of machines whose functions fall into three principal classes.

(1) Those which co-operate with the main engines and boilers in the propulsion of the ship—*e.g.*, boiler feed-pumps, air and circulating pumps for condensers, fans for producing pressure in the stokeholds or furnace-blowing engines for working at "forced draught," steering engines, capstans for raising anchors, &c.

(2) Functions relating to the operation of the ship as a fighting machine—*e.g*, engines for moving turrets and for elevating and loading guns, hoists for raising ammunition, compressors for the supply of air under pressure to torpedoes, &c

(3) Domestic functions—*e.g.*, dynamos for lighting and fans for ventilating the ship, refrigerating plants for preserving food, pumping service for fire, bilge drainage, supplying fresh water and the like, hoisting machinery for lowering and picking up boats, &c.

In all, a first-class battleship carries nearly 100 sets of machinery, and a first-class cruiser 50 sets to 70 sets. Until a few years ago the whole of these auxiliaries were steam driven, with the exception of the gun-working machines, for which hydraulic power has long been preferred. By degrees electric driving has been applied to one and another, the most "advanced" examples being the United States battleship "Kearsage" just completed, which carries 55 motors and a generating plant of 350 kw. capacity. More has been written and said, both in Europe and America, within the last two or three years on this section of the subject than perhaps on any other, some persons roundly asserting that the time has come for driving all auxiliaries by electricity, while others are sceptical as to the desirability of employing electricity at all except for lighting and bells. Between these two extreme views, opinions exist of every intermediate grade



1-2.	Steering Engines .. .. 2 sets	14-15.	Steam Dynamos .. .. .. 2 sets	40-45.	Boiler Feed Pumps .. .. 6 sets	73.	Capstan Engine.
3.	After Capstan	16-19.	Main Circulating Pumps .. 4 sets	46-50.	Furnace Air-Blowing Engines .. .. 5 sets	74-75.	Refrigerators .. .. .. 2 sets
4-7.	Ventilating Fans .. .. 4 sets	20-21.	Auxiliary ,, .. 2 sets	51-56.	Ventilating Fans .. .. 6 sets	76.	Workshop Engine.
8-9.	Air Compressors .. .. .. 2 sets	22-25.	Air (*i.e.* Hotwell) Pumps .. 4 sets	57.	Steam Dynamo.	77-80.	Ventilating Fans .. .. .. 4 sets
10.	Main Hydraulic Engine.	26-29.	Fire and Bilge Pumps .. 4 sets	58-59.	Boat Hoists .. .. 2 sets	81-82.	Air Compressors .. .. .. 2 sets
11-12.	Turret Turning Engines .. 2 sets	30-31.	Starting Engines .. .. .. 2 sets	60-61.	Coal .. .. 2 sets	83.	Main Hydraulic Engine.
13.	Turret Auxiliaries—	32-33.	Turning Engines .. .. .. 2 sets	62-66.	Ash .. .. 5 sets	84-85.	Turret Turning Engines .. 2 sets
	Shot Hoists.	34-35.	Distiller Pumps .. .. .. 2 sets	67-72.	Ammunition Hoists .. .. 6 sets	86.	Turret Auxiliaries—
	Rammers, etc.	36-37.	Ventilating Fans .. .. .. 2 sets				Shot Hoists.
		38-39.	Ammunition Hoists .. .. 2 sets				Rammers, etc.

FIG. 29.—Location of Auxiliary Machinery on a Typical Battleship.

PART II.—MACHINERY AND POWER DISTRIBUTION.

The machinery of a modern ship of war consists of—

(*a*) *Main Propelling Machinery*, consisting of high-speed steam engines and high-pressure boilers. From the figures given by Sir William White at the 1899 meeting of the British Association at Dover as to the output and efficiency of this class of machinery for a given weight, and from calculations made by Mr. Alexander Siemens as to the weight of accumulators required to perform the same work, there is no difficulty in concluding that electricity will have no place for many a long day in the propulsion of large ships.*

Electricity as a motive power is now so commonly used on land that the charge against naval administrations in general, and the British Admiralty in particular, that they do not sufficiently avail themselves of this new mode of transmitting energy, is repeated with monotonous regularity by writers on the subject. It must, however, be remembered that it takes about three years to build and equip a large warship; if any novelty has been introduced in the design of the ship, it is not unreasonable to allow a year for trial of the novelty at sea, whence it follows that the experience available to naval designers to-day is that of the methods of four years ago. Now in electrical development four years is a long time, and thus it is evident that, judged by the standards of present-day land practice, naval designers would appear to be several years more backward than they really are.

The conditions under which auxiliary machinery works on board a warship are of a very special kind, requiring motors of special design to meet them successfully. Thus, a glance at diagram No. 29

* "With modern twin-screw engines and high steam pressure each ton weight produced from 6 H.P. to 7 H.P."—Sir William White, *loc. cit.*, *Engineering*, LXVIII. 341.

"A 6,000-ton ship propelled by 8,000 I.H.P. will take about 150 hours to cross the ocean, equal to 1,200,000 H.P. hours. Fairly efficient accumulators give about 10 watt hours per 1lb. of their weight, so that a horse-power hour can be obtained for 75lb. of accumulators. The ship in question would therefore have to load about 40,000 tons of accumulators for the trip across the Atlantic."—A. Siemens, *loc. cit.*, *Journal Soc. Arts*, XLVII. 820.

In other words, for 150 hours steaming 1 H.P. is produced from five tons of accumulators; hence, neglecting weight of electric motors and accessories, electric propulsion is inferior to steam propulsion on the score of weight in the ratio of at least 1:30.—AUTHOR.

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shows that auxiliary machines are located all over the ship. Boat hoists and ash hoists are located on the upper and boat decks, exposed to all conditions of sea and weather. Motors in barbettes and turrets, fans in ventilating trunks, and (sometimes) capstan engines are liable to be drenched with water by seas shipped, or at least to suffer from the effects of spray; the machines on the upper decks get covered with grit when coaling, while machines working in machinery compartments below decks have to endure high temperatures for prolonged periods. All, wherever situated, have to be able to withstand rough usage, and are liable to be left idle for long periods when the ship is out of commission. The mention of these difficulties suggests that, with very few exceptions, electric motors used on board ship should be of enclosed watertight and dust-tight type, of extra strong mechanical construction to stand overloading, and arranged with long bearings and good automatic lubrication, so as to run for long periods with no attention at all; they should also be designed to work sparklessly with constant lead for all loads, so that the brushes are fixed; and moreover, the brush gear must be so designed that the brushes do not jump off the commutator if the machine is exposed to external vibration; the motors should run for normal periods with moderate temperature rise (the rise permissible depends on what is called the "normal period" of running, and will be different in such cases, for example, as electric ventilating fans, which ought to be able to run for two or three weeks on end, and capstan motors or boat-hoist motors, which in normal circumstances would work less than an hour at a time). The switchgear should be of massive construction, and should be an engineering apparatus, as substantial as a stop valve or a starting lever.

It cannot be said that all these requirements could have been met by the general run of electric motors produced four or five years ago, but they can all be met to-day. Cases, unfortunately, have occurred in which motors fulfilling none of the above conditions have been put on board ship. The cheap stock motor, suitable only for dry situations on land with good foundations, and requiring careful attention, has been installed and sent to sea. When, as is inevitable, such motors fail, the report sent in is less likely to be to the effect that "this particular motor is unsuitable" as that "electricity is not adapted to this class of work."

The modern traction type of motor best meets, on the whole, the requirements laid down as necessary for ship work, and the conditions under which it actually works on land are as bad, if not worse; yet the accumulating experience of the world that such motors will endure the very roughest usage, makes it unnecessary to argue further that enclosed motors can be built, of moderate weight and cost in relation to output, that will leave nothing to be desired on the ground of reliability. Reliability being the first consideration, the next in importance is simplicity in operation, combined with ease of inspection and repair. An electro-motor is a simpler machine to operate than a steam or hydraulic engine. It has fewer working parts requiring attention. Indeed, if only attention is given to supplying the bearings with oil and to cleaning the commutators periodically, there is nothing else for an attendant to do. Also a motor is cleaner in operation; it is not necessary to drain out a pipe full of water before it will start, and not only is the mess due to the absence of drainage water saved, but there is the advantage that the motor can be started instantly.

Cables for motors may, in like manner, be held to be a simpler means of transmission than steam or hydraulic pipes; they are more easily led about, weigh less, and take up less room than pipes capable of conveying an equivalent power, and they interfere less with the tructure and disposition of space in the ship. It has been objected against them that faults in cables are not so easily found as in the case of steam pipes, but if the cables are originally watertight, and are led about the ship from point-to-point junction or fuse boxes, it is not difficult to isolate the sections one at a time and locate the fault rapidly. If a fault exists, when it is found it can be repaired much more expeditiously than a leaky joint or other fault in pipes can be, especially steam pipes, which have to be allowed a long time to get cool before they can be handled. Further, if it is not convenient to repair a cable fault immediately, a temporary length of cable, not necessarily of the same size, can be run in and the faulty section disconnected. This cannot be done with pipe systems of distribution.

American writers point out two other disadvantages attending the use of steam-pipe system of distribution—(*a*) that the steam pipes heat the living spaces to an uncomfortable extent, (*b*) that pipes exposed to the effects of shot and shell are likely to be injured in action, and to lead to the demoralisation of the guns' crews. Neither of these considerations apply to modern British ships. Steam pipes do not pass through living quarters. Pipes to the steering and capstan engines pass through certain storerooms below the protective deck, but these are so chosen that the heat is unobjectionable. As regards the pipes to the deck hoists, which are exposed, they are usually led up the stokehold fidleys amidships, and are provided with valves below by which they can be shut off from the steam main in time of action.

(To be continued).

ON DISTANT ELECTRIC POWER TRANSMISSION.*

BY PROF. GEORGE FORBES, F.R.S.

Your President did me the honour to invite me to read a Paper on the subject of the distant electric transmission of power, to which I have devoted much attention during the last ten years. From the remarks he made at the time, it seemed to me that what he most desired was a description of the works of this character which have been established in different parts of the world, with the object of provoking a discussion on their various merits and defects by members of the Institution. I regret that to myself it seems undesirable that anyone should give to the Institution descriptions of works carried out elsewhere if he has not an intimate personal practical knowledge of the works; but in view of the fact that the discussion of this Paper may bring out information from those who have actually had the handling of such works, I have yielded to the President's wish to a certain extent. The first part of the Paper is devoted to the description of certain selected transmission plants, each one put up by a different contractor, and each one having some special point of interest. But I must freely confess that the only one of these of which I have that intimate practical knowledge which enables one to judge on the merits or defects of a scheme is the plant at Niagara Falls, the plans for which were prepared by me in 1890 and carried out between that date and 1895, and the actual working of which I have thoroughly investigated up to the summer of 1899, by a study of the journals, log-books, and complaints from consumers about faulty supply. Concerning the other installations, I have had to make use of the printed descriptions appearing in technical and other journals, which are always liable to mislead, especially as to the satisfactory nature of the supposed uninterrupted supply of power.

The second part of the Paper deals with some of the problems that face the consulting engineer in his attempts to introduce the highest economy, especially in the transmission lines, as this is the most important part when the distances are great. To these sections of the Paper some words have been added to give a general view of the methods in use by different contractors. Hitherto manufacturers and contractors in this country, having few great water powers in Great Britain, have neglected to attempt the supply of suitable machinery for other parts of the world, and run a risk of being passed over entirely in the future as they have been in the past, when tenders for the electric utilisation of water powers are asked for; it is perhaps wrong to say that they have been overlooked, and more just to say that they have refused to undertake such work. I venture to put forward the opinion that this is unwise, and I trust that the immediate progress that we expect in the transmission of power generated in the neighbourhood of coal-pits, will lead the manufacturers of this country to appreciate the large field that is opened to them abroad for the utilisation of water power.

If this be done I believe that British manufacturers may work upon new and independent lines, and that they will have a large outlet in our colonies and other parts of the world; because, out of numerous tenders that have been submitted to me for the transmission of power from waterfalls, none of the foreign firms who have tendered seem to me to have started on the best lines for making such a work successful and absolutely free from interruptions.

If our manufacturers, owing no doubt partly to the fact that their hands are full, have been unwilling to undertake these great works, while foreign firms have been making a splendid start, it must be allowed that the want of progress in our colonies is also largely due to the timidity of our financial men. It is not in this country that you would have found men with the boldness to risk their capital in transmitting and distributing electricity for power purposes, at a date (1890) when there was only one example of such transmission and distribution—viz., in a small village near the frontier of France and Switzerland. Nor would confidence have been placed by them in an electric transmission by means of alternating current, at a date when there was not a single alternating-current motor in commercial use, nor in the advantages of lower frequency than any which had been thought of up to that date (1893), when nine-tenths of the members of this Institution who rose to discuss the question condemned a frequency of 25 periods per second as impossible and extravagant.† Our capitalists are too apt to say that such things are too experimental, when any step is taken to improve methods. Yet the capitalists in America who undertook to utilise the Niagara Falls did all these things—they made a commercial and engineering success of their works, and have been imitated in their methods all over the world.‡

* Paper read before the Institution of Electrical Engineers, April 26.

† The unqualified success of the low frequency of Niagara Falls has now, however, converted even former opponents, and this Institution passed a recommendation last year that a frequency of 25 should be a standard for power transmission.

‡ The only financial group who ever in this country showed such boldness in electric matters was the band of men who realised that Ferranti's brilliant views were right, and who started the London Electric Supply Corporation.

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Attention must now be drawn to a few of the most interesting cases of using electricity for developing the power of waterfalls.

1. Of the various plants for transmitting electrical power from waterfalls, one which derives its chief interest from the greater distance to which the energy is transported, is in South California at San Bernandino and Los Angelos, carried out by the General Electric Co., U.S.A. The water is taken from the streams in the San Bernandino Mountains, and it is carried in canals and tunnels for about 2¼ miles. It develops power under the head of over 700ft., three-phase electric currents are there generated and raised by transformers to a pressure of 33,000 volts, and the current is transmitted over a distance of 80 miles to Los Angelos; 80 per cent. of the water conduit is in tunnel, and of the rest part is open masonry canal and the remainder timber flumes. There are 18 tunnels whose total length is 11,555ft., the longest being 2,074ft. There are 2,662ft. of wooden flumes, 167ft. of open masonry canal, 121ft. for a sand box, and 57ft. of reservoir and forebay at the head of the penstock. The water is taken from a point 3,422ft. above sea level, the power house being at a level of 2,670ft.; the slope of the canal is 9·5ft per mile, leaving an available head of 728ft. at the power house. The streams used are the Santa Anna River and the Bear Creek.

The best description of the civil engineering works is given in the *Engineering News*, New York, March 9, 1899: Pelton wheels are used, with a nozzle 3⅜in. in diameter; the wheels are 82in. in diameter; the regulation is obtained by deflecting the nozzle from its most effective position as the load falls off: four such wheels and generators are in place; the generators deliver current in three phases, and the revolving wheels carry 20 poles, the armature being external. Each generator delivers 1,000 H.P., running at 300 revs. and giving 750 volts. There are 12 transformers, in banks of three, on foundations of steel beams and concrete, 30in. above the floor for the purpose of cooling by a forced air draught. Each transformer raises the pressure to 19,000 volts, making 33,000 volts between wires on the three-phase circuit, the star connection being used; three eighths of an ounce pressure is used, with blowers 280in. diameter, each requiring 3 H.P. There are two three-wire circuits of No. 1 (B. and S.) copper wire, and the insulators are placed on the posts at the angles of an equilateral triangle. These insulators, over 6in. diameter, are bell-shaped, of glazed porcelain, and are bolted to the cross-arm. There are 44 posts to the mile of white cedar, from 35ft. to 65ft. high, with 8in. tops. At Pesadena the voltage is reduced by oil-cooled transformers to 2,200 volts, and the current is used to work a synchronous motor which drives a direct-current generator of 525 kw. At Los Angelos there are six 250 kw. transformers reducing the electric pressure to 2,200 volts, and four synchronous motors which drive generators for lighting with continuous current. The information which would be most useful as to the results of working this plant would be about the continuity of working and freedom from interruptions. Such information cannot be obtained accurately except by a prolonged stay at the spot, examination of journals, &c. I am unable to assist in this.

II. The Snoqualmie Falls* have been developed for transmitting power to Seattle and Tacoma, by the Westinghouse Co., U.S.A. The features of greatest interest in this case are the use of the high electric pressure of 30,000 volts and the use of aluminium for the conductor on the long transmission line. It is impossible for any one to know what success has attended these novelties, unless he were to examine not only the plant but the log-book and correspondence. Continuity of performance is of primary importance, but we cannot tell from published accounts whether this has been attained in the present plant with 30,000 volts. Also we have not any means of knowing what success has attended the use of aluminium wire. In the development of the Snoqualmie Falls a vertical shaft has been dug 260ft. deep, 10ft. by 25ft., and the tail-race tunnel is 200ft. A 7ft. 6in. steel penstock is in place, and there is room for another. The underground chamber for machinery is 200ft. long, 40ft. wide, and 30ft. high. The penstock is connected at the bottom to a steel receiver 10ft. diameter, 1in. thick, and 80ft. long horizontally, besides 60ft. length of pipe 7ft. 6in. diameter.

There are four 1,500 kw. three-phase alternators at a frequency of 45 cycles, and at 1,000 volts. The armature rotates, and is 8ft. diameter, and weighs over 10 tons. Laminated poles are cast into the field frames. Transformers of 500 kw. with oil insulation are used. Mesh connection (or Δ) for the three phases is used both in primary and secondary. As to the high-pressure transmission line of 30 miles, it is said that 33 tons of aluminium are used for going to Seattle and 34 tons for going to Tacoma, and that each route has two separate three-phase circuits with 30in. between wires, that the average span to Seattle is 110ft. and to Tacoma 150ft., that Nos. 1 and 2 B.S. gauge and McIntyre joints are used. There is some discrepancy between the weights of wire used and the power that is said to be transmitted.

The whole of the information here given is taken from technical journals. On this line the electric pressure has sometimes been raised to 40,000 volts, when the phenomena of brush discharge acquire considerable importance. This led Mr. Scott, of Pittsburg, to his interesting experiments on this subject, published by the American Institute of Electrical Engineers.

III. The Paderno development of the* Adda River for supplying electric energy to supplement that in use at Milan, a distance of 33 kilometres, derives its chief special interest electrically from the fact that the energy is generated direct in the alternator at the comparatively high electric pressure of 13,500 volts, the plant having been designed and constructed by Messrs. Brown, Boveri and Co. The only other plant in the world which can be compared in this feature with Paderno is the transmission by the General Electric Co., U.S.A., from Mechanicsville to Schenectady, where both generator and motor are used at 10,000 volts without the intervention of any transformer.

It would be interesting to discuss the hydraulic part of the work at Paderno, but it is advisable under present conditions to confine remarks as far as possible to some of the electric details. Under the former head it may be said that the minimum flow of the river is taken at 45 tons per second. The dam is 150 metres long. The canal has a slope of 2 per cent., giving a velocity of 2·70 metres a second when the flow is the maximum allowed for. There are three tunnels, whose total length is 1,686 metres. The open canal is 582 metres. The total fall varies from 28·82 metres to 24·92 metres. The total head available is constantly 22·85 metres, and the suction varies from 6 metres to 2 metres, giving a total power of 13,000 B.H.P. The type of turbines is horizontal axis, double turbine to balance pressures, radial intake and axial outlet. Each double turbine developes 2,160 B H.P. at 180 revolutions per minute. A safety valve is provided, but is not required, as it was found, when closing the outlet of a fully loaded turbine in two seconds, that the pressure rose only 9 or 10 metres without using the valve.

The dynamos are of the well-known Brown construction. Each is of 2,160 H.P. at 180 revolutions, and developes three-phase currents. The armature is fixed and external to the revolving field, which carries 28 poles of steel with laminated horns. The poles are wound with copper strip edge-on. The diameter of the revolving field is 4·1 metres, and that of the whole machine is 5·14 metres. The exciter is in line with the alternator. The frequency is 42 cycles per second. The normal pressure is 13,500 volts at the terminals, and the current should be 64·5 amperes per phase with an induction factor of 1, or 79 amperes with 37deg. of lag. The efficiency in the former case is 95·1 per cent., in the latter 93·4 per cent. The maximum rise of temperature is 280°C. The machines were deliberately tested at 20,000 to 21,000 volts, and it is said that accidentally they were caused to generate current at 30,000 volts without injury.

The line consists of three independent three-wire circuits on two lines of posts 2 metres apart, the distance between any two wires of one circuit being 0·6 metre. The mean distance between the posts of one line is 60 metres. The distance of the high-tension transmission is 32,500 metres. The wires are of copper, 9mm. in diameter, the ohmic loss is 8·1 per cent. and the total loss is 11·7 per cent. for a lag of 37deg. A lag of 45deg. has been observed with a line on short circuit. Wurtz lightning arresters are used at both ends of the line on two of the circuits, and Siemens and Halske horns on the other. At Milan the pressure is reduced by Ganz transformers of 350 kw., and transmission gives place to distribution. The above statements of facts are on the authority of E. Vannotti, and were published by *Le Génie Civil*, Paris.

IV. The Rheinfelden plant† is here mentioned to allow of discussion on it, and because it is the most successful development of a low fall on the general lines of the Niagara undertaking. It resembles Niagara in using a vertical shaft for each turbine and dynamo. It differs from Niagara in having four different types of dynamos, some giving continuous, and others alternating, current. The turbines are by Escher Wyss, the dynamos by Oerlikon, and the Allgemeine Elektricitäts Gesellschaft. The hydraulic works are a model of good work, which I constantly kept before me when planning the work to be undertaken on the Nile Cataracts for the Egyptian Government.

If I were attempting here to give full descriptions, I would devote much space to this excellent installation. Many members of this institution have, however, inspected the plant, and every engineer who wishes to master this branch of our profession is obliged to read the most admirable description published at Berlin (*Die Kraftübertragungs-Werke Rheinfelden*).

V. In a Paper dealing with transmission schemes which have been carried out, the Genoa continuous-current plant deserves great attention. Here water power is available. The turbines are connected by insulating Raffard couplings to insulated dynamos, which are electrically connected in series. Thus 6,000 to 8,000 volts are delivered at Genoa to work insulated motors, also put in series so as to attain this high electric pressure. In a scheme purely for transmission, and not for distribution, this method of using continuous currents has a great deal of merit, and I believe that we shall all

* [See *The Electrician*, Vol. XLIV., p. 5 —ED. *E.*]

* [See *The Electrician*, Vol. XLII., pp. 255, 361 and 413.—ED. *E.*]

† [See *The Electrician*, Vol. XLIII., p. 521, and also Vol. XXXVIII., p. 716.—ED. *E.*]

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agree that we owe a debt of gratitude to M. Thury for the way in which he has worked out the method at Genoa and elsewhere. A full account of this work has been published, and deserves the closest attention. I could mention cases which have come under my own notice where this system with continuous currents would give better results than the Niagara system with alternating currents.

VI. Having satisfied your President's wish and put forward as a basis of discussion some of the plants in different parts of the world, with the actual working of which I have no practical experience, it is a pleasure now to turn to the work of the Niagara Falls Power Co, concerning the working of which I may be able to supply useful information.

I do not propose here to give a full account of the machinery which we have made use of. It has been well described in the *American Electrician* for January, 1900.* It will be better to pass lightly over this part, and devote more attention to the lessons to be learnt from the five years of working. This plant derives its chief interest from the following facts: (1) It was the first place except Oyonnax where a scheme was started on for generating electricity at a waterfall, transmitting it to a distance, and distributing it to consumers for power; (2) It was and is the largest project of the kind; (3) It was the first case of using the alternating current for power commercially. (4) It was the first case in practice where the commutator for continuous currents was placed at the distant end of the transmission line; (5) It was the first plant to adopt low frequency; (6) All the generators are of the same size and pattern; (7) The Niagara system in its general features has been adopted in almost every subsequent electrical development of water power. The principal feature of the dynamos is that the shaft is vertical, and that the revolving field has its poles external to the armature. In the original drawings and specification issued to manufacturers a circulation of fluid for cooling the armature was provided; the poles were wound with copper strip and mica insulation, and not with wire; and there were no bolts on the outside ring to create undue air friction. I allowed the first three dynamos to be built without these features, but the last seven have had them reintroduced.

The transformers at the power house are the first ever made of great size, and also the first made with great attention paid to cooling by air-blast or oil. Those by the General Electric Co. are 1,250 H.P. Those by the Westinghouse Co. are 2,500 H.P. For the factories within half-a-mile a subway is used, which I built of concrete. For the new Carbide works a "Camp" conduit, like our "Doulton" conduit is used with 10,000 volts. For the Buffalo transmission bare overhead wire cables are used.

The Aluminium Co. had great trouble at first with the rotary transformers used for commutating the current. These were, I believe, the first machines of this class ever ordered for commercial use. The Mathiessen Alkali Works have 11 such machines, with one induction motor for starting the middle one. The others are started from this by temporary belts. They have no hunting, no sparking, and no grooves on the commutators. Hunting is prevented by a modification of the Leblanc cage on the poles. Each machine has six poles, and sparking is prevented by connecting together metallically all the commutator-bars which are in the same phase. To prevent grooving of commutators the shaft is free to move axially, and motion is given to it by an electro-magnet and spring, the current for the electro-magnet being periodically interrupted by clockwork mechanism on the wall.

The Carborundum Co.'s plant is chiefly interesting for the adjustable transformers, which allow very large variations in the volts and current. These have often been described in technical journals. This service could not have been given had we adopted three-phase alternators, and the rotary transformers would not have succeeded but for our low frequency. In the new works of the Carbide Co., 10 Wagner transformers, each of 2,000 H.P., were being put in when I was last there. This plant is interesting from the fact that the serious short circuits frequently occurring in the electric furnace can be satisfactorily dealt with.

Passing over other matters concerning which a volume might be written, it will be well to say a few words about the transmission line to Buffalo. The chief peculiarity of the Buffalo transmission line is that three-phase currents are used, though generated in two phases. I very much preferred alternators of two phases as being more easily tested and attended to, and as giving a more useful machine. For the transmission to Buffalo I had no great preference for one over the other, but I found that we should be better served by yielding to the wishes of the contractors and putting in Mr. Scott's ingenious arrangement for changing from two-phase to three-phase. *Fig.* 1 shows the connections.

There were six bare cables on one cross-arm of the posts all the way from Niagara to Buffalo, but this arrangement is to be altered.

From Niagara to Terminal House, Buffalo, is 25 miles.
From Terminal House to Railway House is 2 miles.
From Terminal House to Lighting House is 4 miles.
From Terminal House to 3 Sub-stations is 4½ miles.

The full-load inductive E.M.F. is 15 per cent. of the whole. At some stations the current leads the E.M.F. instead of lagging. The Buffalo cables are three insulated lead-covered cables in a pipe, and the capacity of each is 0·55 m.f. per mile from copper to lead. The conductors on the transmission line are 0·6in. diameter, 18in. apart half the way, 36in. the rest. The posts are 75ft. apart. The top cross arms are 30ft. above ground. The posts are 8in. diameter at the top. They are not strong enough for the weight and are bent badly. Originally a barbed wire ran the whole distance over the conducting wires. After the snowstorm of Dec. 4, 1898, it was removed. It was grounded at every second post. Having looked carefully into the cause of every interruption of electric supply that has occurred in four years, I have to say that not a single electrical trouble has occurred that might not be prevented in any similar plant laid down in future.

In this brief reference to the work at Niagara Falls many features of considerable importance must be omitted; but I should like to draw attention to the ingenious automatic cut-outs with the introduction of which I had nothing to do, and which I am therefore free to praise, as they have been of the highest value in preventing interruptions of supply on the Buffalo transmission. The electro-magnetic arrangement, which comes into play when excessive current passes due to a short circuit, merely serves to start some clock mechanism which after a short period cuts out the line if the excessive current is still passing. On the Buffalo distribution these automatic cut-outs are set so as to act after one or two seconds; at the Buffalo end of the transmission line after three seconds, and at the Niagara end after four seconds. Thus a short in Buffalo cuts out the distributing lines, and no others. At the Terminal House, Buffalo, it cuts out the supply mains, but not the transmission line; and at Niagara, if a short last four seconds, the supply to the transmission line is cut out.

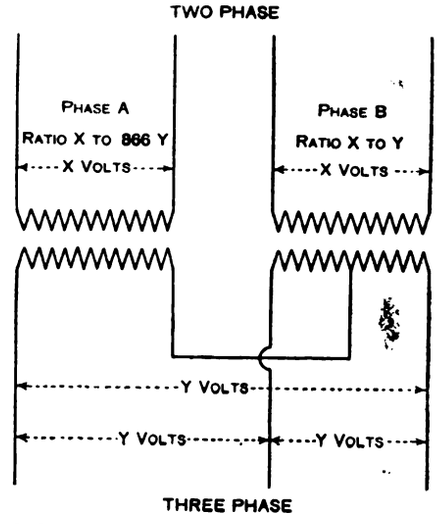

FIG. 1.—Sketch showing transformation from two phases to three phases.

Another ingenious appliance at Buffalo is a motor supplied by the three transmission cables, so balanced that the motor will not move except when the balance is destroyed by an earth or short circuit on the line, when its motion removes the defective line, or switches the whole load on to the other line.

There is a practical matter regarding the regulation of the turbines which deserves notice. At the period of my last inspection Buffalo was supplied by two dynamos. Now the first three turbines put down were regulated by a purely mechanical governor; the later ones by a more sensitive electrical governor. It is found in practice that the supply at Buffalo is most steady when the two turbines driving the dynamos are regulated, one by a sensitive, and the other by a coarser governor.

In conclusion of these remarks about the Niagara-Buffalo transmission it may be interesting to mention a few of the causes of interruption of the current. Some of the Italian workmen stole copper wire. They were put in prison. Whereupon their relatives short-circuited the wires. Boys threw chains over the transmission wires to watch the sparks until the detectives caught them. Short-circuits or earths have also been caused by fumes and carbon dust deposited on snow on the insulators, by fourth of July rockets, by sleet, by lightning, by careless workmen, by rats. Interruptions have occurred by overload on rotary transformers, by attendants using switches wrongly, by lightning arresters, by bad switches on consumers' premises, by accidental fire, by ice blocks on the canal headrace. Insulators are a temptation to the owners of revolvers, but this trouble has not existed at Niagara so much as in Switzerland. These are only extracts from the nearly complete list which I made out from four years' working.

(To be concluded.)

* [See *The Electrician*, Vol. XLIV., pp. 617, 653 and 775; also Vol. XLII., pp. 565, 596 and 601; and for a previous Paper by Prof. Forbes, *The Electrician*, Vol. XXXII., pp. 70, 98, 119, 181 and 194.—ED. *E.*]

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BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Magnetic Induction in Iron and other Metals." By Prof. J. A. Ewing, F.R.S. 3rd edition. (London: "The Electrician" Printing and Publishing Co.) 10s. 6d. net.

"English and American Lathes." By J. G. Horner. (London: Whittaker and Co.). 21s.

"Publications of the British Fire Prevention Committee." Edited by E. O. Sachs. Vols. II. and III. (London: British Fire Prevention Committee.) 20s. each.

"Traité Elementaire d'Electricité." By R. Colson. Third Edition. (Paris: Gauthier-Villars) 3fr. 75c.

"Impianti di Illuminazione Elettrica." By Emilio Piazzoli. Fourth Edition. (Milan: Ulrico Hoepli.) L6.50.

"Power Transmitted by Electricity." By Philip Atkinson. Second Edition. (London: Crosby, Lockwood and Son.) 7s. 6d.

"Trasmision Elektrika de Potenzia a Largas Distanziaa." By A. E. Salazar. (Santiago de Chile: Hume, I. Kª.)

"The Slide Rule." By C. N. Pickworth. 6th edition. (Manchester: Emmott and Co.) 2s.

"*Journal* of the Institution of Electrical Engineers." April. No. 144. Vol. XXIX. (London: E. and F. N. Spon.) 3s. 6d.

"Science Abstracts." No. 4, Vol. III. (London: E. and F. N. Spon.) 2s.

"*Proceedings* of the South African Society of Engineers." Vol. V. 1898-1899. Edited by G. S. Burt Andrews. (Johannesburg: W. E. Curzons.)

"The Official Gazette of the United States Patent Office." Nos. 1, 2, 3 and 4, Vol. XCI. Published by authority of Congress. (Washington: Government Printing Office)

Alphabetical Lists of United States Patentees and inventions for the quarter ending Dec. 31, 1899. Vol. LXXXIX.

ELECTRICITY WORKS ACCOUNTS.

Brighton Municipal Electric Supply Works.

From our table summarising the accounts of the Brighton undertaking for 1899 it will be noticed that the excellent results of the preceding year have hardly been maintained either in respect of increase of business or in economy of working. In the latter sense the retrogression has been very slight, and has been due to extraordinary expenditure. The rise in the aggregate costs of 0·12d. per unit has brought them up to 1·8d.—a figure still most satisfactory, even in view of the large output and the increased load factor of 16·6 per cent. with which the undertaking was blessed last year. The fuel charge has diminished, and stands at what is a most reasonable figure for a town situated as Brighton is in respect to a coal field. If there are any items which seem a little high to us, they are those of wages and repairs and maintenance at the station, but management and property charges present practically the same satisfactory figure that they did in 1898.

The reduction in the tariff has had its due effect on the revenue, the total from all sources being 3·06d. per unit or 2·94d. for supply for lighting, public and private. Again, in view of Brighton's situation this is an excellent result, and will stimulate the progress of the undertaking in the matter of lamp connections, the increase in which last year fell to 19·7 per cent. The increase in the output was also not so great as in 1898 being only 21 per cent. Considering the order of the output in relation to the size of the town it is surprising to find the progress in lamp connections so well maintained as it is.

The load factor shows a gratifying increase from 15·4 per cent. in 1898 to 16·6 per cent. last year, the maximum demand on the mains (selling load) being 1,962 kw. in 1898 and 2,206 kw. in 1899, while the maximum load reached was 2,376 kw. in 1898 and 2,538 kw. last year.

In the original accounts, under the headings "Street lighting installations" and "Attending public lamps and repairs, including materials supplied," there are items for 1898 of £366 and £3,437, and for last year of £157 and £4,350 respectively. These charges in the expenditure are exactly balanced by similar figures in the revenue, in addition to the sums accruing from the charge per unit for supply for public lighting. We have allowed the amounts stated to vanish from both sides of the account, so that as our analysis stands the costs and revenue are directly comparable with concerns where the arc lighting would have been by private consumers. If the items had been included, the total revenue, instead of figuring at 3·43d. in 1898 and 3·06d. per unit in 1899, would have come out at 3·77d. and 3·39d., while the total costs, instead of being 1·68d. in 1898 and 1·80d. in 1899—as shown in our table—would have stood at 2·025d. and 2·14d. respectively.

We learn that items of unusual expenditure out of revenue were—alteration to buildings, £200; renewal of accumulators, £470. These, with the increased cost of labour, are chiefly accountable for the slight advance in the costs, and more particularly the two items which were referred to above as appearing high.

The Eastbourne Electric Light Co. (Ltd.)

Although we are again able to record material progress in the year's results of working of this undertaking, its position is still below what might reasonably have been expected of a concern of such long standing. Both the costs and the revenue continue to stand at figures above what they should be, even considering the disadvantageous situation of Eastbourne in respect of cheap fuel supply.

Last year the lamp connections were increased by 18·6 per cent., while the output reached 857,585 units sold, or about 16 per cent. above that of 1898. In view of the high price per unit, it is somewhat surprising that the business continues to increase at the rate it does.

The load factor here is above the average, in 1898 it was 11·3 per cent. and last year 11·8 per cent.

Among the costs, the "management and property charges" per unit are very moderate, but all the generating costs, except "repairs and maintenance at station," still stand at high values, although they have been reduced.

The sale of the undertaking was completed on Jan. 1, since which date the concern has been under municipal control.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, 1900	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 18, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Salford (Municipal)	Feb. 23, 1900
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, 1900	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	May 26, 1899
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, ,,
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	Feb. 2, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wandsworth (Company)	Aug. 15, ,,
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, 1900
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Woolwich (Company)	Jan. 18, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kensington & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	June 9, 1899		

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	BRIGHTON.		EASTBOURNE.	
Undertaking Worked by	Corporation of Brighton.		The Eastbourne Electric Light Co. (Ltd.)	
Date of Commencement of Supply	September, 1891.		1882.	
System of Supply	3-wire with batts. combined with H.T. (alt.-curr. trans. sub-stations).		[and street boxes. H.T. alternate-current with trans. in houses	
Chief Engineer	Arthur Wright.		J. K. Bridges.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	3,242,017	3,815,743	466,688	565,209
„ SOLD (TOTAL)	2,648,701	3,206,623	308,037	357,585
„ sold to consumers	2,098,796	2,604,039	284,924	339,586
„ sold for public lighting, &c.	549,905	602,584	23,113	18,000
„ used on works	158,198	160,650	10,530	207,624
UNITS SOLD PER 8 C.P. LAMP CAPACITY	26·5	24·4	19·4	15·1
Maximum supply demanded	1,962 kilowatts	2,206 kilowatts	310 kilowatts	346 kilowatts
Number of public lamps	257 arc, 941 incan.	257 arc, 1,027 incan.	25 arc	25 arc
Number of consumers	2,063	2,410	400	409
Connections to mains in 8-c.p. lamps	108,560	129,950	23,028	27,311
CAPACITY OF PLANT IN 8-C.P. LAMPS	100,300	131,500	15,900	23,730
CAPACITY OF PLANT IN KILOWATTS	3,210	4,210	510	760
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£290,881 / £90·6	£354,881 / £84·3	£50,000 / £98	£50,000 / £65·8
Share	nil / —	nil / —	50,000 / 98	50,000 / 65·8
Loan (including Debenture charges)	290,881 / 90·6	354,881 / 84·3	— / —	— / —
RECEIVED (TOTAL)	223,155 / 69·5	273,155 / 64·9	53,605 / 105	53,605 / 70·6
Share	nil / —	nil / —	25,105 / 49·2	25,105 / 33·0
Loan (including Debenture charges)	223,155 / 69·5	273,155 / 64·9	28,500 / 55·9	28,500 / 37·5
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	67,726 / 21·1	81,726 / 19·4	— / —	— / —
Share (unissued)	nil / —	nil / —	— / —	— / —
Share (uncalled)	nil / —	nil / —	— / —	— / —
Loan (including Debentures)	67,726 / 21·1	81,726 / 19·4	— / —	— / —
REPAID (TOTAL)	9,611[a] / 2·99	9,611 / 2·28	— / —	— / —
RESERVE OR SINKING FUND	21,985 / 6·85	33,856 / 8·04	3,250 / 6·38	2,924 / 3·85
DEPRECIATION FUND	6,938 / 2·16	4,881 / 1·16	3,391 / 6·65	3,311 / 4·36
EXPENDED (TOTAL)	237,987 / 74·1	290,930 / 69·1	57,538 / 113	63,247 / 83·2
Lands and buildings	36,399 / 11·3	36,482 / 8·66	7,726 / 15·1	8,023 / 10·6
Plant	89,861 / 28·0	117,178 / 27·8	29,019 / 56·9	33,385 / 43·9
Mains	102,499 / 31·9	127,973 / 30·4	14,020 / 27·5	15,063 / 19·8
Miscellaneous	9,228[b] / 2·87	9,297[b] / 2·21	6,773 / 13·3	6,775 / 8·91
BALANCE OF CAPITAL ACCOUNT	−14,832[c] / −4·62	−17,775[c] / −4·22	−3,933[a] / −7·72	−9,642[a] / −12·7
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£37,831 / 3·429d.	£40,857 / 3·058d.	£9,449 / 7·354d.	£11,345 / 7·617d.
Revenue from supply	31,932[d] / 2·894d.	35,264[h] / 2·640d.	8,140 / 6·340 l.	9,906 / 6·648d.
„ meters, &c.	948 / 0·086d.	1,122 / 0·084d.	307 / 0·239d.	332 / 0·223d.
„ public lighting	4,731[e] / 0·429d.	4,040[i] / 0·302d.	752 / 0·536d.	714 / 0·479d.
„ sale of lamps, &c.	200 / 0·018d.	411 / 0·031d.	42 / 0·033d.	335 / 0·225d.
„ miscellaneous sources	21 / 0·002d.	21 / 0·002d.	207 / 0·161d.	59 / 0·040d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£18,542 / 1·680d.	£24,065 / 1·800d.	£4,874 / 3·793d.	£5,267 / 3·536d.
WORKS COSTS	14,606 / 1·324d.	19,254 / 1·441d.	3,809 / 2·964d.	4,144 / 2·783d.
Generation of electricity	*13,224 / 1·199d.*	*17,370 / 1·292d.*	*3,192 / 2·484d.*	*3,650 / 2·450d.*
Fuel (including cartage, &c.)	7,104 / 0·644d.	8,331 / 0·623d.	1,717 / 1·336d.	2,065 / 1·386d.
Oil, waste, water, stores	952 / 0·086d.	1,213 / 0·091d.	274 / 0·213d.	304 / 0·204d.
Wages at station	3,424 / 0·310d.	4,460 / 0·334d.	950 / 0·740d.	1,096 / 0·736d.
Repairs and maintenance at station	1,744 / 0·158d.	3,266 / 0·244d.	251 / 0·195d.	185 / 0·124d.
Distribution of electricity	*1,382 / 0·125d.*	*1,984 / 0·149d.*	*498 / 0·388d.*	*398 / 0·267d.*
Wages, &c.	626 / 0·057d.	858 / 0·064d.	225 / 0·175d.	238 / 0·160d.
Repairs, renewals of mains, &c.	756 / 0·069d.	1,126 / 0·084d.	274 / 0·213d.	160 / 0·107d.
Public lighting	— / —	— / —	*119 / 0·093d.*	*96 / 0·064d.*
Attendance	— / —	— / —	} 119 / 0·093d.	96 / 0·064d.
Renewals	— / —	— / —		
MANAGEMENT AND PROPERTY CHARGES	3,934 / 0·357d.	4,811 / 0·360d.	1,065 / 0·830d.	1,123 / 0·754d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*1,209 / 0·110d.*	*1,091 / 0·082d.*	*301 / 0·234d.*	*231 / 0·155d.*
Management	*2,725 / 0·247d.*	*3,720 / 0·278d.*	*764 / 0·595d.*	*892 / 0·599d.*
Salaries	1,932 / 0·175d.	2,619 / 0·196d.	513[b] / 0·399d.	542 / 0·364d.
Stationery, &c.	234 / 0·021d.	380 / 0·028d.	44 / 0·034d.	61 / 0·041d.
Establishment charges	417 / 0·038d.	391 / 0·029d.	78 / 0·061d.	134 / 0·090d.
Law charges, &c.	142[f] / 0·013d.	330[j] / 0·025d.	129[c] / 0·100d.	155[c] / 0·104d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£19,289 / 8·57%	£16,700[k] / 6·31%	£4,574 / 8·24%	£6,077 / 10·06%
Sum carried to Depreciation Fund	864 / 0·384%	170 / 0·064%	400 / 0·720%	nil / —
Sum carried to Reserve or Sinking Fund	6,554 / 2·91%	8,099 / 3·06%	nil / —	nil / —
Net interest on loans (incl. Debenture charges)	5,844 / 2·59%	7,145 / 2·70%	1,370 / 2·47%	1,584 / 2·62%
BALANCE FROM LAST ACCOUNT	2,864 / 1·27%	6,802 / 2·57%	451 / 0·812%	1,121 / 1·86%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	8,891 / 3·95%	3,590[l] / 1·36%	3,676[d] / 6·62%	5,614[f] / 9·29%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	12½% / —	12½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	49·0%	58·9%	51·6%	46·4%
Expenditure per kilowatt capacity	£5. 15s. 7d.	£5. 14s. 4d.	£9. 11s. 2d.	£6. 18s. 8d.
REVENUE PER KILOWATT CAPACITY	£11. 15s. 7d.	£9. 14s. 4d.	£18. 10s. 0d.	£14. 18s. 7d.
Expenditure per 8-c. lamp capacity	3s. 8½d.	3s. 8d.	6s. 1½d.	4s. 5¼d.
REVENUE PER 8-C.P. LAMP CAPACITY	7s. 6½d.	6s. 2½d.	11s. 10½d.	9s. 6½d.
REVENUE PER 8-C.P. LAMP CONNECTED	6s. 11½d.	6s. 3½d.	8s. 2½d.	8s. 3¼d.
Price charged for lighting, per unit	} 7d. to 1½d.[g]	7d. to 1d.[g]	7½d.	7½d. to 4d.[f]
Price charged for power, per unit		{	—	4d.
Price charged for public lighting	—[e]	7d. to 1d.[g]	By contract.	£30 per lamp per ann.

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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PROSPECT AND RETROSPECT.

The country is on the eve of an industrial crisis. The moment is at hand when Parliament will have to decide whether the United Kingdom is, or is not, to be blessed with the advantages accruing from a widespread supply of really cheap electric power. In view of the industrial and social importance of cheap power, and taking into consideration the national character of the issue, we feel justified in describing the impending Parliamentary decision as one that constitutes a national crisis. At the present moment, some six bills relating to schemes of unusual magnitude for the supply of cheap electric power are entering the committee stage of their progress through the House of Commons, besides numerous other bills relating to electrical undertakings of various kinds, which are in different stages of progress. Parliament has already recognised, in the Joint Committee which made its report in 1898, the principle upon which depend the six schemes referred to—namely, that "where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage." The Committee further thought "that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing Acts." Since this enlightened report was made Parliament has seen fit to throw out more than one bill based upon that principle; and as yet it has never affirmed its adherence to the principle by the passage of any effective Act. Having regard to these Parliamentary precedents, and to the opposition which is being threatened by local authorities to the bills now before the House of Commons, it is of the utmost importance that publicity should be given to the real nature of the present issue before the Legislature.

Let us look backward, for a moment, to the early dawn of electrical supply. The social and industrial possibilities of electricity were then ungauged; imagination painted them in rosy colours and magnified them into gigantic dimensions. The passage of the Electric Lighting Acts, and the advent of public electric supply as regulated by those Acts, were to usher in a new era of social and industrial civilisation—an Age of Electricity, in which all the unhealthy conditions of the age of steam power and gas light were to disappear. Cheap electric power for every existing purpose, and for a host of imagined new purposes, was to lighten the labours of the working class, brighten the conditions of home life, increase the earning power of capital and

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labour, and generally to introduce a millennium of material civilisation. Twelve years have passed since the passage of the Electric Lighting Act (1888), but where is the new civilisation? Where are the towns, the factories of which know no chimneys; the workshops of which are everywhere run by cleanly electric motors, in place of noisy and dangerous shafts and belting; the homes and retail shops and business houses of which have power "on tap" so cheaply that manual labour is materially lightened, and unhealthy gas and oil engines have been abolished for ever? Cities such as this certainly exist, but not under the Electric Lighting Acts; they are to be found only outside the United Kingdom, in places where it is possible to take advantage of the best conditions for supplying electrical energy, unhampered by unwisely restrictive legislation. Within the territory controlled by these Acts sufficient growth of the industry of electric supply has been effectively checked by the confinement of that industry within unnaturally small limits. The industry has never been permitted free expansion; cribbed, cabined, and confined within the narrow area controlled by some one municipal authority, it has been half-stifled and has never grown to full maturity. True, even within these limits, electricity has given considerable indication of its latent powers. It has everywhere proved itself the cheapest and altogether the best form of artificial illuminant; it has offered power to the small user on terms which many have been able advantageously to accept. But, nevertheless, it clearly has not accomplished the results which a more free scope and a wider and more comprehensive arena would have allowed. For, the one fact more unmistakably emphasised than any other by the past twelve years' experience of electric supply undertakings is, that in proportion to the magnitude and comprehensiveness of any system of electrical supply, so is the lowness of the price at which that supply can be made without financial loss. The soil wherein electricity supply most thrives is one in which its roots may strike out beneath a large area, rich in a great variety of nutriment. In plain language, really cheap electricity is impossible unless the area of supply is extensive, and comprises such a variety of consumers that the supply can be maintained constantly at approximately its full-load rate.

This is a fact of engineering; it has nothing to do with politics. Whether the reader be in favour of, or be opposed to, the political municipalisation of electrical undertakings, the great engineering principle stands firm: that in order to obtain the fullest advantages of electric supply, the area of supply must cover not merely one town or city, but many towns —whole counties, in fact; and within that area there must exist demands for current, not merely for lighting, but also for motor power and industrial purposes. Only in this way can the dream of an Age of Electricity have any prospect of being realised in this country. Succinctly, therefore, what is needed is that powers should be granted by Parliament for the construction of large systems of electrical supply, each covering extensive areas and including many towns and villages within its scope. This much definitely settled, the question arises: To whom should such powers be granted? If it is urged that they should be granted to the local authorities, within the meaning of the Electric Lighting Act (1888), our reply is that each separate local authority controls far too restricted an area. Concerted action on the part of all the local authorities within, say, any county is conceivable, though it is doubtful if it would receive Parliamentary sanction; but, be it observed, local authorities have shown no disposition whatever to combine on this large scale—they are engrossed with their own rights to erect petty local systems of supply. Again, it may be thought that the County Councils might take up the business of supplying electricity over their county districts; and doubtless it is open to any County Council to promote a bill to obtain such powers and privileges, but not one has yet done so. No, as usual it has been left to private enterprise to seek authority from Parliament to develop this new class of industry; and all that the local authorities have been content to do has been to present a solid front in opposition.

Amazement at this attitude of our local governing bodies, towards a matter of such vital importance to the nation, is intensified when we consider the weakling arguments which are advanced in defence of their position. It is alleged, for instance, that the new schemes, if put into operation, would supply electricity so much cheaper than the local authorities can supply it that the local works would no longer bring in any contribution for the relief of the rates. This is the cry of the man who says he will not work because he would then no longer receive parish relief. It is to prefer the muckrake of petty socialism to the golden crown of increased industrial prosperity. Let the rates take care of themselves, if so be every encouragement can be given to promote new industries and to increase those existing already! Another argument, equally fatuous and purblind, which is extensively advanced, is that the proposed schemes would create dangerous monopolies. They would create no monopoly of any description, dangerous or otherwise. On the contrary, it is especially provided that each local authority shall have precisely the same rights as hitherto to erect works of its own on its own area. Local authorities have a free option to purchase cheaply in bulk from the distribution company, or to generate expensively in their own sweet way; to their own ratepayers alone stand they responsible for their choice. Where is the monopoly in this? If any exist, it is merely the monopoly naturally acquired by the man who is willing to sell for a penny what no other mortal can make for twice or thrice the money. We repeat, there is no monopoly. Yet another so-called argument advanced in opposition is the outcry that it is monstrous for private companies to be allowed to break up public streets. The streets have to be broken up anyway, and we have yet to discover that a local authority ever does it with less inconvenience to the public than an electric supply company does. But the point of the argument ceases to exist, when we discover in the new schemes that all the alleged objectionable street-breaking is to be done, not by the supply company at all, but by the local authority. It is so laid down in the bills themselves. True, there is a wise provision that a local authority may, if it pleases, hand over this work and all the business of retail supply to the company; but there is absolutely no ground for the stump orator of any local authority to make such a clamour about the breaking-up of streets. Yet supine and indifferent ratepayers by the thousand are being lulled into unconsciousness of the true nature of the crisis by clap trap talk and inspired newspaper misstatements throughout the country. Local authorities have set their faces against the principle underlying these bills, and they are banded together to oppose it wherever it appears before Parliament. They are actuated purely by a selfish and narrow-minded determination to sacrifice every consideration of national welfare rather than that their own pet theories of socialism should be set at naught, or that their own little schemes for local electricity supply should be eclipsed by anything better adapted to the needs of the locality, and of the nation at large.

May the hollowness of the pretensions of these enemies of industrial and social progress be exposed in time to

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prevent the mischief they are plotting. It is the duty of every member of the electrical profession to thwart them in every possible manner. Conversely, it will be to his eternal shame and disgrace, if any member of this profession should appear before the Committee of the House of Commons in order to give evidence against the principle involved in these projects. We hear that an eminent electrician—possibly more than one such—intends to give evidence against the bills. On a technical matter of detail it is possible, of course, that a consulting engineer might find reasonable ground for objecting to a portion of any individual scheme; but the nature of the objection should be most carefully explained to the Committee, and every electrical engineer who gives evidence should testify to the just claims of the schemes, each considered as a whole. Details of this character, moreover, need not destroy an entire scheme; they can be adjusted by the Committee without sacrificing the bill. Indeed, so entirely reasonable appear all the bills at present before Parliament that it should be an easy matter to get over any such technical objections that may arise. But even though one or two of the bills may unfortunately be thrown out, the passage of the remainder will be the signal for the inauguration of a new era in electricity supply, and one that will witness a widespread development of industrial and social electricity utilisation, compared with which the past twelve years of local electricity supply will be but as "a very little thing."

NINETEENTH-CENTURY CLOUDS OVER THE DYNAMICAL THEORY OF HEAT AND LIGHT.

The first Friday evening discourse after the Easter recess was delivered by Lord Kelvin, on the above subject, on Friday evening last at the Royal Institution. At the outset Lord Kelvin remarked that his subject was necessarily a sombre one. It dealt with the clouds which had hung over the dynamical theory of both heat and light ever since its inception, and which alone tended to obscure the great brilliancy and the perfect clearness of this theory. The theory was one, in that heat and light were both considered to be "modes of motion," subject to the same laws as those connecting the motion produced in matter by a force acting on it.

The first cloud to which he referred was that one which came into evidence with the undulatory theory of light, and was first dealt with by Fresnel in a letter to Arago, published in the *Ann. de Chimie u. Physik* (1818). It consists in the difficulty of conceiving how, if the ether be assumed to be an elastic solid, as demanded by the undulatory theory, the earth and other bodies can move so freely through it. Young thought that the ether may be considered as blowing through gross matter, like "the wind through a grove of trees." Further investigation enabled us to add, "much more so," and still in spite of this extraordinary mobility of the ether, and in spite also of the remarkably ingenious and delicate experiments of Michelson and Morley, in America, on the relation between ether and matter, leading to the result from which he (Lord Kelvin) saw no possibility of escape, *i.e.*, that there is no motion of the ether relative to matter, he persisted in his opinion that matter does *not* move freely through the ether.

The second great cloud over the dynamical theory lay in the Maxwell-Boltzmann doctrine of the partition of kinetic energy. This cloud was now 30 years old, and was not yet dissolved. Maxwell himself was not absolutely convinced of the truth of this doctrine, and in his address to the Chemical Society (1875) openly expressed some of his doubts. Lord Rayleigh also, so recently as January, 1900 (*Phil. Mag.*), sought "some escape from the destructive simplicity of the general conclusion relating to the partition of kinetic energy." The easiest escape was to reject the doctrine altogether, and to say that, in spite of its support by Maxwell, Boltzmann, Poincaré, Rayleigh, and by Watson and Burbury, the mathematics did not prove it.

The discrepancy between theory and experiment is most strongly marked in the case of the ratios of the specific heats of various gases, and illustrated in the following table:—

Substance.	Ratio of specific heats.	
	According to M.B. doctrine.	Found from expt.
Air	$1\frac{2}{7}=1{\cdot}2858$	1·406
H_2	,,	1·42
O_2	,,	1·41
Cl_2	,,	1·32
CO	,,	1·39
NO	,,	1·39
CO_2	$1\frac{1}{3}=1{\cdot}1667$	1·30
N_2O	,,	1·331
NH_3	$1\frac{1}{3}=1{\cdot}111$	1·311

An absolutely true doctrine, Lord Kelvin thought, was first proposed by Clausius, according to whom the relation between the specific heats is given by the formula

$$\frac{C_p - C_v}{C_p} = \frac{2}{3}\,\frac{\text{average translational energy}}{\text{whole energy of motion of centre of mass}}$$

He had recently been occupied with a very simple case, that of the motion of a particle in a plane, or, say, a ball on a billiard table. But instead of a rectangular billiard table, he would suppose a triangular one to be available. If the Maxwell-Boltzmann doctrine were true, then, after a large number of impacts, the average kinetic energy in any two perpendicular directions must be equal. Since January he had worked out about 1,000 cases, and he was able to say, as a result of those calculations, that the Maxwell-Boltzmann doctrine was not true. In two typical cases, after 100 impacts, the average kinetic energies in two perpendicular directions came out to be 56 and 44 in the first case, and 53 and 47 in the second case. He held, therefore, that the Maxwell-Boltzmann doctrine did not hold for this simple case, and therefore that it was absolutely disproved. In conclusion, Lord Kelvin brought forward some considerations respecting the structure of the atom and the ether, pointing out that the ether must be truly imponderable, and quite outside the law of universal gravitation.

A CENTURY OF CHEMISTRY AT THE ROYAL INSTITUTION.

LECTURE I.

At the Royal Institution, on Thursday, April 26, Prof. J. Dewar, F.R.S., delivered the first of a series of four lectures on "A Century of Chemistry at the Royal Institution." He began by referring to the centenary of the Institution, which had been celebrated last year, and suggested that these celebrations naturally raised a spirit of inquiry and criticism as to how much his own predecessors did, and how much they had suggested and contributed to chemical science of to-day. There existed considerable interest at the beginning of the century relative to the wonderful discovery of the voltaic battery by Volta in the previous year. Many suggestions were made, and theories were proposed, to account for its action, and it was remarkable that after a whole century of discussion and investigation these were still carried on along the lines originally suggested by Davy. His explanation of the voltaic battery, both in its essence and its elements, still held good to-day. Again, in advanced chemistry scientists are still concerned with attempts to discover answers to the questions: What is solution? What does solution do? How does it act? How is solution related to the production of electricity? These same questions, almost in the same form, were originally asked by Davy.

Prof. Dewar next made some remarks on the genius of Davy. He considered him one of the most remarkable geniuses that ever lived. He was practically self-taught; he had never seen any experiments made; all his scientific

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knowledge and his very ingenious experiments were made from close study of the existing text-books. His early essay, so full of crude suggestions, "learned" him very much in the unsparing criticism to which it was subjected by the scientific world. It contained, however, the description of some very ingenious experiments, some of which the lecturer repeated. Thus his well-known experiment on the rubbing together of two blocks of ice in a closed chamber, in proof of the immateriality of heat, was described at this time, and thus anticipated Rumford's experiment having a similar object. Davy also described a second experiment, in which two metal plates were rubbed together, the heat generated being sufficient to melt a block of wax on which they rested. It was as a result of these experiments that Davy was led to enunciate his now famous theory that "heat is a mode of motion."

Davy was next heard of in connection with his appointment as scientific adviser to the Pneumatic Institution, founded by Dr. Beddoes, of Bristol, in which capacity he personally carried out a number of very startling experiments on nitrous oxide and other gases, so dangerous in their character that the modern chemist marvels that he survived. In 1802, Prof. Hope introduced Davy to Rumford, the founder of the Royal Institution, who immediately procured him an appointment there. He first worked at, and lectured on, the chemistry of tanning, and also that of agriculture, in both of which departments he discovered and invented many processes, a number of which are employed even to the present day.

It is, however, in connection with the voltaic battery, about which the minds of scientists were at that time much excited, that Davy was found at his best in devising decisive experiments and proposing suggestive theories. He showed: (1) two distinct metals were not absolutely necessary in the production of a current, but that two distinct electrolytes, in each of which the same metal is immersed, would act equally well; (2) a metal was not absolutely necessary, and that a non-metal, like carbon, in the presence of nitric acid was equally successful in producing a current; (3) water could be decomposed by a sufficiently strong electric current. This last experiment was suggested by the discovery of the electrolysis of certain liquid solutions by Nicholson and Cruikshank. Davy's experiments on electrolysis led him to ask the very important question whether they were the constituents of the same original particle which, after decomposition, appeared at the two poles. After much speculation and thought, he concluded that there was a "migration," as it would now be termed, and that, as a result of this migration, the "acid" portion of this particle appeared at the one pole and the "alkali" portion at the other.

(*To be continued.*)

PROJECTED ELECTRICAL POWER SCHEMES.

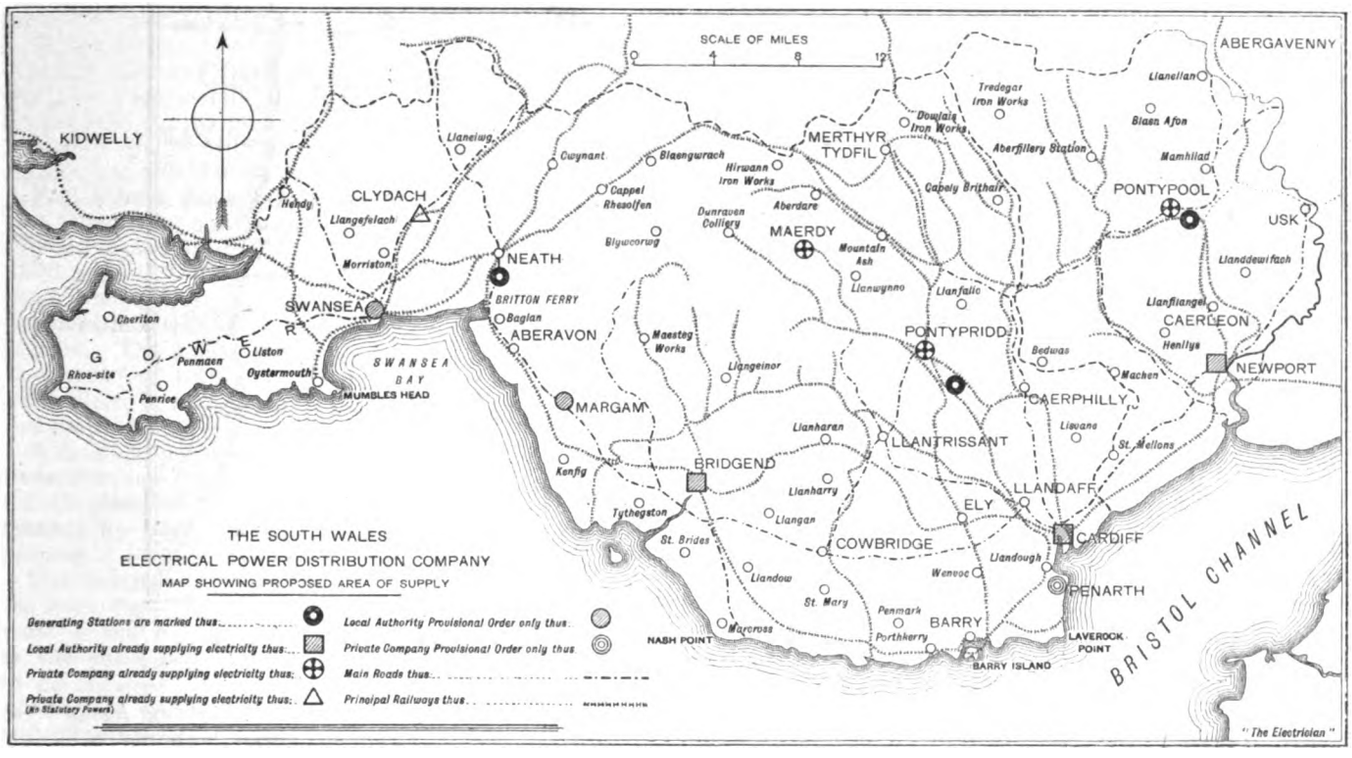
A number of bills have now reached the committee stage of their proceedings before the House of Commons relating to schemes for the supply of electrical power in bulk over extensive areas, in many cases involving entire counties. These comprise the following schemes:—

1. South Wales Electrical Power Distribution Co.
2. County of Durham Electric Power Supply Co.
3. Lancashire Electric Power Co.
4. Shannon Water and Electrical Power Co.
5. Tyneside Electric Power Co.
6. North Metropolitan Electric Power Supply Co.

At this stage in the progress of these important undertakings, it will be of interest to consider the main features of the various schemes. These are set forth in the following sections of this article.

1. The South Wales Electrical Power Distribution Scheme.

This scheme is for the distribution of electrical power over the area indicated in the accompanying map. The area comprises 1,050 square miles, and of this vast territory only 16½ square miles, that is to say, $\frac{1}{60}$th of the total area, is at present supplied with electricity. The promoters of the bill are Sir W. T. Lewis, Bart., Sir John Gunn, and Messrs. E. P. Martin, R. Forrest, A. Hood, A. T. Walker, A. Keen, E. Ruffer, E. W. Richards, T. F. Brown, F. L. Davis, T. Webb, R. Jones, Mark Robinson, J. Cory, P. Morel, H. Radcliffe, L. Wood, J. H. Simpson, G. F. Insole, and W. H. Lewis; and the Directors of the South Wales Electrical Power Distribution Co. are Sir W. T. Lewis and Messrs. E. P. Martin, R. Forrest, A. Hood, A. T. Walker, A. Keen, E. W. Richards, and T. F. Brown. The capital of the company is fixed at £1,000,000, of which £750,000 is share capital and £250,000 debentures. Under the scheme presented in the



MAP OF THE SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.'S PROPOSED AREA OF ELECTRICITY SUPPLY.

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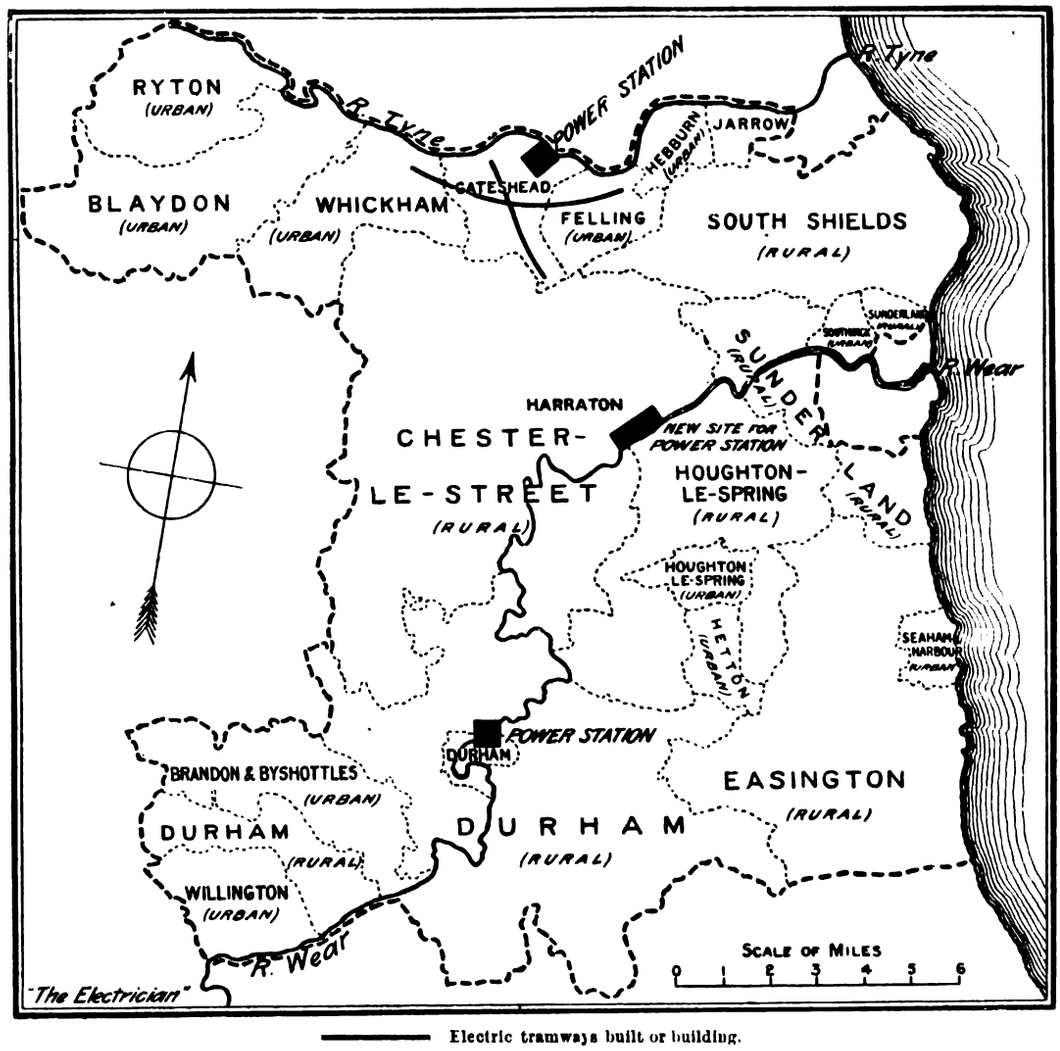
bill it is proposed to erect three electric power stations, viz., at Neath, Pontypridd, and Pontypool; and from these three stations there will be spread out an extensive system of mains for the supply of electricity over the whole of the area, which includes the entire county of Glamorgan and that portion of Monmouthshire which lies to the west of the river Usk. Within this area there are a large number of businesses and factories, &c., which might advantageously use electric power if supplied at a low price. Moreover, the area includes a very extensive colliery district enabling the generating machinery to be run at a very low cost as regards the price of fuel. Among the works which might be expected to utilise electric power and which abound in this district are collieries, steel works, tinplate and copper works, quarries, railways, tramways, engineering and ship repairing works, industrial factories and chemical works.



Electric tramways built or building.

MAP OF THE COUNTY OF DURHAM ELECTRIC POWER SUPPLY CO.'S PROPOSED AREA OF ELECTRICITY SUPPLY.

The promoters seek to obtain no monopoly. It is expressly provided in the bill that "Nothing in this Act contained shall confer or be construed to confer upon the company the exclusive right to supply energy within the area of supply." Moreover, the scheme is intended only for wholesale consumers, such as local authorities who seek to control their own local electrical supply. The "wholesale consumer" is defined by the bill as one who undertakes to take not less than 20,000 Board of Trade units per annum. The maximum prices fixed by the bill are as follows: (*a*) for any quantity not exceeding the equivalent of 400 hours' supply at the maximum power which has been demanded, at the rate of 4d. per unit; (*b*) for any further quantity exceeding the equivalent of 400 hours of supply at such maximum power, at the rate of 2d. per unit. It is fully expected, however, that power will be actually supplied at very much lower rates than the above: less, in fact, than 1d. per unit. The prices to be charged are to be regulated on the same principle as those under the Gas Acts, by which the company will have a direct interest in continuing to reduce its charges to the consumers, the profits distributed being made to depend upon the price charged.

This bill is drafted in terms which should prove acceptable even to the most "progressive" of local authorities. Any local authority may, at its option, take power at wholesale rates from the Company and distribute to consumers within its own area, or it may arrange with the company to undertake this business on behalf of the local authority. With regard to the powers to break up public streets, it may be stated that except where it is necessary to reach a factory the promoters seek no power to break up streets. Finally, the undertaking specified in this bill is to be subject to the usual form of the compulsory sale clause of the Electric Lighting Act of 1888, *i.e.*, the bill confers upon any local authority the right to purchase as much of the company's undertaking as is used for the supply of its district at the expiration of a term of 42 years, the price to be paid being the bare value of the plant without any allowance for goodwill. Without entering into a statement of the minor features of this promotion, sufficient has been said to indicate that it is a highly public-spirited and moderate scheme, and one that should certainly receive the assent of Parliament.

2. County of Durham Electric Power Supply Scheme.

This scheme provides for the supply of electricity in bulk over an area comprising the greater part of the County of Durham, the actual area proposed being indicated on the accompanying map. It will be seen that South Shields,

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Sunderland, and a large district north of Hartlepools have been omitted from the area it is proposed to supply. The promoters of this bill are Messrs. W. L. Madgen, J. S. Raworth, E. Garcke and R. Percy Sellon. The proposed company is affiliated to the Electric Power Distribution Co., the British Electric Traction Co., and is associated with a number of electrical undertakings on the north-east coast, including the Hartlepool Electric Tramways, the Gateshead and District Electric Tramways, electricity supply in the municipal areas of Gateshead and Durham, the North Shields and District Electric Tramways and the South Shields Electric Tramways. The promoters seek power to supply electrical energy not only in bulk to local authorities, but also to anybody duly authorised by provisional order or possessing other statutory powers to supply or use electrical energy for any purpose whatever. It is provided that the local authority or other authorised undertaker in each section of the area shall lay its own system of distribution mains, the company merely supplying electricity in bulk to that section of the area. Arrangements have been made, contingent upon the passing of this bill, to supply the local authorities of Gateshead, Durham and other districts for the purposes of electric lighting and power supply. In some of these districts the actual house-to-house supply is to be undertaken by the company, provision being made whereby the local authority, if it so desires, can acquire the network of mains within its area at stated periods. The maximum tariff, as regulated by the bill, is based on the Wright system of charging; the rate for the first 100 hours per quarter of maximum demand will not exceed 4d. per unit, for all in excess the rate is to be not more than 2d. per unit.

(To be continued.)

CORRESPONDENCE.

MATTHIESSEN'S STANDARD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have recently had occasion to study the Report of the Committee on Copper Conductors, published in the *Journal* of the Institution of Electrical Engineers, January, 1900, page 169. The amount of searching required to get to the bottom of it is so great that I append the result of my own investigation, with the view of saving labour to some of your readers. The puzzle is to understand how "Matthiessen's standards" of 0·153858 and 0·150822 are arrived at by the Committee, having regard to the fact that these numbers are not given by Matthiessen.

A note appended to the report informs us that these figures have been calculated for 60°F. from the figures 0·1469 and 0·1440 given by Matthiessen for copper at 32°F., his own formula for temperature correction being employed for this purpose.

The investigator, looking up "Augustus Matthiessen" in the R. S. Catalogue of Scientific Papers, finds in two different volumes the references to a large number of Papers relating to the resistances of metals. Only two of them appear to be required for our purpose. One of these is in the *Phil. Trans.* for 1862, and contains at page 23 the formula $100 - 0{\cdot}38701\,t + 0{\cdot}0009009\,t^2$ for the conducting power at t°C. of a copper wire whose conducting power at 0°C. is called 100. This, when reduced to the Fahrenheit scale, agrees with the formula quoted in the Note, and when worked out for 60°F. give 0·941978 as the ratio of the resistance at 32°F. to that at 60°F.

The other Paper is in the *Phil. Mag.* for 1865, Vol. XXIX, where, at page 362, the statement is made that a hard drawn copper wire, 1 metre long, weighing 1 gramme, has at 32°F. a resistance of 0·1469 of the B.A. unit. This is one of the numbers quoted in the note. The other number, 0·1440, quoted for annealed copper, does not occur in the Paper, so far as I have been able to find; but on page 363 data are given for annealed and hard drawn, which imply that the ratio of their resistances is 2,057 to 2,104. This would give, not 0·1440, but 0·1436, and I am not able to explain the discrepancy.

Dividing 0·1469 by 0·941978 we get 0·1559485 as the resistance at 60°F., in terms of the B.A. unit originally issued, and taking that unit as 0·9866 of a true ohm we finally obtain 0·15386, which is in substantial agreement with the value adopted by the Committee for a hard drawn copper wire at 60°F. If we take the B.A. unit as 0·98656 we get 0·153853; and the adopted value 0·153858 lies between these two.

The value 0·150822 for annealed copper will be similarly accounted for when we know how the committee obtained the 0·1440. Perhaps the Honorary Secretary will kindly furnish this information.—Yours, &c., J. D. EVERETT.

Ealing, April 25.

P.S.—I have found two errata in the report: *Clarke* for *Clark*, and *square miles* for *square inches*.

We have sent a proof of the above letter to Mr. A. H. Howard, the hon. sec. of the "Committee on Copper Conductors," and have received the reply below. This correspondence is referred to in our editorial columns:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The figures attributed to Matthiessen for the comparative resistances of annealed and hard drawn copper vary considerably in the different reports:—

—	Hard drawn.	Annealed.	Per cent. increase of H.D.
Phil. Mag., May, 1865, p., 363. Resistance	0·02104	0·02057	2·284
Phil. Trans., 1860, p. 86. Conductivity ...	95·31	97·83	2·644
Phil. Trans., 1864, p. 197. Conductivity...	99·95	102 21	2·261
"Reports of Electrical Standards," F. Jenkin, p. 227. Resistance	0·1469	0·1440	2·014

As the experience of the members of the committee showed that the latter figure was the most accurate for modern commercial copper, and as the table in Prof. Jenkin's book had been adopted by the Post Office and by many manufacturers as a basis, the figure of 0·1440 B.A. units for one metre gramme of annealed copper was chosen, and the various constants were found by simple calculations which hardly need explanation.

The Committee were engaged in fixing a commercial standard, and not in accurate scientific research, so that the question as to which of Matthiessen's investigations was the most reliable did not concern us; but only which was in best accord with present conditions.

It may be of interest, however, to point out that Matthiessen did not determine a practical standard of resistance for copper, inasmuch as he omitted to ascertain the specific gravity of the wire used. In one of his later Papers he refers to this omission as a grave error. The result is that some specific gravity must be assumed in order to find the resistance of a wire of any given diameter; and as the specific gravity of copper varies from 8·89 to 8·95, a possible error of nearly ¾ per cent. may be introduced at once.—Yours, &c.,

A. H. HOWARD,
Hon. Sec. Committee on Copper Conductors.

London, May 1.

PARLIAMENTARY INTELLIGENCE.

THE POST OFFICE AND THE TELEPHONE.

In the House of Commons on Friday last, on the vote to complete the sum of £8,843,605 for the Post Office, Sir C. Cameron moved the reduction of the vote with the object of calling attention to the action of the Department in connection with the telephone. He said the policy pursued appeared to him to be contrary to the intention of Parliament, unfair to the municipalities, and at variance with the policy connected with the telephone scheme inaugurated last year. The object of Parliament had been to safeguard the powers of municipalities controlling the streets and roads against the action of private trading companies, while affording facilities for the Post Office. In 1897 the National Telephone Co. applied to the Glasgow Corporation for liberty to lay underground telephone wires, but the Corporation had a great objection to allow outside bodies the right of breaking up streets, and refused the application, although the company

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offered a considerable sum for the privilege. At the same time a similar application was made by the Post Office, and the Corporation offered to grant the permission sought on condition that it was not made use of simply for the benefit of the National Telephone Co. The Post Office objected to this condition, and in 1898 served the Corporation with a notice under the Telegraphs Act requiring it to grant the facilities. This led to a dispute, and the question was referred to the sheriff for decision, and he, early in 1899, declared in favour of the Post Office. An appeal to the Railway Commissioners confirmed the sheriff's decision. He held that it was not in accordance with the policy recently approved by Parliament for the Post Office to step in and take away a right in public streets which conferred on municipalities certain advantages over their competitors.

Mr. J. WILSON said the Glasgow Corporation objected to the National Co. or, in fact, any private company coming in behind the Post Office and getting the benefit of privileges that Parliament had conferred upon the Department, and the Corporation, he contended, were acting in the interests of the community. The citizens should not be asked to put their money into the pockets of the company when they could obtain a better service from the local authority.

Mr. URE said there was no community which had been worse served in regard to telephonic communication than Glasgow. There were ten times more complaints per head from Glasgow than from Birmingham, and seven times more than from any other commercial community in the country, and this was certainly not attributable to the overhead system and the absence of the twin-wire circuit. The Corporation had no objection to the Postmaster-General opening up their streets, but objected to giving him such powers for the benefit of the National Co.

Sir J. WOODHOUSE said general apprehension prevailed, on the introduction of the Telegraphs Bill in 1892, that the National Co. might be placed in such a position as would prevent competition. In consequence of this feeling and of representations from municipal bodies, it was provided by that bill that, notwithstanding anything in the Telegraph Act of 1878, a licensee should not exercise any powers without the consent of the municipal authority directly interested, and should be subject to such terms and conditions as the local authority might attach to its consent, and should comply with any regulations of the local authority in force in relation to telegraph lines. He felt that in Glasgow's case the Post Office had done indirectly what the House by this provision intended should not be done. The House ought to show its repugnance of the action taken by the Post Office.

Mr. STUART WORTLEY thought to refuse all powers to the only telephonic organisation in existence when the Act was passed was an extreme course. The inability to arrive at an arrangement was little creditable to either the Corporation or the company, and was injurious to the public interests.

Mr. PARKER SMITH considered there was room in Glasgow for both the company and the Corporation; but if the municipality wished to try the experiment of establishing its own telephones they would not be unduly restrained by Parliament or the Post Office.

Mr. HANBURY, in reply, said the question of the telephone service in London, although it concerned wayleaves, was an entirely different matter to that of Glasgow. In London, partly owing to snow storms, and partly to the decision of the Duke of Bedford, the service of the National Co. in certain parts of London necessarily became inadequate. This difficulty arose mainly in connection with overhead wires. It was contended that it should be possible to lay these wires underground, and complaint was made against the London County Council that they would not give their permission for this to be done. Under ordinary circumstances, perhaps, the Council would be carrying their control over the streets too far to refuse that concession to the public convenience, because there could be no doubt that a telephone service, whether by the State or by a company, was a great public convenience, and the Council would have to take that point into consideration. But the State was itself engaged in constructing a system of telephonic communication all over London, and it was obvious that in the public interest there should be inter-communication between these two systems. If that could not be brought about, then the difficulties of having the two systems working side by side, especially over so large and important an area as London, would be very serious, and therefore everything that was fair and reasonable to the company should be done to require the National Telephone Co. to work in inter-communication with the Government telephone system. This being so, the Council were not acting at all unreasonably in the matter; they recognised that they ought not to deny the use of underground wayleaves from any spirit of pique or opposition to the National Co., or from any inflated idea as to their rights over the streets. They had the power, if the company was reasonable, to give that company every facility to provide, in conjunction with the State, as good a telephone service as existed anywhere. The Council, acting entirely in the public interest, held that it was doubtless in the public interest that the company should have facilities for placing their wires underground, but it was also equally in the public interest that the company should work in inter-communication with the Post Office service, and therefore the Council were prepared to grant such facilities in the interests of the public, if the company would recognise that it had to establish its service for the general benefit of the metropolis. With regard to Glasgow, the Corporation of that city had put themselves in the forefront of Corporations, and had, in his opinion, set an excellent example to other municipalities. He had himself always tried to deal fairly with the National Telephone Co., but undue facilities ought not to be given to any one private company. When the National Co., long before competition was threatened, applied to the Corporation of Glasgow for power to establish a telephone service, the Corporation had the undoubted right to refuse that permission, but they gave the permission, and had to bear whatever consequences such permission involved. After the service was started, an agreement was entered into between the company and the Post Office under which the company could not interfere with the streets, and could not lay underground wires and this agreement must be rigidly respected. There was misapprehension as to what the Post Office had actually done. The circular recently issued by the National Co., if he read it rightly, implied that the Post Office had entered into an agreement with the company, binding the Post Office to lay wires for them wherever they chose to go. If that was the meaning conveyed in the circular, then the company were entirely wrong. The circular was, in fact, a most misleading document. The agreement between the company and the Post Office did not bear out what that circular said. Under the agreement the Post Office were required to lay down wires between exchange and exchange, and nowhere else, and if the agreement, and nothing beyond the agreement, was carried out it would not prejudicially affect the undertaking of the Glasgow Corporation. The Corporation would have had fair ground for complaint if the Post Office had laid wires between the exchanges and the subscribers, but that had not been done. That agreement was executed before there was any competition impending, and though they might regret that that agreement had been come to, it must be faithfully carried out. It did not, however, operate to the disadvantage of Glasgow Corporation. There was a definite agreement drawn up between the National Co. and the Post Office, and he believed the actual date of signing that agreement was 1895, but the original heads of the agreement were drawn up in 1892.

Mr. T. SHAW said the circular undoubtedly made a claim which, upon investigation, could not be sustained.

Sir J. FERGUSSON hoped the hon. and learned member (Mr. Shaw) would not, in calmer moments, urge the Government to set aside the agreement of 1895. The National Telephone Co. expected the Government to do nothing beyond the agreement of 1895, and what the Government proposed to do in Glasgow was to get the trunk wire and save the telegraph revenue.

Mr. BURNS denied that the National Co. had been subjected to unreasonable restrictions by the London County Council. When Glasgow was asked to confer on a private company like the National Co. with its past history and present conduct of affairs, the same privileges and advantages they might reasonably give to the Post Office, he contended that the Corporation of Glasgow would be neglecting their duty if they did not differentiate between a public department and a private company.

Sir A. ROLLIT said there had been a deal of misconception in the whole matter before the House. He would not question the divine rights of local authorities over the streets in their localities, but that right was subject to the law of the land, to agreements which had been entered into by a public department even if only with a private company, and, what was absolutely paramount, to the public interest. What was the basis of the new departure with regard to the telephones? That basis was "free and equal competition"; but the conditions now sought to be imposed, taking the case of London first, would render that free and equal competition impossible. The terms to be compulsorily accepted by the company were to be those formulated by the Government, whatever they might be—that was, they were to compulsorily adhere to unknown terms. Such conditions would be a gross injustice to an established interest and at the same time a grave disadvantage to the public.

Mr. BURNS said he hoped that until the National Telephone Co. granted the same facilities for inter-communication which its own subscribers would receive it would meet with continual hostility in the House of Commons and the County Council, and that every municipality would boycott it.

Mr. McCRAE thought there had evidently been considerable misunderstanding of the attitude of the Post Office, and Mr. Hanbury's statement would be much appreciated by the Corporations of Edinburgh and Glasgow. The control of the streets by the municipal authorities went to the root of municipal efficiency.

Mr. CALDWELL said the National Co. established itself in Glasgow without consulting the Corporation at all. He contended that the agreement between the Post Office and the company was not a valid agreement, or one that could be enforced upon the Corporation of Glasgow.

Sir J. FERGUSSON reminded the House that this agreement of 1895 was part of the original agreement detailed to Parliament in 1892, when it was perfectly understood, and objected to by no one. Its terms were carried out by succeeding Governments on the understanding that they had received the full assent of Parliament.

In the House of Commons on Monday, Mr. Kimber asked the Secretary of the Treasury what was the cause of the delay in announcing the telephonic facilities proposed to be offered by the Postmaster-General, and when these arrangements were likely to come into operation; and if he was aware that the National Company were serving notices upon telephone subscribers that they might at any moment have their telephone communications withdrawn in consequence, as the company alleged, of the refusal of the London County Council to give the company underground wayleaves, whereas the Council had in fact offered to give such leave if the company would give telephonic inter-communication.

In reply, Mr. HANBURY said that it was not considered expedient yet to announce the actual rates of subscription to Post Office telephone exchanges until further progress had been made. The Postmaster-General had no official means of knowing what notices were sent by the National Co. to their subscribers except from the ordinary sources of information. But Mr. Burns on Friday stated in this House the terms upon which alone the County Council would grant wayleaves to the company. The conditions imposed were wholly in the public interest, and he was in entire agreement with the Council in the course they were taking. He hoped the arrangements being made by the Post Office would come into operation during the autumn or before the end of 1900.

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UNDERGROUND TELEGRAPH CABLES.

In the House of Commons on Tuesday, Mr. Hanbury stated that if the underground telegraph cable from London to Birmingham proved successful, the Postmaster-General would consider in what other directions underground wires could with advantage be laid down, with a view to increasing the stability of the telegraph system.

MUNICIPAL TRADING.

In the House of Lords on Tuesday, the Earl of Morley moved that a committee of five lords be appointed to join with a committee of the House of Commons, to consider and report as to the principles which should govern powers given by bills and provisional orders to municipal and other local authorities, for industrial enterprise within or without the area of their jurisdiction.—The motion was adopted.

It is stated that the following have been appointed to represent the House of Commons on the Joint committee of both Houses on the question of municipal trading:—Sir E. Hoare, Sir L. Lyell, Sir W. Foster, Mr. Grant Lawson, and Mr. Hobhouse.

COUNTY OF DURHAM ELECTRIC POWER BILL.

The Committee appointed by the House of Commons to consider the provisions of bills dealing with the supply of electric power sat for the first time yesterday (Thursday), Sir J. KITSON presiding. The other members of the committee are Sir A. Scoble, Mr. Bartley, Mr. Ashton, Mr. Howard, Mr. Billsom, Col. Long, and Mr. Bonham Carter (referee). The first bill to be dealt with was that introduced by the City of Durham Electric Power Supply Co. (A sketch map of the Durham Co.'s proposed area of supply is given on page 58 of this issue).

Mr. Balfour Browne, Q.C., Mr. Worsley Taylor, Q.C., and Mr. Moon appeared for the promoters, while the petitioners were represented as follows: The Felling District Council and the Hebburn District Council by Mr. J. D. Fitzgerald, Q.C., and Mr. J. D. Williams; the promoters of the Tyneside Electric Power Bill of the present session by Mr. Pember, Q.C., Mr. C. Baggallay, Q.C., Mr. H. Lloyd, and Mr. Frere; and the Lambton Colliery Co. by Mr. E. H. Lloyd.

In opening the promoters' case, Mr. BALFOUR BROWNE said the bill was one for incorporating and conferring certain powers on the County of Durham Electric Power Supply Co., and for other purposes. It was proposed to establish at Gateshead a central station for generating electric power, and to supply therefrom energy in bulk to local authorities over a wide district. The bill was promoted by certain gentlemen who already had a large interest in electricity in Durham. The promoters were connected with the Gateshead tramways, authorised by an Act of last session, and by the Gateshead Light Railway Order of 1899, and with the electric lighting of Gateshead and Jarrow. They were also interested in the electric lighting order which the Corporation of Durham had agreed to transfer to them. They asked for power to supply electricity in bulk to a large area in the County of Durham, including Gateshead, Jarrow, Durham City and Seaham Harbour; South Shields and Sunderland having been excluded at the desire of the Corporations of those places. the whole of the local authorities whose districts were included in the bill were favourable, with the exception of the District Councils of Felling and Hebburn, both Tyneside authorities. The intention of the promoters was to put up a central generating station at Gateshead from which it would be possible to supply electric energy at very low prices indeed. They took power to supply any lighting authority, any statutory authority for the supply of electric energy, and any local authority, company, or person, authorised by Act of Parliament to use electrical energy for any prescribed purpose. Under the bill they would not be able to distribute electricity in competition with any local authority, but they thought that they would be a most useful assistant to any local authority. By manufacturing on a very large scale they would be able to manufacture exceedingly cheaply, and to supply a district like that of Houghton-le-Spring, for instance, at a rate much lower than that at which the district could manufacture for itself. There was at the present time a good deal of doubt in the public mind as to how far municipal corporations ought to be allowed to go in the matter of trading, and he asked the Committee to say that the supply of electricity to this district was more likely to be better done by a company than by a corporation—that the supply of power for manufacturing and traction purposes could be more properly trusted in the hands of private enterprise than in the hands of a corporation. A corporation must buy its coal if it made its own electricity, and he could not see why, instead of buying the coal it should not be allowed to buy its electricity in bulk. In the county of Durham the local authorities generally took the companies view of the matter. They did not want to become large manufacturers, but they did desire to retain in their own hands the distribution of the power. Of course the alternative, if electric power was needed, was to have a manufacturing station in each district, and it was obvious that the expense of such a system would enormously increase the cost of the production of electricity. The result would be that such a system would never be carried out, because electricity could not be supplied for power purposes unless it competed successfully in other kinds of power production. The company placed themselves under the obligation of supplying electricity to all the local authorities in the district who demanded it, but they could not compel any authority to take a single unit. The company could be even compelled to supply part of a local authority's demand if an arbitrator thought that a partial supply was reasonable. It was proposed to take power to break up streets and roads, and all the local authorities except Felling and Hebburn assented to the proposal. The estimated cost of manufacture would be little more than a halfpenny per unit, and the promoters expected to be able to supply energy at 1d. and certainly at not more than 1½d. There was a considerable margin for profit therefore, even on the £457,000 which it was proposed to expend. The total amount of the company's capital would be £500,000.

Mr. FERRANTI, examined by Mr. Moon, said he was an electrical engineer, and was also a manufacturer of all the machinery necessary for carrying out such a scheme as that embodied in the bill, his works being at Hollinwood, Lancashire. He was of opinion that if electricity could be cheaply supplied it would be applied to many purposes for which in this country other motive power was now used. In many districts in America there was a cheap supply of power on a great scale, and on the Continent of Europe such a state of things was general: there were an immense number of large institutions for supplying power wholesale over large districts. The manufacturers on the Continent readily took advantage of it, and were enabled, largely on account of this, to compete more severely than ever with the manufacturers in this country, who had not such advantages. He did not think that a better thing could be done for the small manufacturers in this country than to supply them with cheap mechanical power, and he was sure that such men would employ such power if they could obtain it advantageously.

The CHAIRMAN said he thought the committee would admit that it was an advantage to have a cheap supply of electric energy.

Witness went on to say that he did not think there could anywhere be better conditions for a cheap supply of electricity than would be provided by the bill. It would be possible for a generating station on the Tyne to supply the whole district cheaply and well. The load factor would mainly depend on the diversity of the demand for energy. By dealing with a large area, and supplying electricity for many purposes, a company would stand the best chance of getting the longest possible utilisation of the power per day. The purposes for which the power supplied by the company would be used would be principally (1) electric lighting, (2) the running of tramways, and (3) the driving of motors in works, or wherever they might be required. These three separate kinds of demands were calculated to give the best load factor it was possible to obtain. He had worked out a scheme for supplying a maximum demand of 9,000 kilowatts or 12,000 horse power. The total power of the installation, would be, however, greater than that because a reserve power was provided. Roughly, the maximum power of the engines and boilers would amount to 20,000 H.P. The whole generating plant would cost £297,000. The cost of transmission would be £160,000 and with contingencies the total cost of the scheme would be £500,000. The "maximum demand" of 9,000 kw. was taken as being the demand on which the company could start business and by no means represented the demand of which the district was capable. It referred simply to the amount of plant provided for making a start. 2,500 kw. were put down for lighting purposes. The company knew that 1,000 kw. would be required for tramway purposes already arranged for, and the balance of 5,500 kw. would be available for motive power. This proportioning of load was important, because therefrom was obtained the probable load factor and therefore the commercial results obtainable. It was estimated that the load factor would be 25 per cent. The 2,500 kw. for lighting purposes were put down as an 8 per cent. load factor. The 1,000 kilowatts for tramways were put down at 40 per cent., though in a good many cases the tramway load factor was better than that. The 5,500 kilowatts for power purposes was put down at 30 per cent. He considered that all these figures were perfectly safe, and in combination they made a load factor of 25 per cent. The nett result of the calculations he had made as to the cost of generation was that it would come to 0·44 of a penny per unit. The cost of transmission would require the addition of about 0·2 of a penny per unit. The total result was that the cost would be something under 0·7 of a penny per unit. With an average price of 1¼d. per unit, the company would get a nett revenue of about £104,000. The total working expenses at 0·7d. per unit would amount to £60,000. This would leave £44,000, which was enough to pay 8 per cent. on the capital, and leave £4,000 to carry forward. 1¼d. would be a low enough price to tempt almost everybody—certainly everybody ought to utilise to its full capacity the plant to be provided now, and much more besides. It was proposed to adopt the extra high-pressure system, which electricians had found to be the most economical one for transmitting a large power over a long distance without serious loss. A proportion was proposed to be transmitted at 10,000 volts and a proportion at 5,000 volts; but he was of opinion that the scheme would probably be carried out at one pressure—namely, 10,000 volts, as there was not the least difficulty in using that pressure.

In cross-examination by Mr. J. D. Fitzgerald, WITNESS said that he was not interested in the bill in any way. It was necessary for the success of the scheme that the company should be able to lay their mains in Felling and Hebburn, but of course if those districts did not want to avail themselves of the supply offered them they need not do so.

The Committee then adjourned till to-day (Friday).

BAKER-STREET AND WATERLOO RAILWAY BILL.

The Select Committee of the House of Commons, presided over by Sir Ughtred Kay Shuttleworth, on Tuesday considered the measure promoted by the Baker-street and Waterloo Railway Co. for the extensions of their authorised line, the erection of a generating station, and other purposes,

The promoters were represented by Mr. Worsley Taylor, Q.C., Mr. E. Page, Q.C., and Mr. J. Shaw. The Metropolitan Railway Co., the only petitioners applying by counsel, were represented by Mr. Littler, Q.C., Mr. Balfour Browne, Q.C., Mr. Freeman, Q.C., and Mr. F. G. Thomas.

Mr. WORSLEY TAYLOR, Q.C., for the promoters, said powers were now sought to make extensions at both ends of the company's present authorised line. It was proposed to extend the railway on the northern side, from the Great Central Railway terminus as far as the Paddington station of the Great Western Railway, and on the southern side to construct an extension from Waterloo to the Elephant and Castle. The length of these extensions would be about 2¼ miles, and subways would be constructed to give access to the Great Western Railway terminus at Paddington, and to the City and South London, and London, Chatham, and Dover Railways at the Elephant and Castle. The committee of 1893,

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which had considered the question of these electrical lines, had reported that it was advisable to relieve the congestion of the London streets, by connecting the great railway termini by means of these lines to be worked by electricity. The original scheme of the Baker-street and Waterloo Railway was before that committee, which had approved of it as an instalment. The Elephant and Castle was the second most congested spot in the metropolis, and that congestion would be relieved under the bill, as would also that at Charing Cross, Piccadilly Circus, and other places. Under the original bill of the company there was to be a generating station for the working of the line at Waterloo Station. Subsequent to the passing of that bill there came the Waterloo and City Railway, and it was found that the land scheduled for the generating station was necessary for the purposes of the South-Western and Waterloo and City Railways. There was, however, a convenient site available in the St. George's-road, Southwark, and evidence would be given that no nuisance would be created by the erection of the generating station there. There was no opposition to the use of this site for the purpose. By the bill, Parliament was asked to do what had been done in the case of other undertakings of a similar character. The learned counsel then gave a financial history of the company, and said that the London and Globe Finance Co. had practically become the dominant parties in this undertaking. The capital now asked for for the works to be carried out under the bill was £1,000,000 of share capital, and further borrowing powers of £333,000. A contract had been entered into between the London and Globe Co., under which they were to acquire the land for the generating station and to construct and equip the extensions in the same way as they had constructed and equipped the original line. Their payment for that would be £336,000 in shares, with a corresponding proportion of debentures, and there would be a margin, if everything went right, for the London and Globe Co. of about £95,000 for the whole risk taken. The present need of the Baker-street Co. was a generating station, and to get to one erected on the proposed site in St. George's-road an extension would have to be made without which the authorised line could not be worked. But if the line were extended so far a very small further capital expenditure would extend it as far as the Elephant and Castle.

Evidence was then given in support of the bill.

Mr. GALBRAITH, C.E., said he had been consulting engineer to the London and South-Western Railway for 40 years. He was one of the engineers for the Baker-street and Waterloo Railway Co. Witness then gave evidence as to the difficulty in raising the capital for the construction of the various electrical underground railways directly from the public. In the case of most of the electrical railways, the capital had been underwritten. In describing the works proposed by the bill, witness said there would be a new station at the Edgware-road besides the terminal one at Paddington. He anticipated that the traffic would be very large. They proposed to put the station at the Elephant and Castle on public ground, as had been done at the Bank, and was proposed to be done at Charing Cross. The cost of doing this with the necessary subways would be £9,000, and the local authorities had agreed to assist them in carrying out the work.

Mr. Wilkinson, general manager of the Great Western Railway Co., Mr. C. J. Owens, general manager of the London and South-Western Railway Co. and Sir William Pollitt, general manager of the Great Central Railway Co., gave evidence in support of the proposals of the bill.

Mr. HARE, deputy-chairman of the promoting company, said there would be no difficulty in obtaining capital to carry out the proposals of the bill as his company had made a contract with the London and Globe Co., which was a very strong body.

Witness was cross-examined for the Metropolitan Railway Co. to show that the London and Globe Co. would make a very large profit on the undertaking, if not an undue one.

Sir BENJAMIN BAKER, C.E., engineer to the scheme, said that on his advice the contracts had been prepared four years before the London and Globe had had anything to do with the line. There was no possibility of "plunder," as had been suggested, in the interests of the London and Globe Co. The public would get the new line, over the whole six miles of which they would be carried for 2d. He had told the London and Globe Co. that the electric installation would cost more than they had been told, and they accepted his figures.

Sir J. WOLFE BARRY, K.C.B., C.E., was called in support of the petition of the Metropolitan Railway Co. against the bill. He said that the extension of this line to Paddington really meant a complete reversal of the original idea, which was for a north and south line. It was now sought to make it an east to west line within a quarter of a mile of the Metropolitan Railway, obviously to be further extended to the west, and perhaps to the east also. Last year the Metropolitan and Metropolitan District Railways each subscribed £10,000 towards working experimental electric trains between Earl's Court and High-street, Kensington, and employed Messrs. Siemens Bros. and Co. to put down the necessary works. Electric conductors had been laid along the rails so as not to interfere with the steam locomotives. The new electric trains were complete, together with the new electric motors. The electric trains would carry more passengers than the ordinary trains, and they had been run experimentally for some weeks, and had been inspected by the Board of Trade, and as soon as the Board's report had been received the trains would be run for the conveyance of passengers. These experiments had been a conspicuous success. Trains weighted with iron to represent the heaviest loads carried on the line had been run, and it had been found that the electric motors could be stopped and started more quickly and were more powerful than steam locomotives. The average rate of travel by the new trains would be considerably greater than with the steam locomotives. Both companies were completely satisfied with the experiments, and they had a keen interest in extending the use of electricity as their lines suffered very much from the lack of ventilation.

Mr. J. BELL, manager of the Metropolitan Railway Co., having given evidence against the bill, counsel addressed the Committee.

The Committee ultimately decided to pass the preamble of the bill.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY BILL.

A committee of the House of Commons yesterday commenced the consideration of this bill. Mr. A. H. Brown presided.

Mr. PEMBER, Q.C., for the promoters, said the measure arose out of the provisional order bill passed last year. That order contained one special provision, in consequence of which the company had again to come before Parliament. That provision was that the company should provide within two years a new generating station for the supply of the City of London such site to be approved by the City Corporation. The site had been fixed in the borough of West Ham at a point which was well away from any residential district, and the object of the bill was to authorise the acquisition of this site and the laying of the mains from the generating station to the City. There was also a proposal to supply electricity in bulk to any local authority on the line of route to the City. There were altogether 11 petitioners against the bill, one of them being the Corporation of West Ham, who objected on various points of detail. The London County Council also petitioned, boldly declaring that no public necessity could be shown for the powers authorised by the bill. The other petitioners included the Whitechapel District Board of Works.

Among the witnesses called was Mr. W. H. PATCHELL, the company's engineer, who stated that the site of the proposed generating station had an area of 7½ acres, and the mains would extend from West Ham for about 3¼ miles to the City boundary, through Poplar, Mile End, and Whitechapel. After serving the City, the mains would extend to parts of the West End of London.

After hearing further evidence the Committee adjourned till to-day.

SOUTH LANCASHIRE ELECTRICAL TRAMWAYS BILL.

Yesterday (Thursday) a Committee of the House of Commons, under the presidency of Mr. Seale-Hayne, sanctioned the incorporation of the South Lancashire Tramways Co., the members of which are Messrs. James B. Atherton, Jacob Atherton, and William M. Brigg. The company is formed to construct about 67½ miles of tramway in Burton Wood, Newton-in-Makerfield, Westhoughton, Bolton, Tyldersley-with-Shakerley, Worsley, Swinton, Eccles, Haydock, Pemberton, Abram, Ince, Hindley, Little Hulton, Golborne, Ashton-in-Makerfield, and Astley. The committee also sanctioned the raising of capital to the amount of £1,100,000.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said there was really very little opposition to so large an enterprise. The proposed tramways numbered in all forty-five, and would form a complete system connecting large centres of population and affording communication by tramway with Liverpool to the westward and Manchester to the eastward. The gauge would be 4ft. 8½in., and the undertaking would be completed in four or five years. The generating station would be at Leigh, the centre of the district. Owing to the expense of electric equipment, the promoters thought the 21 years allowed by sec. 23 of the Tramways Act did not give them a fair chance of recouping their capital, and they therefore asked for a 35-year period, as allowed under the Light Railways Act, the promoters reserving the right to run over the section purchased by any local authority. Most of the local authorities were in agreement with the bill. The three great railway companies—London and North-Western, Lancashire and Yorkshire, and Great Central—originally opposed the bill on the ground of competition with their systems, but they had withdrawn their opposition, having evidently become convinced that the tramways would act as feeders to their lines. Of the 29 local authorities in the area of the proposed tramways, only four were opposing—Ashton-in-Makerfield, Swinton, Eccles, and Worsley. The promoters had promised the local authorities in some cases to widen the roads, and in others also to light the tram route by electricity. The length of line to be constructed was 44 miles of single line and 23 miles of double line, and would extend over 67 miles of road, of which 54 miles were in the districts of local authorities who were not opposing. Within the area proposed to be covered was a population of 440,000 people, and, reckoning Liverpool and Manchester, over 2,000,000 people.

Mr. JAMES ATHERTON, managing director of the British Insulated Wire Co., one of the promoters, stated that the means of inter-communication in South Lancashire had for a long time been inadequate, and the proposed scheme had been formulated by him to meet what he considered a public need. Such a system of tramways was, in his view, the best way of dealing with congested districts, and would serve the convenience of South Lancashire well. He denied that the promoters intended, as soon as the bill had passed, to transfer the scheme to a company.

Mr. LEWIS COWARD, Q.C., pointed out that the bill contained conceded clauses committing the promoters to the widening of 100 thoroughfares as well as the lighting of the entire route by electricity. Had the promoters, he asked, power to execute such work?

Mr. ATHERTON said he understood the powers were in the bill. If not, they would go to Parliament for them.

Colonel MILWARD (a member of the committee) asked if the promoters were going to light the whole line of route, town and country?

Mr. ATHERTON: Yes. It will, we think, benefit the tramway by facilitating the traffic at night.

Mr. J. E. WALLER (Messrs. Kincaid, Waller and Manville), engineer for the scheme, estimated that £488,559 would be required for the construction of the tramways. The electric current for lighting the line of route would cost less than ¾d. per unit. The posts for overhead wires would be utilised for the public lamps. The total cost of these tramways was the amount provided by the bill for capital powers—£1,100,000. The permanent way would cost £1,520 per mile. The original estimate for road widenings was £45,000, but an additional £70,000 had been imposed by the concessions made to local authorities since the bill was deposited. The overhead electric equipment would cost £70,500.

Other evidence having been tendered, and most of the opposition having been withdrawn, the committee, as mentioned above, sanctioned the bill.

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GREAT GRIMSBY STREET TRAMWAYS BILL.

A House of Lords committee has passed the bill of the Great Grimsby Street Tramways Co., which confers powers to construct new tramways in the Cleethorpes district, to work the lines by electricity or other mechanical power, and to give effect to a provisional agreement entered into between the company, and the Corporation from which the latter body desired to recede. The committee decided that the agreement between the Corporation and the company must stand, and remain a part of the bill. They also decided not to permit the proposed crossing of the Great Northern Railway.

LEGAL INTELLIGENCE.

City of London Electric Lighting Co. (Ltd) v. Corporation of London.

This case came before Mr. Justice Farwell in the Chancery Division on Friday last.

Mr. CRIPPS, Q.C., said the action was brought to determine whether certain contracts in which plaintiffs were interested, and of which they were assignees, were valid and binding between them and the City of London. The question turned on the construction of the Commissioners' Acts of Parliament of 1848 and 1851. The contract in question was entered into in 1890 or 1891, and had been acted upon by both parties, and the plaintiff company had expended a very large sum upon the understanding that the contract was binding and effective. There had been litigation before Mr. Justice Kekewich, in which certain terms of the contract were considered on the basis that it was a binding contract. It was only lately that the suggestion had been made by the Corporation that the contract was null and void. There were three separate contracts for the lighting of the central, eastern and western areas of the City. As regarded the central and western, at the time the contracts were made there were among the Commissioners of Sewers certain aldermen and common councilmen who were also shareholders in the Brush Electrical Engineering Co., with whom the contracts were originally made, and the suggestion was that if they were members of the syndicate or company which entered into the contracts *ipso facto* the contract was null and void, and for that contention the defendants relied upon the terms of the statute. The third contract was entered into when no member of the Commissioners of Sewers or alderman or common councilman was a member of the contracting syndicate or company; but at some time subsequently, certain shares were taken in the plaintiff company by members of the Corporation, and the suggestion was that if, even after the contract had been entered into, any City councillor or alderman took shares, that *ipso facto* rendered the contract null and void. Counsel submitted that, although at the time of two of the contracts being made some of the Commissioners were shareholders, that fact did not nullify the contract. In the case of the Eastern district, the original contract became vested in the plaintiff company, of which some members of the Corporation were shareholders, and the defendants now said that that fact made the contract null and void *ab initio*. The plaintiffs therefore asked a declaration that all those contracts were valid. The defendants said that, under the Commissioners of Sewers' Act of 1848, if any alderman or common council man was directly or indirectly interested in any contract for works, &c., with the Commissioners, such contracts became null and void. The learned counsel submitted, however, that this provision was limited in its operation, and did not apply to the circumstances of the contracts now in question. He contended that it was intended only to apply to the case of persons directly carrying on their own or a partnership business, and not to the case where the person was a shareholder only in a public company, and who took no personal step to effect the procuring of the contract. An alderman and a common councillor might hold a share in the gas company, the electric lighting company, or the New River Co.; then if the defendants' contentions were correct, upon an information being laid, the City might be plunged in darkness, and have its water supply stopped. He submitted that that was an unreasonable contention.

Mr. SWINFEN EADY, Q.C., for defendants, said he disputed altogether the statement which had been put forward by Mr. Cripps that a shareholder in a company was not a person interested in that company. The true construction of the contract was that it was a contract to execute "works." It was true that the "works" when executed were to remain the property of the contractors, but an option of purchase was given to the Commissioners. It was not merely a contract to supply electricity but it was a contract to execute "works" in respect of which there was a detailed specification, from which no deviation was to be permitted. His submission was that the Commissioners were authorised to enter into this contract by virtue of Section 33 of the Act. The learned counsel submitted that the proposition which had been argued, that a person who took the whole of the profits obtained under a contract as a shareholder of the company was not a person who was directly or indirectly interested in the company, was scarcely worth replying to.

Mr. DANCKWERTS, Q.C., said he would like to put right a statement made by Mr. Cripps in his opening. Mr. Cripps had stated that it was not until after the action before Mr. Justice Kekewich was decided that the Corporation raised this question of the validity of the contracts. That was not so, because the question of the validity had been raised in the Council before that decision was given. The Act under which the Corporation were proceeding provided that no commissioner of sewers or alderman or common councilman should be "interested directly or indirectly" in any contract made with the Commissioners or the Corporation. "Interested" could only mean having a share of the profit or the loss, as the case might be, made upon the contract, and therefore every shareholder was "interested" in this contract.

At the close of the hearing, his lordship reserved judgment till yesterday (Thursday).

JUDGMENT.

Yesterday (Thursday) Mr. Justice Farwell delivered judgment in this action.

His LORDSHIP said that the present question arose on the construction of the City of London Sewers Acts of 1848 and 1851, in which it was set forth that no person being a commissioner should be, directly or indirectly, interested in any contract entered into with the commissioners, otherwise the contract would be null and void and the commissioner committing the offence would be liable in a penalty of £100 for each offence. It was admitted that at the date of the contract some commissioners were shareholders in the company. The Court could not set aside an Act of Parliament, even although its application might involve hardship; but if there were two possible constructions, then the Court might adopt the more reasonable of the two. In his opinion the Acts contemplated contracts of two sorts—construction contracts and contracts for supply of, say, water, gas, or otherwise. In his lordship's opinion the distinction between power to enter into construction contracts and the power to contract for the supply of light or water was reasonably plain. But it had been said that the contracts in this case contained clauses which made them construction contracts. In his lordship's opinion that was not so. The powers were given by provisional orders under certain electric lighting acts. The works connected with the supply remained the property of the plaintiff company, and the contracts were not construction contracts within the meaning of the Sewers Act of 1848. As to a commissioner being "interested," the Act of 1851 provided that no person being a commissioner, who was a shareholder in a lighting company, should be eligible to sit or vote as a commissioner while such a contract was under discussion by the commissioners; but to say that because a commissioner was a shareholder, and therefore that the contract was null and void *ab initio*, would be unreasonable. The commissioners were 91 in number and the common council numbered more, and that argument might mean that if one of them had held a single share in a gas company the contract with that company might at any moment be voided, and the result might be the absolute prohibition of the use of gas or electric light in the City. Again, assume that a company had spent a large sum in supplying the City with electric light, and it was subsequently discovered that one councilman had had a single share should the whole contract be void? As there were two alternative constructions capable of being put upon the Acts, he adopted the reasonable one, and made the declaration asked for by the plaintiff company that the contracts were good. The defendants would be ordered to pay the costs of the action.

Jandus Arc Lamp and Electric Co. (Ltd.) v. Johnson.

This was an action heard before Mr. Justice Farwell in the Chancery Division on Friday last on an application of the defendant.

Mr. GRAY (for defendant) said this was a summons for leave to amend the defence. The action was brought for payment of royalties under a licence, and the defence alleged that there were certain misrepresentations in the licence which destroyed the consideration that the defendant got under it. The defendant since Easter had discovered other misrepresentations, and he desired to amend the defence accordingly.

Mr. Graham (for plaintiff) did not oppose.

Mr. GRAY said he had also to ask for discovery. The defendant alleged that certain licences had been granted to others on better terms than had been granted to him. He therefore wanted to see all the licences which plaintiffs had granted as they had guaranteed to him that they had given him the best terms, but he had discovered one which was better, and there might be others.

Mr. GRAHAM said he would make an affidavit.

His LORDSHIP said it might be that the licences were not all in the same form, and the defendant would be entitled to see them all so that he might choose the best. The plaintiffs had better therefore make the affidavit, and the costs of this application be paid by the defendant.

Frankenburg v. David Moseley and Sons.

This case was in the list for hearing before Mr. Justice Farwell in the Chancery Division yesterday (Thursday), and was an action brought by plaintiff to restrain the defendants, by injunction, from infringing plaintiff's patent relating to improvements in the manufacture of indiarubber. The defence, among other things, was a denial of the infringement.

Upon the case being called on, Mr. Fletcher Moulton, Q.C., stated that the parties had come to terms, and the action would be withdrawn on terms, with his Lordship's consent.

His Lordship assented, and the action was accordingly withdrawn on terms which were not stated.

National Telephone Co. v. Tunbridge Wells Corporation.

The Tunbridge Wells Corporation have decided to apply to the High Court for a writ of prohibition in this case (particulars of which were given in our issues of March 23 and April 26) to prohibit Judge Emden from further dealing with the matter.

Workmen's Compensation.

In the course of an action heard before Judge Gye at Basingstoke County Court, under the Workmen's Compensation Act, an important point was raised as to the position of insurance companies. Plaintiff was a labourer named Penfold, defendant a builder named Tarrant. Defendant was nominally represented by Mr J. A. Kingdon, a solicitor, who, however,

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in the course of the proceedings, clearly represented not the actual defendant, but the General Accident Assurance Co., of Perth, N.B., with whom defendant had insured his risk under the Act. In the course of the proceedings a receipt in full discharge to the agent of the insurance company was put in. Judge Gye asked if the defendant was willing to pay any reasonable amount apart from the insurance company's payment. The reply was that he was willing to pay reasonable compensation, but the insurance company had obtained a receipt in full from the plaintiff, and had taken the matter out of his hands altogether. Judge Gye said this was exactly what he had anticipated: it was the insurance company who were fighting the action. The evidence showed that the plaintiff had agreed with defendant that 11s. 6d. per week was reasonable compensation, and subsequently the agent of the insurance company induced plaintiff to obtain from his medical attendant a document showing the length of time he was likely to be unable to work. This document gave the period as four weeks, and a sum covering this period was paid by the company and a receipt in total discharge promptly secured. At the expiry of the four weeks it was found that plaintiff was unable to return to his employment, and a certificate to this effect was sent to the insurance company, with the result that the receipt in full discharge was put in as a bar to any further payment. During the evidence, Mr. Kingdon (the solicitor) attempted to cross-examine the witnesses, but Judge Gye peremptorily refused to hear him, and decided that he would not allow the intervention of the insurance company. The plaintiff was entitled (he declared) to claim compensation from his employer, the defendant, and it was, therefore, for these parties to the action to decide the points in dispute. There was, added Judge Gye, no place in the Act for the insurance company, nor had the Act contemplated any such parties' intervention. It will, of course, be observed that the Judges' objection was not to the act of insurance, but to the attempted transfer of plaintiff's right to sue his employer for compensation.

At the first hearing the case was adjourned to enable defendant to obtain legal advice, and on its resumption Mr. Temple Cooke appeared on defendant's behalf, and said it was important that the case should be defended, or otherwise the insurance company might dispute the policy.

Judge GYE said he had nothing to do with this point. He had only to deal with the case as between plaintiff and defendant, and he could not allow any insurance company to intervene. He had not taken this course without due consideration, but he found over and over again that the "undertaker" was willing to pay, but that the insurance company refused, and by this course were endeavouring to defeat the aims and ends of the Workmen's Compensation Act. In the present case a most disgraceful defence had been put forward on behalf of the insurance company.

Mr. TEMPLE COOKE said the term "Compensation Act" was a misnomer. It was really an Insurance Act.

Judge GYE: Nothing of the sort. The insurance companies have stepped in as they do everywhere. He was not prepared to allow them to step in by a crooked path.

Mr. TEMPLE COOKE said the practical result of his honour's ruling was that no employer would insure against accident to his employees.

Judge GYE said that in the Act there was no mention of insurance companies; only the word "undertaker" was mentioned, and the "undertaker" must fight it out with the insurance company separately. If the insurance company wished to fight the matter they must do it on appeal.

Mr. TEMPLE COOKE then assured his honour that he appeared for the defendant, and not for the insurance company.

Judge GYE: If that is the case, it would be dangerous for me to disallow you to appear.

In the course of the evidence which followed, the receipt was again put in, and purported to be a receipt in full discharge of all claims made, or to be made, under the Workmen's Compensation Act, 1897, the Employers' Liability Act, 1880, or at common law. A consultation took place between Counsel with a view of settling the case, but Judge Gye stated that he would not agree to any settlement of the action.

Mr. TEMPLE COOKE said he was not aware that it was necessary to get the consent of the Bench to a settlement in an action of this character.

Judge GYE replied that there had already been a settlement, which was repudiated.

At the conclusion of the evidence, Mr. TEMPLE COOKE submitted that the defendant was justified in defending this action; otherwise, if he went to the insurance company and claimed further payment to his workmen under the policy the company might say he had not troubled to dispute this matter. On the faith of the doctor's certificate, the company were justified in taking the course they had done. It was true they had snatched this settlement from plaintiff, but they were a commercial body and wished to make the best they could out of it. If it were not for the insurance companies where would the employers be under the Act?

Judge GYE: You have summed up the case neatly. But the insurance companies make a really good thing out of this business.

His HONOUR in giving judgment said it was clear plaintiff was entitled to further compensation. The very point raised in this case was one which he had expected would be raised ever since the Act came into operation, and he was surprised it had not been raised before. The object of the Act, he understood, was that a workman should be entitled to receive compensation from his employer for any injury he might receive in the course of his employment. The legislator had removed a large number of restrictions and legal defences from the operation of the law as it stood before this Act was passed, and it was provided that, broadly speaking, unless the workman brought about the accident by his own wilful misconduct he should be able to recover from his employer damages for any injury happening under any of the circumstances specified and enumerated in the Act. It was intended by the Act that a workman thus injured should, during the period he was incapacitated, receive the means of livelihood. Further than that, it was intended by the Act—a point in which it had lamentably failed—that the workman should be enabled to conduct the proceedings for arbitration without professional assistance, and that workmen meeting with a variety of small injuries should not be obliged to go to a solicitor and incur costs. It was, in short, intended to put the matter as much as possible in the man's own hands. But the unfortunate technicalities and complications of the Act had rendered it absolutely impossible, in a great many cases, that a man of even more than ordinary intelligence could find out what the Act meant on this or that point. That difficulty had been considerably enhanced by the intervention of the insurance companies. They, being commercial concerns, issue policies to employers to cover all those accidents and risks, a state of things, he ventured to think, that was never contemplated by the legislature when the Act was passed. The effect of that intervention on the part of the insurance companies and of the universal desire to insure liabilities on the part of employers had been that, when from motives of honest and kindly feeling an employer was only too willing to compensate a man for injury, the insurance company stepped in and said "we shall fight this." The result was that an extraordinary number of cases were fought by the insurance companies for their own purposes, and they endeavoured to keep from the workman that compensation which his employer was willing and desirous he should receive. The sole end and aim of the insurance companies was to get rid of the liability, and the workman stood the risk of being deprived of compensation, not by the wish of the employer, but by the sole consideration of £. s. d. by the insurance companies. The Act was difficult enough to administer when both sides were willing for arbitration; but it was almost impossible to administer it when every little point was taken by counsel or solicitor to defeat the claim of the applicant. The Act itself bristled with difficulties; little wonder, then, that the insurance companies gladly fastened on the difficulties, and endeavoured to defeat these claims. It was a rich harvest for them. He (Judge Gye) had no hesitation in saying that if a receipt such as had been put in in this case had been obtained over an ordinary action for a money claim, and the plea had been put forward that the signatory did not know what he was signing, an action for fraud would be successful. If such procedure were allowed to go on it would put an end to honest dealing between workmen and employers. A great deal of injury to both was undoubtedly done by this busy intervention on the part of insurance companies. The balance due to plaintiff was £8. 1s. 6d., and he gave judgment for that amount, with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Arcona.—At Arcona, the northern point of the island of Rgen, a new lighthouse is being erected at a cost of £11,823. The light adopted is an electric flash light of one-tenth second duration at intervals of $4\frac{9}{10}$ seconds. The light will be visible 22 miles.

Atlantic Cable Enterprise.—According to a telegram published in the Paris edition of the *New York Herald*, a company is to be formed (under a charter to be obtained from the State of New Jersey), to be called the American-European Cable Co., with a capital stock of $10,000,000, the bulk of which, it is stated, has been subscribed. Mr. W. H. Worl and a number of capitalists are said to be behind the company, which proposes to lay a cable from New York to Portugal, under what is described as "a right ceded in 1867 to the American Atlantic Cable Co. by special Act of Congress to lay cables on the Atlantic Coast of the United States without conditions or restrictions."

Birkenhead.—During the past year 238,546 units of electric current were supplied to 215 consumers, compared with 169,676 units and 158 customers in 1899.

Birmingham.—The City Council on Tuesday adopted the recommendation of the Public Works committee to authorise the City of Birmingham Tramways Co. to equip the Bristol-road tramway route on the overhead trolley system. At present the accumulator system is employed.

Blackpool.—The receipts of the electric tramway department to March 31 amounted to £22,570, compared with £18,196 in 1899. The number of passengers carried was 3,421,730, compared with 2,881,027, and the distance covered 318,885 miles, against 259,754. Various extensions of the lines are being carried out.

Bootle.—Differences have arisen between the Council and the Liverpool Corporation in regard to the running of through trams. The chairman of the Highways committee (Councillor Hall) announced on Wednesday that further communication had passed between the committee and the Liverpool Tramways committee, but a settlement had not been arrived at. The matter had been referred to the Board of Trade. The committee contended that the responsibility for the electric cars not being yet placed on the Bootle lines rested with the Liverpool Corporation.

Bristol.—The Local Government Board have sanctioned the borrowing of £145,150 for electric lighting extensions. The period of the loan is 25 years. An application from the Mangotsfield Parish Council for a supply of current has been refused.

British Fire Prevention Committee.—Vols. II. and III. of the publications of the British Fire Prevention committee, advance copies of which we have received, contain among other matter a description of the testing station of the committee and accounts of tests with unprotected columns, floors, ceilings, glass, doors and

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partitions. A reprint of a Paper on "Conflagrations During the Last Ten Years," read by Mr. C. E. Goad before the Insurance Institute of Manchester, will also be read with interest in view of the recent disastrous fire in Ottawa, and of the Charity Bazaar Fire in Paris, of which to-day is the anniversary. The publications are edited by Mr. Edwin O. Sachs.

Brussels-Antwerp Electric Railway.—The Bill for the construction of the proposed line has been defeated in the Committee of the Belgian Chamber.

Canada.—The electrical industry in Canada is, according to recent reports, participating fully in the prosperity which is a feature of the time. The leading electrical manufacturing and supply companies report that the volume of business for 1899 exceeded that for 1898 by upwards of 75 per cent., and this notwithstanding that only comparatively small additions have been made in the form of new undertakings. Progress has been shown in the substitution of up-to-date plant for that previously in use, and in very considerable extensions and improvements to existing lighting and power undertakings. The market quotations for stocks and shares in electric joint stock concerns in the Dominion show a marked rise, and further advances are confidently predicted. The utilisation of water power for the generation of electric current is being taken up with great energy, and cheapened production is resulting in largely increased demands for electric enterprise throughout the country.

Cardiff.—A meeting of the Electric Lighting committee was held on Tuesday to consider a report from the borough electrical engineer (Mr. N. Appelbee) on the electrical undertaking, and particularly as to the advisability of erecting new electricity works for supplying electric current for lighting and traction. Mr. Appelbee recommended that he be instructed to prepare detailed plans and estimates for the proposed works, and that application be made for borrowing powers; that trials should be made with inferior grades of fuel, using induced or forced draught; that the coal elevator and conveyor scheme as originally arranged should be carried out; that Messrs. Siemens Bros. and Co. be asked to give a quotation for a 500 H.P. steam alternator, and Messrs. Babcock and Wilcox for an additional boiler; that the equivalent of 500 H.P. in transformers be obtained; and that two additional feeder cables from the works to the centre of the town be laid at once. Mr. Hallett thought that forced draught would not be advisable, and the electrical engineer did not press the point, so this portion was struck out. It was stated that the present plant would only carry the department over the coming winter. The committee deferred considering the recommendations to enable Mr. Appelbee to draw up a further report, particularly upon the advisability of at once considering the necessity of providing a new generating station.

"Carols from Car."—Mr. Geo. M. Baines, accountant at the Eastern Telegraph Co.'s station at Carcavellos, Portugal, is as well known in this charming district for his poetry and music as for his skill in the profession of which he is a respected member. In a volume of carols just published Mr. Baines tempts the muse in many strains, from the lullaby of the sunny south (*à la* Eugene Stratton) to the more ambitious sonnet and serenade. The introduction of "service" technicalities into some of the verses is very neatly accomplished, and will raise many a smile. Here and there a carol deals with local subjects, and Mr. Baines' residence for some years at Fayal, in the Azores, as superintendent when the cable was first laid to that island, affords him the opportunity of expressing in trenchant verse his longing to return to the home of his choice—Carcavellos. This regard for "Car.," where men in the service of the Eastern and associated companies spend so many pleasant days, is very general, and fully excuses Mr. Baines for devoting many of his carols to the glorification of the Mecca of at any rate the younger members of the submarine cable services to the East and West. The book has been nicely printed in Lisbon and is frontispieced by a photograph of the exterior front of the Carcavellos station, an old Portuguese baronial house of bold design, charmingly situated.

"Cassier's Magazine."—The May issue includes articles on "Electric Riveting Machinery," "Electric Central Stations and Isolated Plants," "Systematic Piece-work Pricing," and "Typical Horizontal British Steam Engines."

Central London Railway.—Mr. D. J. Ross, engineer to the City of London has been given permission by the Corporation to accept a gratuity of £1,050, for services in connection with the Bank station and subways of the Central London Railway.

Country House Lighting.—Gayhurst House, Bucks, the residence of Mr. W. W. Carlile, M.P., has been provided with a very complete electric lighting installation. The work was entrusted to Mr. R. F. Yorke, M.I.E.E., of Glasgow, and under his supervision was carried out by Messrs. G. and W. Simpson. 280 lamps have been installed. Current is supplied by a Laurence Scott shunt-wound dynamo, driven by a 12 H.P. Hornsby oil engine, with a 6in. Hendry's patent laminated belt, and in addition there is a battery of 66 Chloride cells. The stables and outbuildings are also lighted electrically.

County Councils and Electrical Undertakings.—A deputation from the County Councils Association and other bodies waited upon the Board of Trade last week, to obtain Government support for the bill exempting County Councils from responsibility for damage to electrical communication through the necessary widening and repairs of bridges. In reply, the President (Mr. Ritchie) said the principle contended for by the deputation appeared to be a reasonable one, although objection might be taken to its being retrospective. It was rather a strong order to say, when Acts of Parliament and provisional orders had been obtained by electric lighting undertakings under the protection of the existing law, that they should now be made liable under this bill to expenses to which they were not previously liable. The bill, which was very defective, had a most unfavourable position in the House, and he suggested that it would be better if it were withdrawn and reintroduced in an amended form. The position of electric lighting was not what it was in 1882, and he thought the deputation's case would be stronger if they went to Parliament, and asked for a reconsideration of the position in which local authorities were placed in connection with such expenses.

Customs Duties.—Under the new Spanish tariff every description of electrical and scientific apparatus and instruments is classed under a heavy rate, and is plus a 20 per cent. war tax.

Under the new customs tariff of Paraguay telegraph wire, steam engines and fittings, calcium carbide and scientific instruments are admitted free.

Dinner.—The fortieth annual dinner of the old students of King's College, London, will be held at the Holborn Restaurant on Monday, June 18, when the Hon. Sir John Alexander Cockburn, K.C.M.G., Agent-General for and formerly Premier of South Australia, will preside. His Royal Highness the Duke of Cambridge has notified his intention to be present. Students can obtain all information of Mr. W. Vincent at the college.

Dock Lighting.—The Mersey Docks and Harbour Board have decided to light the Birkenhead foreign animals wharf electrically. The Woodside portion has for some time past been so lighted, current being supplied by the Birkenhead Corporation; but the board have now decided to put down an independent plant.

East London Technical College.—Mr. J. T. Morris will give a special course of six lectures on "Electric Lighting and Power Stations," on Thursday evenings, commencing 17th inst., and a course of eight lectures on "Three-phase Currents," on Tuesday evenings, commencing 8th inst. Some particulars are given in an advertisement, and further information can be obtained from the director of studies (Mr. J. L. S. Hatton, M.A.), People's Palace, London, E.

Eastbourne.—An important report by Mr. W. C. C. Hawtayne on the position of the electricity undertaking was considered by the Council yesterday (Thursday). Mr. Hawtayne states that as the company's undertaking was commenced in 1882, some of the machinery is old and very inefficient, and recommends the Council to instal a direct complete set capable of developing 400 kw., and an additional boiler, the cost of the new plant being £5,050. The re-modelling of the mains was the most important matter. In regard to the transforming of the high-pressure current for private supply, Mr. Hawtayne points out that the duration of the maximum load was only about 1 to 2 hours per day, so that for approximately 22 hours out of 24 a considerable amount of energy was being wasted, and that waste could only be checked by getting rid of as many of the small transformers as possible, and substituting for the present system of distribution a proper low-pressure system of mains fed at intervals by large transformers grouped in sub-stations. The alterations suggested should bring down the losses from the inefficiency of the present system to about 15 per cent. of the units sold, against about 60 per cent. The change of pressure would enable them to take twice as many consumers on the low pressure mains, while also halving the losses in distribution. The cost of the alteration would be approximately £10,700. The present house service fuses and meters would also partly require replacing, involving a further cost of about £4,000. The 25 public arc lamps on the sea front running in series off the old Brush machines should be connected up to the low-tension distributing network, and would therefore require to be altered, or preferably replaced by lamps of a later type, at a cost of about £260. If the Corporation proposed to extend the arc lighting to certain additional thoroughfares named in the report, 38 additional arc lamps would be required, and the capital outlay would be about £1,500. Those lamps would replace about 33 existing incandescent gas and 30 ordinary burner lamps, costing about £37 per annum, and if the Corporation decided upon a charge of £17 per 1,000 c.p. arc lamp per annum, the extra annual expenditure for arc lighting would be £409. The electric arc lamps would give about ten times more light than at present. The provision of a new switchboard would cost approximately £1,100. On the question of the site of the works, Mr. Hawtayne advised the construction of new works at Roselands in conjunction with the re-modelled refuse destructor and sewerage works. In any event, whether the electricity supply works are erected at Roselands or not, a considerable expense must shortly be incurred on buildings in order to place the existing works on a proper footing. The cost of

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this work might amount to anything between £2,000 and £3,500, according as to whether or not a new shaft is required. The cost of buildings with a new chimney shaft for a combined scheme of lighting, sewerage, and destruction of refuse would be about £9,500. On the question of changing over from the alternating-current to the continuous-current system. It would not be possible to adopt the continuous-current system without considerable alteration to the whole of the cable network, and practically reopening the whole of the streets where cables were now laid. Lighting the remaining streets by incandescent electric lamps (997 16 c.p. and 53 32 c.p. lamps) would cost £17,450, and the total annual expenditure for maintenance, &c., is estimated at £4,231. The Electric Light committee recommend the Council to transfer the works to Roselands, and to instruct Mr. Hawtayne to prepare the necessary plans and specifications; that the borough engineer prepare the plans of the new building required, in consultation with Mr. Hawtayne; and that tenders be at once invited for the new main switchboard and 400 kw. steam alternator, with boiler. The total cost of the proposed works is estimated at £33,562. After discussion the Council yesterday (Thursday) decided to adopt Mr. Hawtayne's report and recommendations.

Edinburgh.—The Electric Lighting committee have issued their draft estimates for the year 1900-1901. The estimated expenditure, including £5,800 for rates and taxes, is £45,715, making, with £40,000 for sinking fund and interest, a total of £85,715, against £63,285 this year. The estimated revenue, after taking into account the proposed increase of ¼d. per unit on the present price of 3½d. for private lighting, in consequence of the rise in the price of coal, is £90,000, compared with £73,405 in the current year. The estimated capital expenditure in 1900-1901 for works at the Dewar place and M'Donald road stations, and the extensions of mains and cables, &c., is £113,450. The price for public lighting has been fixed at £13 per lamp per annum, a reduction of £1; the price for motor power is to remain at 1½d. per unit. The number of lamps applied for during the last fortnight was equal to 5,348 8 c.p. lamps, and includes 15 motors.

Edmonton (Middlesex).—At its last meeting it was resolved by the District Council that application be made for an electric lighting provisional order.

Electric Traction in Spain.—A Royal order was recently issued authorising the construction of electric tramways in Almeria and the vicinity.

Engineering Education.—Instruction is given in civil, mechanical and electrical engineering at the Hertfordshire Training School of Engineering, and some particulars are set out in an advertisement.

Factory and Workshops Bill.—This bill, now before Parliament, if passed as it stands, is calculated to considerably increase the liability of occupiers of factory premises in the provision of means of escape in case of fire, and the Manufacturers' Section of the London Chamber of Commerce suggests various amendments to the bill, and particularly to sec. 15, which deals with the means of escape to be provided. It appears that under the Act the occupier of any factory erected since Jan. 1, 1892, or of any workshop erected since Jan. 1, 1896, in which more than 40 persons are employed, must, if situate in the area over which the London County Council has control, be furnished with a certificate from the Council that reasonable provision has been made for escape in case of fire of all persons employed above the ground floor, or otherwise the upper floors must not be occupied. It is pointed out that the bill proposes to give the Council the same power for old as for new factories and workshops, *i.e.*, the power to decide whether a factory or workshop may continue to be used or not. The London Chamber of Commerce calls the attention of factory owners to the clauses of this bill. Copies of the suggested amendments can be obtained on application to the secretary, Mr. K. B. Murray, Botolph House, Eastcheap, E.C.

Gravesend.—Mr. W. H. Trentham is to attend the next meeting of the Electric Lighting committee to discuss the question of the erection of electricity works.

Hales Owen.—Acting on the advice of Mr. R. P. Wilson, the District Council have resolved not to dispose of their electric lighting order until they have obtained a tramway provisional order, which will be applied for next session.

Leeds.—The salary of the mains superintendent has been increased from £208 to £230, with a further increase to £250 at the end of twelve months.

Leicester.—A sub-committee has been appointed to visit Paris, Brussels, Berlin, and Budapest, in order to report to the Council upon the systems of electric traction in operation in those towns.

Leith.—The burgh electrical engineer (Mr. W. A. Bryson) has tendered his resignation, as he intends to confine himself to consulting work. The Council are advertising for Mr. Bryson's successor in another column.

Limerick.—Progress is being made with the electric lighting scheme, the plans of which have been approved by the Local Government Board. The consulting engineer is Mr. J. Enright.

Lymington.—The Lymington Electric and Power Co. are commencing the work of erecting their electricity supply station.

Maidenhead.—The Council have decided to apply for sanction to a loan of £25,000 for electric lighting.

Manchester.—At the Corporation meeting on Wednesday, the estimates for the ensuing year were presented by the Finance committee and approved. Last year the Electricity committee contributed £10,000 to the relief of rates, but this year the contribution will be nil. The Gas committee's contribution has been reduced from £52,000 to £20,000. In reply to questions Ald. Higginbottom said the engineer had withheld the supply from Cheetham Hill because he could not, with the existing plant, have maintained the voltage required. The mains were being prepared for tramway and lighting, and they would be carried to Cheetham first. The Electricity committee had handed over £68,000 to the City Fund, and had built up a reserve fund of £40,000 out of the profits, and yet they were told they might have been in bankruptcy because they did not feel justified in handing over £10,000 or £20,000 to the City Fund. The mains were laid down under the best advice in the country. It had been found, however, that the damp climate of Manchester would not allow the indiarubber cables to "live" there. It was only those cables which had proved defective, and he did not think they would have any trouble from any of the cables with which they had been replaced. With regard to explosions, Manchester was not worse off than other places. The extension to outside districts was carried out in accordance with the policy of providing electric tramways and lighting for the out-districts.

Marylebone (London).—The Parliametary committee has been instructed by the Vestry to take the necessary steps to oppose in all its stages the bill for confirming the provisional order to the Marylebone Electric Supply Co.

Newcastle-on-Tyne.—An inquiry was held on Tuesday by Mr. A. P. Trotter into the application of the Corporation to borrow moneys for electric tramways. The town clerk (Mr. Hill Motum) and the consulting engineer (Mr. C. Hopkinson) supported the application. Provisional contracts have already been let, and Mr. Motum said the Corporation had authority to construct 20 miles of double tramways and to work them electrically. The tramways were in course of construction, and about 11 miles were at present being proceeded with. They proposed shortly to invite tenders for the remainder. He asked that as long a time as possible should be allowed for repayment of loan. Mr. Trotter said that the usual terms were 50 years for buildings, 20 years for electrical equipment, and 15 years for cars, and sometimes an average was struck. The Corporation asked for 50 years for the buildings loan, but that was an unusual time, and he was afraid it was not possible under the Tramways Act. The town clerk submitted that the application was not made under the Tramways Act, but under the Local Act of last year. Mr. C. Hopkinson gave technical particulars. The power station, he said, was being built larger than was immediately required so that there might be provision for extensions. They were going to have 100 cars built at present. The gradient would be about 1 in 13. The brake to be used would be a mechanical brake, but they were arranging the cars so that they could add a further brake to the bogey cars. There was no opposition.

Mr. Cail, chairman of the Tramways committee, has been commissioned to pay a visit to the German Steel Works, in Westphalia, to make an expert inspection of the next delivery of 600 tons of tram rails on behalf of the Corporation. If necessary, Mr. Hopkinson, the electrical engineer, is to accompany Mr. Cail.

Norwich.—The new Technical Institute has been provided with an electric lighting installation by Messrs. G. N. C. Mann and Co. There are about 800 lights.

Police.—At the Marylebone (London) Police Court on Wednesday, a youth named Toye was charged with loitering in the Harrow-road for the supposed purpose of committing a felony, and further with inciting David Catherall and Walter Gower to steal. Prisoner had been in the employ of Messrs. Evershed and Vignoles, electrical engineers, Woodfield Works, Harrow-road, W., and was discharged two months ago. Catherall, who was called as a witness for the prosecution, gave details of his connection with the prisoner, who apparently had arranged a plan for obtaining possession of the cash bag of Messrs. Evershed and Vignoles' cashier, but the plan failed as the cashier did not return by the usual route. The magistrate (Mr. Curtis Bennett) complimented the two witnesses, Catherall and Gower on their conduct and rewarded them for their loss of time. Prisoner was sentenced to three months' hard labour.

At West Ham on Friday, Charles Maddock, wireman, was again charged with attempting to set fire to a building at Factory-road, Silvertown, the property of the Indiarubber, Gutta Percha and Telegraph Works Co. Particulars of this case were given in our last issue. After taking further evidence the magistrate committed the prisoner for trial to the next sessions of the Central Criminal Court.

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Prague (Bohemia).—In a report on the trade of Bohemia, just published, it is stated that an excellent service of electric tramways now runs through the principal thoroughfares of the city. Prague is well lighted by electricity, the municipality being the owners of the undertaking. Public and private supply is generally adopted. The telephone service, which was originally established by an English company, is excellent, and the city is in direct communication with Vienna, Berlin, Dresden, and other important Continental cities. The telephone service is owned by the Imperial Government.

Plymouth.—There was a net profit of £298 on the Corporation tramway undertaking last year. The adverse balance, due to the accumulated deficits of previous years, stood on March 31, 1899, at £8,659. The actual deficit of the previous year was £1,321, so that the accounts of the year just closed show a total gain as compared with 1898 9 of about £1,600.

Personal.—A marriage has been arranged, and will take place at Brighton, on July 7, between the eldest daughter of the mayor of Brighton (Ald. J. E. Stafford) and Mr. W. C. P. Tapper, resident electrical engineer at the Whitechapel (London) electricity works.

Presentation.—On 28th ult, the employés of the Brush Co. assembled in one of the new shops at Loughborough to present a testimonial to Mr. C. E. Hodgkin on the occasion of his retirement from the post of works manager. The presentation, which consisted of a bacteriological microscope and lamp, chemical balance and weights, 10 power Ross binocular and an album containing the signatures of the subscribers, was made by Mr. F. E. Andrews, the works secretary, supported by Mr. Councillor Yeomans. Mr. Hodgkin suitably acknowledged the present.

Private Bill Legislation.—The Liverpool Overhead Railway Co. propose to apply for leave to introduce clauses in their bill empowering them, with the consent of the Mersey Dock and Harbour Board, to equip the Mersey dock railway electrically.

The Dublin Electric Lighting Billwas read a second time in the House of Commons on Monday.

The Vale of Rheidol Light Railway bill has passed through the committee stage of the House of Commons, and has been ordered for third reading.

Opposition to the Preston Corporation's Tramway and Extension bill has been withdrawn.

Of the 19 petitions originally lodged against the London United Tramways (Extensions) Bill only one (by frontagers in the Richmond-road, Twickenham) remains. The bill will be considered by a House of Commons committee, under the chairmanship of Sir U. Kay Shuttleworth.

The Standing Orders committee of the House of Commons have allowed the Glasgow District Tramways bill to proceed, but the tramways on the north side of the Clyde, with the exception of those projected in Dumbarton, have been struck out.

Rhyl.—An inquiry was held last week into the application of the Council to borrow £37,000 for electric lighting, refuse destructor and other works. The clerk (Mr. A. Rowlands) said the Council anticipated making a substantial profit on the first year's working, as an agreement had been entered into with the Rhyl and Prestatyn Light Railway Co. to supply electrical energy for their tramway, at a profit of over £400 per annum. It was intended to supply current to private consumers at 6d. per unit.

Ruthin (Denbigh).—A special meeting of the Council is to be held to consider the advisability of applying for electric lighting powers.

St. Helens.—The Electric committee recommended at the Council meeting on Wednesday that the salary of the borough electrical engineer (Mr. J. S. Highfield) be increased from £300 to £500 per annum. It was explained that Mr. Highfield was first appointed in 1898 at a salary of £200, and in July, 1899, he had the option of accepting another position at a salary of £500 per annum. The committee gave him a bonus of £100, and promised that if he would not leave until the electrical equipment of the tramways was completed, he should have £500. Notwithstanding this promise, an amendment was carried that Mr. Highfield's salary be only increased to £400. The salary of the assistant electrical engineer (Mr. E. M. Hollingworth) has been increased from £110 to £150, and the salaries of Messrs. G. H. Carter and E. E. Eccles. shift engineers, from £100 to £125.

St. Pancras (London).—The Vestry have sanctioned an expenditure of £3,000 for laying a new feeder for the Seymour-street district, with an ultimate extension to Somers Town. The outlay includes cost of distributing and arc lighting mains in Ampthill-square and Bedford-street. A proposal by the Electricity committee to reduce the charge for current to churches, chapels, and hospitals from 5d. to 3d. per unit as from July 1 next was referred back. The chairman (Dr. W. Smith) said that there were 65 churches and chapels in St. Pancras, of which only 12 were supplied with current by the Vestry, but if the proposed alteration was made he believed they would be able to induce all to become customers.

Salford.—A special meeting of the Corporation will be held on Monday to consider the report of the Electric Light committee relating to the resignation of the late chairman, Councillor Haworth and the matters connected therewith.

Scarborough.—The Corporation are negotiating for the purchase of the undertaking of the Scarborough Electric Supply Co. (Ltd), and the company intimate that they are prepared to sell "on the basis of the present and prospective value." The committee having charge of the negotiations offer to buy at a valuation to be fixed by an arbitrator.

Shoreditch (London).—The electrical engineer (Mr. C. N. Russell) has been unable to recommend the acceptance of either of the two tenders received for the supply of four 165 kw. transformers, and the Vestry have decided to invite fresh tenders, and to permit makers to offer their largest size of transformers suitable for the purpose. One of the original tenders was not according to specification, and the price of the other was considered to be too high.

Stafford.—During the past year the electricity department generated 118,341 units of electric current, an increase of 27,207 over last year. The department is in negotiation with Mr. W. O. Rooper for an annual supply of about 100,000 units for works lighting and motor driving.

Stettin (Germany).—The total length of electric tramway lines belonging to the Stettin Electric Street Tram Co., opened to traffic at the end of 1899, was 44,373 metres (about 27½ miles). The company's rolling stock consists of 82 motor cars, 22 closed and 21 open cars, one snow-clearing car, and four salt-strewing cars. The net profits for 1899 reached £9,376, and the company paid a dividend of 6 per cent. The overhead electric trolley system is now in operation over all the lines.

Stores Lighting.—The extensive range of shops occupied by the Bon Marché Co., at Stoke Newington, London, are to be lighted throughout electrically. Jandus arc lamps are to be used for the interior lighting, and Crompton-Pochin open type for the exterior. An independent gas-driven generating plant is being installed. The consulting engineers are Messrs. Taylor and Field.

Sunderland.—According to the report of the electrical engineer (Mr. John F. C. Snell) the profit on the electricity undertaking during the past year amounted to over £1,000, of which £700 has been applied to reduction of rates.

Telephone Wayleave Charges at Newcastle-on-Tyne.—A committee has been considering the advisability of charging a rental for underground telephone wayleaves to the Post Office and the National Telephone Co. The Post Office authorities requdiate any liability to such a charge. The committee recommend that no charge be imposed on existing renters, but that, in the case of all new subscribers, the charge be at the rate of 2s. 6d. per renter under both telephonic services.

Telephone Wayleaves.—The summons against the National Telephone Co. for opening up the pavement in Marshalsea-road, Borough, for the purpose of laying down telephone conduits and wires without the usual notice, has been withdrawn by the Vestry of St. George the Martyr (Southwark). At the police court on Tuesday the vestry clerk (Mr. Johnson) stated that the company had admitted that the wires were laid without authority, and agreed to pay £10 per annum in consideration of the wires being underground.

The War in South Africa.—The outbreak of hostilities in South Africa and the extension of the period during which these hostilities are likely to continue, has led to large imports of electric machinery and material into Cape Colony, Natal, and other South African ports, which in October, 1899, exceeded those for October, 1893, by £6,000. Reports to hand show that this increase continues a feature in South African imports.

Water-power Utilisation in India.—The Government of India are willing to receive proposals for lighting Wellington by electricity, generated by water-power from the Karteki Falls, in connection with the scheme for the utilisation of water-power from the falls for the cordite factory which is being built in the Arvenghat valley, Nilgiris.

Water-power Utilisation in Spain.—The Sociedad General de Centrales Electricas, Bilbao, has secured the concession for utilising the water-power of the river Leizaran, near Andvain (Guipuzcoa). It is estimated that 2,800 H P. will be available.

West Australia.—At the meeting of the Colonial Consolidated Finance Corporation, on Wednesday, the chairman said they had decided to participate in the proposed scheme for the construction of an electric tramway at Kalgoorlie, and now held a quarter-share in the tramways concession. The intention was to build the tramway without appeal to the public. They were told by the engineers who built the Perth tramways that the Kalgoorlie lines would be a better paying scheme than Perth. They expected to commence constructing at Kalgoorlie at once, and hoped to have some part of the tramway open for traffic towards the end of the year.

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West Bromwich.—An inquiry has been held into the application of the Corporation for sanction to borrow £30,000 for erecting electricity works. There was no opposition.

Weymouth.—The Council have considered and adopted a report by Prof. A. B. W. Kennedy recommending the erection of electricity works, at an estimated cost of £38,300. Application has been made to the Local Government Board for sanction to borrow £42,000 for covering the cost.

Wireless Telegraphy in Germany.—A company, entitled Braunsche Telegraphen Gesellschaft, has been formed in Hamburg with a capital of 2,000,000 marks (£100,000) for the purpose of continuing the experiments of Prof. Braun, of Strasburg, in wireless telegraphy, the exploitation of his patents, and the establishment of complete installations of wave telegraphy on land and sea. The company takes over an agreement made between the Schuckert Co. and the syndicate hitherto dealing with the Braun patents.

Worcester.—In order to encourage the demand for electric current, the Council have decided to ask the Local Government Board to sanction a loan of £1,000 for wiring consumers' premises.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date) a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made quite complete. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is the most complete and correct book of its kind ever published in any language.

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Submarine Cable-Laying and Repairing.—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

The *Postmaster-General* invites applications for copies of the Post Office specification, and forms of tender for galvanised iron strand stay wire for telegraph purposes. Applications to the controller of stores (Mr. Chas. E. Stuart), G.P.O. West, London, E.C. See advertisement.

Glasgow Corporation require tenders for creosoted poles, oak arms, insulators, ironwork, and ironwork used in telephone construction. Specifications, &c., may be obtained from the telephone engineer (Mr. A. R. Bennett), City Chambers, and tenders must be lodged with the town clerk (Sir J. D. Marwick) by Wednesday, 16th inst. See advertisement.

Glasgow Corporation also require tenders for indiarubber-covered and lead-covered branch cables and carbons for one year. Specifications, &c., may be obtained from the engineer (Mr. W. A. Chamen), 75, Waterlow-street, Glasgow, and further particulars are given in an advertisement. Tenders to the town clerk (Sir J. D. Marwick) by 19th inst.

Leeds Lighting committee invite tenders for two or three 630 kw. two-phase generators and one or two sets of surface condensing plant. An advertisement contains further particulars, and specifications, &c., may be obtained from the manager (Mr. H. Dickinson), 1, Whitehall-road, Leeds. Tenders to town clerk (Mr. W. J. Jeeves) not later than 10 a.m. of 28th inst.

Worksop District Council require tenders for electricity generating plant, particulars of which are set out in an advertisement. Specifications, &c., may be obtained from the consulting engineer (Mr. A. B. Mountain), borough electrical engineer, Huddersfield, and tenders must be delivered to the clerk (Mr. Geo. H. Featherstone) not later than 23rd inst.

The Guardians of *West Ham* Union invite tenders for the erection of works detailed in an advertisement elsewhere. It will

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be seen that the tenders are to include maintenance of the installation for 12 months from the date of completion of the whole of the works. The advertisement contains further important particulars of the conditions, and tenders have to be sent in to Mr. Fred. E. Hilleary, clerk to the Guardians, Union-road, Leytonstone, E., by Wednesday, May 16.

Bradford Corporation require tenders for the construction and delivery of two steam engines and two 1,000 kw. dynamos. Specifications may be obtained from the city electrical engineer (Mr. R A. Chattock), and tenders must be delivered to the town clerk (Mr. Frederick Stevens), Town Hall, Bradford, on or before 24th inst. An advertisement gives further particulars.

Bradford School Board invite tenders for the electric lighting of the Carlton-street school. Specifications from the consulting engineer (Mr. A. H. Gibbings), Old Bank-chambers, Cheapside, Bradford, and tenders to the clerk (Mr. Thos. Garbutt), School Board offices, Manor-row, Bradford, by noon of Monday next, 7th inst. See advertisement.

Heywood Corporation require tenders for electricity generating plant. Specifications, &c, from town clerk (Mr. J. H. Baldwick) and tenders by noon on May 14.

The Commissioners of the Royal Burgh of *Perth* invite tenders for 45 enclosed arc lamps and ornamental cast-iron and steel pillars, with switch gear, &c. Tenders before noon on May 7.

Salford Electric Light committee require tenders for two miles of low tension single cable, lead covered, and a battery of accumulators. Tenders by May 7.

Corporation of *London* Streets committee invite tenders for the supply on hire of electrically-driven dust carts. Tenders to town clerk (Sir John B. Monckton), Guildhall, E.C., by June 1.

Manchester Tramways committee invite tenders for 150 car trucks, tramway bonds and special track work and points and crossings. Tenders by May 7.

Paddington (London) Vestry invite tenders for carrying out certain proposed alterations to the existing electric lighting at the public baths. Tenders to vestry clerk (Mr. Frank Dethridge), Vestry Hall, Harrow-road, London, W., by May 14.

Burnley Corporation invite tenders for laying about 2,000yds. of cable. Tenders by May 14.

King's Lynn Corporation invite tenders for the supply of steam dynamos, boiler, switchboard and cables. Tenders by May 17.

Birkenhead Corporation invite tenders for steam pipe work, &c. Tenders by May 15.

Central Electric Supply Co. (*Ltd.*) invite tenders for the supply, delivery and erection of electricity generating plant. Tenders to Mr. F. J. Walker, 19, Carnaby-street, London, W., by 10 a.m. of May 22.

Rhyl District Council invite tenders for the supply and erection of electricity generating plant. Tenders to Clerk by 2 p.m. of May 14.

Brighton Corporation invite tenders for incandescent lamps for 12 months from July 1 next. Tenders by June 11.

The *Bengal Nagpur Railway Co.* (132, Gresham House, Old Broad-street, E.C.) require tenders for electric lighting plant. Tenders by May 10.

Maddelena (Italy) Municipal Council invite tenders and projects, until July 14, for public electric lighting.

TENDERS RECEIVED AND ACCEPTED.

The Southampton Harbour Board received 13 tenders for the supply and erection of a motor transformer. The estimate of the consulting engineer (Mr. J. G. W. Albridge) was £785.

British Schuckert Co. (*accepted*)	£690	Electric Construction Co.	£934
Edison and Swan Co.	1,145	Shalders and Davis	930
T. Scott Anderson and Co.	1,140	T. Richardson and Sons	870
General Electric Co.	1,029	Siemens Bros. and Co.	860
Thomas Barton	990	D. Bruce Peebles and Co.	830
Crompton and Co.	976	T. Parker (Ltd.)	694
Brush Co.	950		

Dundee Corporation have accepted the following tenders:—

Lowdon, Bros., traction switchboard	£1,000
British Insulated Wire Co., distributing mains	8,000
Callender Co., cables for electric lighting extensions	2,000

The Shoreditch (London) Vestry have referred tenders for the supply of cable from Messrs. Siemens Bros. and Co., the British Insulated Wire Co., and W. T. Glover and Co. to the Lighting committee for consideration. The Vestry have accepted the tenders of the Edison and Swan Co. and of the Berrenberg Electric Lamp Syndicate for the supply of incandescent electric lamps during the ensuing year.

The Maidstone District Council have accepted the tender of Messrs. Wallis and Sons for the erection of electricity station buildings at £8,563, and that of Messrs. Aiton and Co., 25, Laurence Pountney-lane, London, E.C., for steam pipes, &c., at £1,432.

Thirty-one tenders have been received for the electric lighting of the Northumberland County Lunatic Asylum, and the report of Mr. A. A. Campbell Swinton upon these tenders is to be considered at the meeting of the Visiting Committee on 21st May.

Leeds Corporation on Wednesday accepted the tender of the Electric Construction Co. for the supply of one, two, or three steam dynamos, for the Tramways department, at £10,149.

The Hart Accumulator Co. have secured the contract for the supply of storage batteries for the Penydaren electricity supply station, Merthyr Tydfil.

The Newcastle-upon-Tyne Tramways committee have let contracts for the ironwork for the tramcar sheds to Messrs. Swinney Bros, and to Messrs. Vipond and Co. for the ironwork for the power station at the Manors.

Rotherham Corporation have accepted the tender of Messrs. Thornton and Sons for erecting electricity station buildings at £8,351.

APPOINTMENTS VACANT AND FILLED.

The Greenock Board of Police require a resident electrical engineer at a salary of £300 per annum. Further particulars are given in an advertisement, and applications must be lodged with the town clerk (Mr. C. MacCulloch) before 10 a.m. of 9th inst.

Glasgow Corporation require an outside superintendent for their telephone exchange system. An advertisement contains additional particulars, and applications must be lodged with the town clerk (Sir J. D. Marwick) not later than May 11.

Leith Town Council require an engineer to take charge of their electricity undertaking. An advertisement contains further particulars, and applications to town clerk (Mr. T. B. Laing) not later than 12th inst.

An outside assistant is required by the Folkestone Electricity Supply Co. Applications to managing engineer (Mr. Thomas Hesketh). See advertisement.

The Newcastle-upon-Tyne Electric Supply Co. (55, New Bridge-street) require a meter inspector. Applications to secretary. See advertisement.

Rathmines (Dublin) District Council require a canvasser in connection with their electric lighting scheme. Applications to clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, Co. Dublin, by 15th inst. See advertisement.

A foreman is required to take charge of the arc lighting department of an electricity undertaking. An advertisement gives further particulars.

Mr. H. Waring, of Burton-on-Trent, has been appointed electrical engineer by the Mexborough Council.

Liverpool Corporation have appointed Mr. P. M'Cullough works superintendent and general assistant of the tramways department, at £260 per annum.

Mr. R. Marshall, of Messrs. Siemens Bros. and Co., has been appointed mains superintendent at Ayr.

BUSINESS NOTICES.

New Firm.—We learn that Mr. F. J. Down is severing his connection with Messrs. Laing, Wharton and Down (Ltd.) and will shortly establish a business in London for supplying specialities for electric traction and lighting contracts. Mr. Down has been a much-respected member of the electrical industry from the early days and has 17 years' unique experience in every department. He enters business on his own account, we are sure, with the best wishes of all who have been associated with or have known him in the past, and with every chance of success in his new undertaking. Mr. Down was a founder of the firm of Laing, Wharton and Down in 1883, and has since that time had a large American and Continental experience and connection.

Messrs. F. R. Hill and A. V. Gifkins, hitherto trading as electrical and mechanical engineers under the style of Hill, Gifkins and Co., at 68, Victoria-street, London, S.W., have dissolved partnership. Business continues under the style of A. V. Gifkins and Co. by Mr. Gifkins, by whom all assets and liabilities will be received and paid.

Prof. Henry Adams, M.I.C.E, M.I.M.E., F.S.I., &c, of 60, Queen Victoria-street, London, E.C., has taken into partnership Mr. Hal Williams, A.M.I.M.E., A.M.I.E.E., &c., and the firm will in future be known as Adams and Williams. Mr. Williams was for some time with the Haslam Foundry and Engineering Co., Derby, and has until recently been principal assistant with Messrs. Bramwell and Harris of Westminster.

The necessity for more room for manufacturing purposes at the British Thomson-Houston Co.'s factory at 63, Bankside, London, S.E, has required the removal of the company's stores to more commodious quarters at Nos. 4 and 6, Bath-street, City-road, E.C.

The Universal Battery Co. have removed to Mid-Kent Works, New Beckenham, London, S.E. Telegrams: "Universal Beckenham." Telephone 133 Bromley.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Motor Manufacturing Co. (Ltd.) is to be wound-up voluntarily for reconstruction purposes.

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A meeting of G. R. Blot and Co. (Ltd.) will be held at 64, Cannon-street, London, E.C., on May 28, to receive an account of the winding up. Mr. A. Dodds Fairbairn is liquidator.

A meeting of the Wray Electrical Engineering Co. (Ltd.) will be held at Central Buildings, New-street, Huddersfield, on 29th inst., to receive an account of the winding up.

A first and final dividend of 9½d. will be payable on 18th inst. at the offices of Messrs. Yates and Scampton, 4 and 6, Wood-street, Bolton, in the bankruptcy (separate estate) of J. H. Clarke, general and electrical engineer (trading with B. Wild as Wild, Rothwell and Co.). A first and final dividend of 2s. 10d. will be payable at the same time and place in the separate estate of B. Wild.

Application for discharge was made last Friday at the London Bankruptcy Court by Walter Philip O'Reilly, manufacturing electrician, 397, Edgware-road. Bankrupt had failed three times. In 1880 he paid 2s., in 1888 6s., and in 1892 his liabilities amounted to £2,365, and assets realised £11. 2s., and consequently no dividend was paid. A further suspension of two years was ordered, the registrar remarking that the bankrupt had apparently been living upon his creditors.

Plant for Sale—The St. Andrew's Hospital (Northampton) authorities have some second-hand electric lighting plant for sale, particulars of which are set out in an advertisement. Applications to secretary.

Mr. Thomas Johnson, Prescot-street, Wigan, has some electric lighting plant for sale, particulars of which are set out in an advertisement in another column.

For Disposal.—There is advertised elsewhere for disposal a private telephone wire with rights of way extending from the west to the north-west of London.

Jandus Arc Lamp—Messrs. Drake and Gorham inform us that during last year, in addition to the ordinary sales, several large installations of Jandus lamps were erected, including the Bon Marché, Brixton (250 lamps); John Barnes and Co., Hampstead; Matthew Rose and Son, Hackney; Gardiner and Co.'s branches at Woolwich and Clapham Junction; and the lighting of Burlington-arcade, Piccadilly, London. Large installations now in hand include the lighting of the Mazawattee Tea Co.'s factory with 180 lamps, and a similar number for a large shipbuilding firm. Considerable success has been obtained with Jandus lamps on high voltage circuits, and they are used four and five in series for street lighting at Chester, Shrewsbury, Darwen, and will also be installed at Fleetwood and Epsom. The Jandus Co. have recently introduced a new pattern lamp for power circuit and street lighting service, with automatic cut-out and resistances self-contained. Some 40 of these lamps are in satisfactory operation on the City and South London Railway, burning direct off the power circuit. Several improvements have been made in the standard pattern lamps, notably in the direction of long burning hours, and the Jandus lamp is claimed to be now far ahead of its competitors in this respect. Messrs. Drake and Gorham are now putting on the market the new Jandus spherical globe lamp, which has been designed to meet the demand for an efficient and serviceable lamp at a lower price than the standard Jandus pattern. They also hope shortly to announce the issue of the Jandus alternating lamp, the preliminary trials of which have proved satisfactory.

Hart Accumulators.—A tastefully-designed hanging show card of the Hart Accumulator, showing a grid section and the company's patent non-corrosive terminal, is sent out by the Hart Accumulator Co., and copies can be obtained by the trade on application to the works, Marshgate-lane, Stratford, E.

"Stellite" Fittings.—A comprehensive and well-illustrated list of "Stellite" electric fittings is now ready for the trade, and can be obtained of the British Electric Works Co. (Ltd.), Cheston-road, Aston, Birmingham. The list includes particulars and prices of the cable connector and terminal recently described in these columns.

"General" Electric Plant.—Circular No. 26 of the General Electric Co. (Ltd.) illustrates accessories for X-ray work, a new pattern focussing hand feed arc lamp, &c. The General Electric Co. are supplying free to the trade a useful foot-rule for the desk or draughtsman's table, containing a quantity of information often required at sight.

B.T.H Plant.—Q.B. (quick break) switches are described and illustrated in pamphlet No. 62 issued by the British Thomson-Houston Co.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 25 to May 1, with the ports of destination:—

Africa—Alexandria, £183 (including £45 telegraph material); Cape Town, £5,875 (including £4,100 telegraph material); Chinde, £54; Durban, £6,432 (including £5,946 telegraph plant); East London, £29. *Argentina*—Buenos Ayres, £30. *Australasia*—Adelaide, £61; Brisbane, £123; Melbourne, £1,131 (telegraph material); Sydney, £957; Wellington, £20. *Brazil*—Rio Janeiro, £198 (telegraph apparatus). *Ceylon*—Colombo, £747 (including £724 telegraph cable). *Chili*—Boca, £425 (telegraph material). *China*—Shanghai, £323 (and 24 tons old telegraph wire); Tientsin, £118 (telegraph material). *Germany*—Hamburg, £135. *Holland*—Amsterdam, £280. *Hong Kong*, £51. *India*—Bombay, £55; Calcutta, £689; Madras, £39. *Japan*—Kobe, £91; Yokohama, £318. *Straits Settlements*—Penang, £103 (telegraph material); Singapore, £268 (including £107 telegraph material). *Sweden*—Gothenberg, £25. Total £18,765, against £10,076 for the corresponding week last year (April 26 to May 2).

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.).

The thirty-third ordinary general meeting of the members of this company was held at Winchester House, Old Broad-street, on Monday, under the presidency of J. HERBERT TRITTON, Esq.

The SECRETARY (Mr. L. Pagenkopf) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, and the declaration of the dividends therein set out, said: Gentlemen, since our last annual meeting, Sir William Brooke, formerly Director-General of Indian Telegraphs, has joined our Board, and his great experience in telegraph matters, particularly of Indian telegraphs, has already proved most helpful to us in our deliberations. The year as to which we are now presenting our report has brought before us an exceptional number of important questions. When last we met, some apprehension was expressed as to wireless telegraphy—apprehension reflected at that time in the falling prices of most telegraph companies' shares; but its commercial value has yet to be proved, and to-day it is not of much, if any, importance. A more important subject—namely, a reduction in telegraphic rates between this country and the East, has been widely agitated during the year, and great pressure is still being exercised in order to bring it about. Your Directors have no wish whatever to stand in the way of a reasonable reduction in the rate of 4s. per word at present in force, but we must bear in mind that in our case the approval and assent of the Governments interested is necessary for any measure of this sort. I am bound to say that it appears highly problematical to me that reduced rates between this country and India will be followed by any large increase of traffic. The conditions of Indian trade and enterprise are wholly different to those of young and growing European communities, stimulated to quite an extraordinary degree by discoveries of gold. Apart from a few great firms, the natives of India have no sort of relation with Europe, and will send no telegrams whether rates be low or high. Quite 90 per cent of our traffic is in code, and the cost per word—per plain word—must be a very few pence. In fact, taking minimum distances into consideration and the risks involved, whether to land lines or cables, the tariff at present seems to us by no means excessive. But we recognise certain anomalies, and, as I have said, we will not stand in the way, provided the Governments, and especially our own concessionary Governments, do not object. The report has already informed you of the gratifying intelligence that, after negociations extending over a very considerable period, our Russian and Persian concessions have both been renewed for a further period of 20 years from 1905—thanks to the benevolent consideration given to the question by these Governments, and—may I add—to the persevering efforts of the company. The working of the line through Russia will remain in our hands, as at present, but, in accordance with the terms of the original concession, the ownership of the line will from the date named vest in the Russian Government. Our tolls have been increased, and a minimum annual payment insisted upon. Though the bargain is a somewhat hard one, we are gratified at its conclusion. As regards the German concession,—the only remaining one—the preliminaries for an extension to the same term have been settled with the Imperial German Telegraph Department, and the Directors have every confidence in anticipating the same benevolent consideration by the German Government itself. That you will consider, I am sure, a very satisfactory announcement. It means years of patient negotiation successfully accomplished. The working of the year has resulted in a somewhat better balance of profit than the preceding year, the receipts having been increased by £7,700 and the expenditure remaining practically the same. A duplicate cable has been laid in the Straits of Kertch, and we have in prospect the necessity of considerably strengthening other sections also, with a view of still further avoiding interruptions to the working from climatic and other difficulties. We have therefore thought it desirable to place to reserve a larger sum than before. The proprietors will have read in the report the announcement of the retirement of Mr. W. S. Andrews from the post of managing director, so successfully filled by him for so long a period. We are glad to say that he will continue to sit on the Board as an ordinary director, and we shall thus have the benefit of his great experience and knowledge. The Board propose, subject to your approval, to grant him a retiring pension of £1,200 per annum, which is practically on the Government scale, and we doubt not you will do this with unanimity. Mr. T. W. Stratford-Andrews, who has been thoroughly trained in electrical and engineering works and administrative business, and who is acquainted with every section of our line, as well as the commercial work of the company, will take his place as managing director. Two members of the staff also have been accorded pensions—Mr. Moll, late secretary, and Mr. Nelson, lately our representative in

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Teheran, both of whom also have served us from the commencement. In all cases, though the vacancies have been refilled, the totals paid in salaries show reduction; and the pensions are, of course, conditional on the continuance of the concessions. It may be that we shall submit to you a general scheme for pensions at our next annual meeting. We have one in contemplation. Another matter which I may perhaps mention to you is the following letter from the General Post Office, dated April 12, which was received by the managing director a few days ago, and which speaks for itself: "I am directed by the Postmaster-General to acknowledge the receipt of your letter of yesterday's date respecting the reduction in the rate for soldiers' and sailors' telegrams between Australia and South Africa, and to request that you will be so good as to convey to your Directors his warmest thanks for their approval of the arrangement suggested in the letter from this Department on the 9th inst." That is, that soldiers' and sailors' telegrams between Australia and South Africa are conveyed at half rates—2s. per word instead of 4s. A telegram has just been placed in my hands relating to an arrangement which we have made—as before—to supply the Shah of Persia with telegraphic messages at any time during his tour in Europe, which has now commenced, and which I am sure his Imperial Majesty will appreciate. In conclusion, we are glad to be able to inform you that the cordial relations which have always existed between this company and its concessionary Governments continue and we have every reason to hope will continue. I have now much pleasure in moving the resolution.

Mr. C. HOLLAND seconded the motion, which was carried unanimously.

The following resolution was then carried unanimously—

"*Resolved that a pension or allowance of £1,200 per annum from the 1st of Jan. last be paid to Mr. W. S. Andrews during his life, or until the further prosecution of the undertaking of the company shall be rendered impracticable by the action of any of the Governments by which the concessions under which the undertaking is now worked have been granted; the arrangement, however, to be subject to revision in case the dividend payable by the company shall fall below 5 per cent.*"

Mr. W. S. ANDREWS: Mr. Chairman and gentlemen, I am very much indebted to you for this resolution. The Chairman has expressed himself eloquently—perhaps rather too favourably—respecting the services I have been able to render to the company; but I may say of those services that they have been so largely facilitated, and so much backed up, by the aid of the Directors, that they are as much responsible as I am for the present well-being and prosperity of the company. It is a prosperous concern, and I am pleased to say that we have all of us—and I am a shareholder myself—done very well indeed. I beg to thank you most warmly for your kindness.

The re-election of Mr. W. S. Andrews and Mr. John von Berenberg Gossler, the retiring Directors, was then approved, and the auditors, Messrs. Kemp, Sons and Co., were re-appointed. A cordial vote of thanks to the chairman, directors, and officials of the company terminated the proceedings.

Cuba Submarine Telegraph Co. (Ltd.).

The report of the directors of this company for the half-year to Dec. 31 announces that the total receipts amount to £19,512. 18s. 6d., and the gross expenditure to £6,192. 2s. 3d., leaving £13,320. 16s. 3d., which, added to £4,582. 7s. 6d. brought forward, leaves £17,903. 3s. 9d. at credit of revenue account. The traffic receipts show a considerable falling off compared with the corresponding period of last year, due principally to the reductions in rates and the competition of the Government land lines in the island of Cuba. £4,937. 16s. 6d. has been added to reserve, which, after deducting £2,937. 16s. 6d. for cable repairs, now stands at £130,000.

The preference dividend will absorb £3,000, and leave £9,965. 7s. 3d., out of which the directors recommend the payment of a dividend at the rate of 6 per cent. per annum on the ordinary shares (free of tax), the balance (£5,165. 7s. 3d.) being carried forward.

Since the last report the Cape Cruz-Manzanillo cable has been repaired, and the cables have remained in good working order, with the exception of the broken Cienfuegos-Cape Cruz cable, which has been abandoned, as the efforts to repair it had to be given up in consequence of its decayed condition. The section is still duplicated by the coast cables, and for the present it is not proposed to replace this cable.

The Foreign Office is continuing its negotiations with the United States of America concerning this company's concessions, payment of subsidy and claims for damage done to the cables during the Spanish-American war. Mr. Keith and Mr. Scott have lately visited America in connection with these negotiations, the settlement of which is still pending.

Great Northern Telegraph Co. (Ltd.).

The annual meeting of this company was held at Copenhagen on April 28.

The chairman and managing director, Comm. E. SUENSON, D.R.N., in rendering an account of the working of the company, said that during the first half of 1899 the condition of their cables was most satisfactory, whilst, in the latter half, numerous interruptions occurred, especially in Europe. Twenty interruptions had affected eleven of the European cables, and in the Far East there had been nine interruptions of six cables. The number of interruptions compared favourably with that of the preceding year. The cable steamer "H. C. Örsted" had been employed on active service for 134 days, and the "Store Nordiske" for 87 days, of which 25 were for the account of others. The efforts of the Imperial Russian Administration to improve the Wladiwostock line had commenced to bear fruit, and although there was still room for improvement, the number of telegrams forwarded showed an appreciable increase. On the expiry of their Danish concessions for the establishment and working of cables connecting Denmark with Norway, Great Britain and Russia, the Danish Government extended the same with certain modifications, the former to Jan. 1, 1911, and the latter to Dec. 31, 1912. At the meeting of the International Meteorological Committee at St. Petersburg in September last, the project for a submarine cable to connect Iceland with the telegraphic system of the world was again favourably received, the Committee, by a special resolution, urging the Danish Government to continue their efforts for the realisation of the project. The Danish Government were less successful in their endeavours to induce the Peace Congress, assembled at the Hague in May and June last, to deal with the question of the legal status of submarine cables in time of war. In the Far East the company had obtained an extension till 1911 of the privileges previously granted them by the Chinese Government, and the China traffic had attained the same level as during the preceding year, whilst the Japan traffic showed an increase. If this satisfactory state of affairs was maintained during the present year, there would possibly be occasion to take up the question of a further revision of rates for telegrams to the Far East, at the International Telegraph Conference to be held in London next year. The excellent results of the year enabled them to pay the same extra dividend as last year—viz., 7½ per cent. (making 12½ per cent. for the year), and at the same time to increase the reserve and renewal fund by a substantial amount. The political events of the past year had more than ever emphasised the important part played by the great telegraphic highways in the political, commercial, and social development of the world. In addition to the old English and American schemes, whose principal object was the establishment of national and independent submarine lines in the Pacific, other schemes and projects with similar aims had sprung up in other parts of the globe. As yet it was difficult to disentangle the numerous ideas and projects, and to foretell the issue, but they confidently hoped that, thanks to the political passivity and neutrality of the nation to which they belonged, and to the admitted discretion and impartiality of its service, the company would continue to enjoy the confidence of all the Governments and administrations whose territories its cables had connected for 30 years. Nevertheless, it was more than ever necessary to prepare for any contingency which might arise from the present complications, by continuing the cautious financial policy which they had followed till now.

The report and accounts were then adopted.

Western Telegraph Co. (Ltd.).

The report of the directors of this company for the half-year to Dec. 31 states that the revenue amounted to £139,596. 7s. 10d., and the working expenses to £25,596. 0s. 11d. After providing £3,200 for debenture interest and sinking fund, and £1,516. 6s. 4d. for income tax, there remains £109,284. 0s. 7d.; to this is added £5,062. 16s. 3d. brought forward, making £114,346. 16s. 10d. Further expenses consequent upon carrying out the arrangements for closer working union with the Western and Brazilian and the London Platino-Brazilian Telegraph companies amounted to £176. 17s. 4d. First and second interim dividends amounting to £62,379 have been paid, and £45,000 transferred to reserve, leaving £6,790. 19s. 6d. to be carried to next account.

In accordance with the terms of the trust deed the first quinquennial examination of the staff pension and superannuation funds has recently been made, with the result that the funds are reported by the actuary to be in a satisfactory condition; they do not, however, admit of the retiring age being reduced from 60 to 55 years, which experience proves would be most desirable. The actuary advises that in order to bring about this change the contributions by the staff and the company to the pension fund would have to be increased from 2½ per cent. to 4 per cent. respectively. It is believed that the staff will readily agree to assume this additional liability, and a resolution will be submitted to the forthcoming meeting of shareholders authorising the directors to increase the company's contribution from Jan. 1, 1900, to 4 per cent., and to provide a sum sufficient to enable the trustees to pay the pensions which have already been purchased to Dec. 31, 1899, at the age of 55 instead of 60 years, the company guaranteeing to make up the loss (if any) that there might be in the fund on account of such reduction.

Submarine Cables Trust.

The report of the trustees states that the revenue for the year to April 15, 1900, including £81. 11s. 9d. from previous accounts, amounted to £24,870. 7s. The expenses amounted to £1,269. 7s. 1d., and the payment of coupons to £20,286, together £21,555. 7s. 1d., leaving £3,314. 19s. 11d. In accordance with the terms of the trust deed, 27 certificates have been drawn by lot for redemption at £120 per certificate, absorbing £3,240, and leaving £74. 19s. 11d. to be carried forward. The Commercial Cable Co. having offered to its shareholders a proportion of new shares, amounting to one-third of their existing holdings, at par, the trustees unanimously agreed to accept the offer on behalf of the Trust, and at the same time to sell £1,200 Anglo-American Telegraph Co.'s preferred stock to meet the cost. A small balance remaining has been invested in the purchase of £15 Eastern Telegraph Co.'s ordinary stock. At an extraordinary general meeting of the certificate holders on July 28 last, Mr. Clement Sneyd Colvin, C.S.I., was appointed a trustee.

Calcutta Electric Supply Corporation (Ltd.).

The directors' report for the year to Dec. 31 states that the supply of electrical energy commenced on April 17, 1899, and at Dec. 31 there were connected to the company's mains the equivalent of 9,463 8 c.p. lamps, of which 8,170 were for lighting and 1,293 for power. 54,897 units were sold (42,947 for lighting and 14,859 for power), and the gross revenue was

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£2,041. 12s. 2d., while the costs, after charging management and administration expenses to revenue, amounted to £1,389. 16s. 5d., leaving a net profit of £651. 15s. 9d., which it is proposed to carry forward. Applications in considerable numbers continue to come in from new customers, and the few wiring contractors in Calcutta are kept well employed. Landlords, both European and native, show a willingness to pay for the electric wiring required by their tenants. It is reported that the design of the whole station and mains is good, and that the supply of electricity has given general satisfaction.

At the time of the formation of the company it was not estimated that any important revenue would be derived from the supply of current for motors, but the use of fans driven by electric power in place of punkahs has become quite popular. It is reported that 2,000 are supplied or on order for use during the hot weather, and the fact that a large proportion will be running during the 24 hours for at least eight months of the year indicates that the employment of electric fans will probably form a large and lucrative source of revenue to the company.

The Government of India is desirous of passing a general Electric Lighting Act for the whole of India, to supersede the present Calcutta Electric Lighting Act, and Messrs. Crompton and Co. have, with the assistance of the directors of this company, prepared a draft of the proposed new Act, which is now under consideration. The difficulties in connection with the extension of the company's licence to the period of 42 years have been removed, and the Government of Bengal have agreed to the renewal, and also to the addition to the original area of large districts to the south of Calcutta, including the Alipore and Ballygunge suburbs. Additional mains have been laid in many of the streets in Calcutta beyond those comprised in the original contract; many more will soon be required, and further considerable capital expenditure will have to be incurred for the supply to the new districts. The directors therefore propose that the nominal capital of the company be increased to £200,000 by the creation of 20,000 additional shares of £5 each.

There are many other towns in India where electricity may, no doubt, be profitably employed, and the directors are in negotiation for the necessary powers to supply some of these places. Should these negotiations prove successful, the shareholders will be called together to consider, and, if approved, to sanction these schemes and to provide the capital required.

CORK ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)—The report of the directors of this company, for the year 1899, states that the result of the year's working shows: Receipts, £26,909. 19s. 7d.; working expenses, £15,367. 14s. 10d.; profit, £11,542. 4s. 9d.; balance forward, £55. 12. 8d.; total, £11,597. 17s. 5d. Interest on debentures has required £2,152; interest on loans, £1,112. 10s. 11d.; bad debts (lighting), £37. 6s. 9d.; proportion of preliminary expenses written off, £213. 6s. 9d.; total, £3,515. 4s. 5d.; leaving £8,082. 13s., and the directors recommend the following dividends: 5 per cent. on cumulative preference shares (£2,823), and 5 per cent. on ordinary shares (£3,303. 16s. 9d.). A large portion of the capital expenditure appertaining to the lighting and a certain portion to the tramways were not of earning capacity during 1899, and the directors therefore regard the results of the first year's operations as satisfactory. £1,758. 8s. 7d. has been carried to reserve and depreciation. The balance of 7,000 ordinary and 7,000 cumulative preference shares, and 548 4 per cent. debentures of £100 each have been issued. The nominal capital of the company has recently been increased to £200,000, in 10,000 ordinary and 10,000 5 per cent. cumulative preference shares of £10 each. An extension of the tramways to Ballintemple was opened in July last for public traffic. It has been found necessary to purchase ten additional motor cars and to extend the car depot. The lighting plant has been considerably increased, and the necessary extensions to the power house carried out. The provisional order for lighting has been acquired from the Queenstown Commissioners, and the work is in course of execution. The supply of current for private lighting has recently been commenced at Queenstown. A contract has been concluded with the Cork Corporation for public lighting, and arrangements are completed for public lighting in Queenstown on similar terms to those of Cork. The company is promoting a bill in Parliament for the extension of the tramways from Ballintemple to Blackrock, and an order in Council has been issued authorising an extension of the line along the Western-road. At the meeting of the company on Tuesday the directors' report was adopted.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)—The directors' report for the year ended Dec. 31 last, states that the debenture stock has been increased from £60,000 to £75,000, and the increase of the loan to the Metall Co. to £73,190, and that the preference shares issued have been increased to £50,000. The dividend of 3s. per share paid to the preference shareholders on May 1, 1899, absorbed £3,348, and debenture interest £5,501. The patent charges are heavier than usual, owing to the cost of working the company's patents in Austria and Hungary, and to charges in connection with the patents for an improvement in steam pipe-joints (invented by Mr. Preschlin, manager of the Schladern Works), which has been taken up by the company. The sales and gross profits of the Metall Co. show a considerable increase compared with the previous year, the profit on trading account being £18,209, against £13,749. The directors report that the past year was one of considerable difficulty owing to the phenomenal rise in the price of copper, and to the scarcity and consequent high price of coal. Owing to the prosperous state of trade in Germany, difficulty was experienced in obtaining labour. The increase in the price of copper not only restricted the placing of orders, but in the case of contracts, which the company had with a large shipyard and the railways, caused actual loss. The rise was also responsible for an increase of £10,000 additional working capital, which the directors had to raise, entailing an increase in debenture interest. The largely-increased demand for the company's manufactures has necessitated considerable extensions to both plant and buildings. After setting aside the usual reserve, the directors of the Metall Co. have declared a dividend equal to 120,000 marks, or £5,853, from which has to be deducted the charges of the Austrian Co. for the past year (£4,133). From the balance the directors recommend the payment of a dividend of 3¾ per cent., or 1s. 6d. per share, less tax, to the preference shareholders. The one-tenth of the net profit due to the ordinary shareholders not being sufficiently large is added to the amount already standing to their credit.

NEW COMPANIES, STATUTORY RETURNS, &c.

ADELAIDE ELECTRIC TRAMWAYS (LTD.)—This company was registered on April 12, with a capital of £3,000, in £1 shares, to carry on the business of electrical and general engineers, tramway and railway proprietors, accumulator and dynamo manufacturers, electricians, &c. The subscribers are J. A. Kelman, D. Sluter, H. Yuill, D. E. Kelman, C. S. Kelman, S. Gibbs, and G. C. Eedes.

BANBURY AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—This company was registered on April 24, with a capital of £25,000, in £10 shares, to carry on the business of electrical engineers, electricians, tramway and light railway proprietors, suppliers of electricity for light, heat, and power, manufacturers of electrical apparatus, &c. The subscribers are W. L. Magden (electrical engineer), E. Hopwood, C. Walmsley, J. Renwick, M. E. Sheerboom, J. S. Raworth (civil engineer), and G. J. Tindall.

COMPRESSING MACHINERY CO. (LTD.)—This company was registered on April 23, with a capital of £10,000 in £1 shares, to carry on the business of mechanical, electrical, and general engineers, leather waste merchants, &c.

COUNTY OF KENT ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—This company was registered on April 24, with a capital of £25,000, in £10 shares. The objects, subscribers, office, and particulars are the same as in the Banbury and District Electric Supply Co.

COUNTY OF NORTHAMPTON ELECTRIC POWER AND TRACTION CO. (LTD.)—This company was registered on April 24, with a capital of £25,000, in £10 shares. The objects, subscribers, office, and particulars are the same as in the Banbury and District Electric Supply Co.

COWPER INVENTIONS DEVELOPMENT CO. (LTD.)—This company was registered on April 24, with a capital of £50,000, in £1 shares, to adopt an agreement with Mr. S. Cowper-Cowles, and to carry on the business of electrical and general engineers, engineers, machinists, tool makers, &c.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—This company was registered on April 25, with a capital of £350,000, in £1 shares, to acquire certain licenses and powers from Marconi's Wireless Telegraph Co. (Ltd.), to carry on the business of electrical and general engineers, and to manufacture and deal in wires, cables, telegraphic apparatus, &c. The subscribers are Major S. Flood Page, H. S. Saunders, H. H. Allen, P. H. Stewart, F. S. Tomkins, J. McGowan, and W. H. Benham. The first directors are M. Balser, Col. Thys, M. Travailleur, M. de Volder, J. F. G. Bannatyne, G. Marconi, A. Ochs, Major S. Flood Page, H. S. Saunders, and Sir C. Euan-Smith. Marconi's Wireless Telegraph Co. (Ltd.) may appoint three directors.

NATIONAL CONSTRUCTION CO. (LTD.)—This company was registered on April 28, with a capital of £10,000, in £1 shares, to carry on in London the business of electrical engineers, manufacturers of conduits, cables, wires, lines, accumulators, &c., for electrical and other purposes, suppliers of electricity for light, heat, or power, &c. The first directors are H. R. Gamble, E. S. Perrot, G. J. Jackson, and F. W. Abbot.

RAILWAY AND GENERAL ENGINEERING CO. (LTD.)—This company was registered on April 25, with a capital of £80,000 in £1 shares, to carry on the business of dynamo makers, engineers, tool makers, &c.

ROBERT ROGER AND CO. (LTD.)—This company was registered on April 24, with a capital of £30,000, in £1 shares, to acquire the business now carried on under the style of Robert Roger and Co., and to carry on the business of electricians, engineers, founders, &c.

ROYLES (LTD.)—This company was registered on April 25, with a capital of £150,000 in £1 shares, to acquire the business carried on by Mr. J. J. Royle, and to carry on the business of iron and brass founders, mechanical and electrical engineers, tool makers, &c.

SOUTH SHIELDS ENGINEERING CO. (LTD.)—This company was registered on April 28, with a capital of £2,000, in £1 shares, to carry on the business of electricians, electrical engineers, suppliers of electricity, manufacturers of electrical apparatus, &c. The subscribers are T. W. Ogilvy (electrical engineer), C. R. Toomer (engineer), J. T. Atkin, A. Purvis, A. P. Stainton, C. Macdonald, and F. McKenna (engineer).

THAMES VALLEY ELECTRIC SUPPLY CO. (LTD.)—This company was registered on April 24, with a capital of £25,000, in £10 shares. The objects, subscribers, office, and particulars are the same as in the Banbury and District Electric Supply Co.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 5/16d. per oz. (May 3). Consols (2¾ per cent.) 100⅜—100½ for money, 100⅞—100¾ for account; 2½ per cent. 97⅛—98⅛ (May 3). Stock Exchange Settling Day: Consols, May 4; Stocks and Shares Continuation Days, May 14 and 29; Ticket Days, May 15 and 30; Pay Days, May 16 and 31; Mining Share Carry-over Days, May 11 and 28.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—A list of the numbers of 140 £100 sterling 4 per cent. mortgage debenture bonds of this company,

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which have been drawn for payment on July 2 at Parr's Bank, Bartholomew-lane, is given in an advertisement in another column.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—Coupons for 1899 (No. 48) of this company's shares should be presented for payment at Messrs. C. J. Hambro and Sons, 70, Old Broad-street, London, E.C.

HAMPSTEAD ELECTRIC SUPPLY CO. (LTD.)—The report of the directors for the first year has been issued. No dividend is declared on either the ordinary or preference shares.

LONDON PLATINO-BRAZILIAN TELEGRAPH CO. (LTD.)—Notice is given that the twenty-second ordinary general meeting of this company will be held at Winchester House, London, E.C., on Tuesday, May 8, at noon. The register of members and transfer books is closed from May 1 to 8 inclusive.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—Subscriptions are invited to an issue of £125,000 4½ per cent. debenture stock of this company at 105 per cent.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has ordered the $3,333,300 additional capital stock of the *Commercial Cable Co.* to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to the further issue of 30,000 £5 ordinary shares and 30,000 £5 6 per cent. cumulative preference shares of the *British Insulated Wire Co. (Ltd.)*, and to allow the £10 shares of the *Cape Electric Tramways (Ltd.)* to be quoted in the official list.

SUBMARINE CABLES TRUST.—The list will be found in another column of 27 certificates of this Trust which were drawn for payment by Messrs. Glyn, Mills and Co., 67, Lombard-street, London, E.C., on and after April 27.

UNION ELEKTRICITATS GESELLSCHAFT (BERLIN).—This company, which has a share capital of 24,000,000 marks (£1,200,000), proposes to issue debentures to the extent of 10,000,000 marks for the expansion of the business.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31 announces that the gross income for the year 1899 was £28,347. 9s. 8d., against £25,080. 1s. 4d. in 1898, and the working expenses £21,065. 0s. 4d., compared with £18,840. 15s. 1d. After providing interest on the 4 per cent. debentures (£6,000) and on the 4 per cent. income bonds (£800), the net balance of profit was £482. 9s. 4d., and with £273. 16s. 1d. brought forward there remains £756. 5s. 5d., out of which the directors have appropriated £500 in reduction of the expenses of reconstruction, leaving £256. 5s. 5d. to be carried forward. During the year there was a general improvement in trade on the West Coast, and the rate of the Valparaiso exchange on London rose to 16d. The company's cables, land lines, and the repairing steamer have been kept in a state of efficiency.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Apl. 28	4,195	+ 176	17	68,964	+ 3,652
Blackpool Corporation...	„ 26	352	+ 143	4	1,623	+ 434
Blackpool and Fleetwood	„ 28	393	+ 100	17	3,919	− 22
Bradford Corporation...	„ 29	397	+ 67	4	1,855	+ 433
Brisbane Trams	Mar.14	1,943	+ 653	21	48,927	+14,933
*Bristol Trams & Carriage	Apl. 27	3,021	− 42	17	46,039	+ 1,850
*Buenos Ayres & Belgrano	„ 1	1,287	- 1,079	13	29,330	+ 4,252
City & South London Ry.	„ 29	1,274	+ 242	17	20,962	+ 2,640
Dover Corporation	„ 28	166	+ 8	4	784	+ 50
Dublin United	„ 27	4,139	+1,388	17	54,231	+11,573
Dublin Southern Dist....	„ 27	1,176	+ 468	17	13,265	
*Glasgow Corporation ...	„ 28	8,951	+ 213	...	...	...
*Liverpool Corporation...	„ 21	8,365	+2,165	16	109,691	+14,581
Liverpool Overhead Rly.	„ 29	1,433	+ 25	17	23,903	+ 1,040
*Sheffield Tramways	„ 29	2,105	+ 839	17	32,231	+10,752
*South Staffs. Trams.....	„ 27	651	− 6	17	10,894	+ 427

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, April 25.	Price Wednesday, May 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 2. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,000	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July	...	...
25,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£322,720	Stock	15/0	Anglo-American	62 66	62 65	5 12 8	Feb., May, Aug., Nov	63	...
£3,062,240	Stock	30/0	Do. Preferred	115 116	114½ 115½	5 4 4	„ „	115⅞	115
£3,062,240	Stock	27/0	Do. Deferred	14½ 14¾	11½ 14¼	9 3 5	...	14¼	...
$10,000,000	$100	$1¼	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	103 104	3 17 0	„ „	103⅛	103
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,600	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11¾ 12¼	11¾ 12¼	5 14 3	Jan., Apr., July, Oct.	12⅛	11¾
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100 103	101 103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	150 155	4 10 4	Jan., Apr., July, Oct.	153⅞	151½
£1,926,988	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	101	98¼
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) ...xd	115 120	114 119	3 7 3	May and November	...	...
250,000	10	6/6	Eastern Extension ..... xd & bonus	16 16½	15¾ 16½	4 6 2	Jan., Apr., July, Oct	16¼	15⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115 120	115 120	3 6 8	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.) ...	100 103	100 103	4 17 1	January and July	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) xd	101⅞ 104⅞	103⅞ 103⅞	3 17 8	May and November	...	...
180,227	10	2/6	Globe Telegraph and Trust ..... xd	11⅛ 12	11¼ 11⅝	4 9 4	Jan., Apr., July, Oct.	11⅜	...
180,042	10	3/0	Do. 6 per Cent. Preference ..... xd	15⅝ 16	15¾ 15⅞	3 16 2	„ „	15⅝	15⅜
150,000	10	15/0	Great Northern of Copenhagen.....ex coupon 48	31 35	32 34	3 13 6	January and July	...	...
£96,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) ...	100 103	100 103	4 8 0	...	...	...
17,000	25	12/6	Indo-European	54 58	54 58	4 6 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 103	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	...	...
3,381	$100 Cert.	6%	Submarine Cables Trust	12½ 12⅞	12½ 12⅞	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 14 7	January and July	...	...
88,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9¾	9½ 9¾	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£50,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July	104	...
£389,781	8 ock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100 104	100 104	3 16 11	June and December	...	...
207,930	10	2/0	Western Telegraph (late Brazilian Submarine)	14½ 15	14½ 15	4 13 4	Mar., June, Oct., Dec.	14⅝	14½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105 108	105 108	4 13 10	June and December	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	3½ 3¾	4 5 9	August	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	...	...	...
400,000	5	3/0	National	5 5½	4⅝ 5¼	5 17 1	February and August	5⅛	4⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14 15	13 15	4 0 0	„ „	14¼	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14 15	13 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛ 5⅜	5⅛ 5⅜	4 13 0	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December	98⅛	98
171,504	1	0/8	Oriental	¾ 1	¾ 1	5 0 0	April and October	1	...
58,000	5	2/6	United River Plate	4¾ 5⅛	4¾ 5⅛	7 2 10	July	...	...
16,638	5	1/4	Do. 5% Cumulative Preference	4¾ 5⅛	4¾ 5⅛	4 15 3	June and December	...	...
£179,917	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, April 25.		Price Wednesday, May 2.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 2.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜	⅝	⅜	⅝	...	...	...	...
6,000	10	10'0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7	7½	7	7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9	10	9	10	4 10 0	February and August	9½	9½
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3	" "	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6½	7⅛	6½	7⅛	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108	111	108	111	4 2 2	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	9½	10½	9½	10½	3 16 2	February and August	10 1/8	9⅞
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 12 4	January and July	12	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	3 16 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅝	13⅜	12	13	4 12 4	March and September	13	13
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109	112	110	113	4 0 9	...	111⅞	111½
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7½	7	7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1½	2	1½	2	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½	4⅝	4½	4⅝	6 6 4	...	4 7/16	4½
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100	102	100	102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½	14⅛	13½	14⅛	3 9 0	April and October	14	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93	98	96	98	3 11 10	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½	7	6½	7	3 11 5	"	...	...
300,000	1	8%	Rand Electric	¾	⅞	¾	⅞	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	...	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	170	190	170	190	4 4 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103	105	104	107	4 4 1	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15½	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2¼	2¾	2	2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85	95	85	95	...	..	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	4½	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	4 3 10	March and September	15	14½
			ELECTRIC MANUFACTURING &c. COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾	⅞	13/16	15/16	6 8 4	...	...	...
85,000	1	...	British Electric Works Co. Ordinary	¾	1	13/16	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	15/16	15/16	15/16	15/16	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6	6½	6	6½	4 12 4	...	...	...
100,000	5	...	British Westinghouse 6% Preference	4⅝	5¼	4⅝	5¼	...	...	...	...
90,060	2	1/2⅝	Brush Electrical Engineering	1¾	2	1¾	2	4 0 0	September	...	...
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cum.	2	2¼	2	2¼	5 6 8	"	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108	113	108	113	3 19 8	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103	105	103	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½	15½	14½	15½	4 16 9	" "	15⅝	15
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112	116	112	116	3 18 5	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½	4	3½	4	4 10 9	January and July	3 11/16	3⅝
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	102	99	102	4 19 3	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½	4⅛	3½	4⅛	6 13 4	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
28,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4½	5	4½	5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101	104	101	104	...	...	...	...
112,100	2	1/2⅝	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 16 0	January and July	2⅛	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛	3⅛	2⅛	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	106	103	105	3 16 2	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜	⅝	...	...	...	...	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½	14½	13½	14½	3 15 10	February and August	14½	13¾
30,000	5	1/3	Do. 4½ per Cent. Preference	5¼	5⅜	5¼	5⅜	3 18 3	" "	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 18 11	" "	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	" "	2 5/8	21½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	103	103	103	3 17 6	March and September	100⅜	102
37,350	12	24/0	Telegraph Construction and Maintenance	35	39	35	39	4 12 4	March and July	37	35½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	10	11	10	11	3 3 7	...	10 5/16	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	12	13	11½	12½	4 16 0	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference ....xd	7½	7¾	7	7⅜	4 0 7	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
12,000	10	10/0	Blackpool and Fleetwood Tramways	17	18	17	18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102	104	102	104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½	23½	22½	23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£8 paid)	8¼	8½	8¼	8½	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 8 5	...	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10	10½	9¾	10¼	4 17 7	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17	18	16	17	3 10 7	...	17	15½
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16½	17½	16	17	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12⅞	13¼	12⅞	13¼	4 10 7	...	13 1/16	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	125⅜	125½
40,000	5	2/8 1/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref.....xd	5	5½	5	5½	5 14 4	...	5 7/16	...
27,500	5	...	Do. "B"	4	4⅜	4	4⅜	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105	108	104	107	4 14 10	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk Prov. Certs (£57½% to be p l.).	37	40	37	40	...	...	...	...
208,940	10	3/0	Central London Ordinary	10½	10⅝	10	10½	2 17 2	June and December	10⅝	...
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	67	70	67	70	2 13 11	January and July	68	68
37,500	10	1/5 1/10	Do. (Nos. 22,501 to 60,000) .....xd	6	7	6	7	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	January and July	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½	23½	22½	23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14¾	15¼	14¾	15¼	3 17 5	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
75,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	...	...	7/16	9/16	...	...	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	...	...	7/16	9/16	...	...	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9½	10½	9⅜	10⅜	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅞	8⅞	8 13/16	8 15/16	4 4 1	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼	13½	13¼	13½	3 14 1	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	2 15 6	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾	4¼	3¾	4¼	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5¼	5½	5¼	5½	5 4 4	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅝	10⅞	10⅝	10⅞	4 13 0	" "	...	...
13,384	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9⅝	10⅜	4 15 3	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100	103	100	103	2 18 8	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,147. [No. 3. Vol. XLV.] FRIDAY, MAY 11, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 32fr., or 70pf.

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NOTES.

The wag who said that single misfortunes never come alone, being a member of Parliament, might also have observed that the same peculiarity attaches to electrical bills. It never rains them but it pours them. Rarely have the Committee rooms of the Houses of Parliament been so much the resort of electrical engineering experts as they have been during the past week and are likely to be for some time to come. Besides the five power bills before the Select Committee presided over by Sir James Kitson, and the bill of the same nature for the North Metropolitan Electric Power Supply, to be heard by another Committee, there are a large number of electric railway and tramway bills. Probably the most interesting of these, from the point of view of the general electrical public, is that relating to the proposed express railway between Manchester and Liverpool. The railway presents many novel features: it is to be constructed on the Lartigue mono-rail system, its cars are to run at 110 miles an hour, it is largely to be an overhead line, and is to hav only the two stations. Vigorous opposition to this bill is being raised by several large railway companies, by the Mersey Docks and Harbour Board, and of course by local authorities. Altogether there are no less than thirty electrical bills which have either just passed, or are now passing through, the Committee stage of their more or less precarious existence.

Work for electrical experts has also been provided by the two legal cases reported in this issue, which afford excellent lessons in patent law, and both of which involve directly and indirectly interests affecting a considerable section of the electrical industry. The one case, that of "Chamberlain and Hookham *v.* the Bradford Corporation," raises the important question whether the Thomson meter when employed on so-called constant-pressure mains is an infringement of the Hookham meter patent, but as this case is still undecided we can offer no comment on it at this stage. We will call our readers' attention, however, to the abstracts of patents, &c., given as an appendix to our report of the case in another column with a view to enable the evidence to be easily read and properly appreciated.

The Jandus—Johnson & Phillips case is interesting, but in a way disappointing. We do not refer to the judgment, which could hardly have been otherwise on the evidence, but to the tantalising fact that, although aspersions were cast on the validity of the master patents covering the enclosed arc lamp, no decision could be given on this point. The defendant in the case, being a licencee under the patents, could not contest their validity, and was liable to pay royalties to their owners whether the patents are valid or not if it could be proved—as was done—that he manufactured a lamp corresponding to the description in the patents. If on a future occasion the validity of the patents owned by the Jandus Co. is to be contested, a large portion of the same evidence will have to be gone through again.

On Wednesday evening, Fellows of the Royal Society once again enjoyed what is popularly termed their "black" conversazione, the black-coat sex being alone admitted. As usual, the proceedings were of a sombre character, while the number and interest of the exhibits was undoubtedly lower than usual. Electrical exhibits, moreover, were among the least rather than the most attractive, the greater number being decidedly commonplace in character. There were, of course, praiseworthy exceptions, notably Mr. A. P. Trotter's timely exhibit of models illustrating leakage from electric tramways. These consisted in surfaces constructed on three Cartesian axes, the vertical representing potentials distributed over the space adjacent to the tramway. Equipotential lines, found experimentally by Prof. W. G. Adams's method, were shown in black, and lines of current flow were drawn therefrom in red.

A rather obvious converse to De la Rive's experiment with a floating battery was shown by Prof. Silvanus Thompson—little floating magnets enclosed in glass tubes taking the

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place of the battery. An immersed hollow coil carrying an electric current provided a sub-aqueous magnetic field by which the vagaries of the magnets were determined. Mr. RICHARD KERR showed a clock controlled by Hertzian waves, the maximum distance at present over which this feat has been performed being about six miles. Lightning conductors from St. Paul's Cathedral were shown by Mr. K. HEDGES, and a compact but powerful influence machine constructed of twelve vulcanised plates, by Mr. WIMSHURST. Mr. P. E. SHAW exhibited the ingenious electric micrometer recently described before the Physical Society and referred to in *The Electrician*, Vol. XLIV., p. 805.

MR. GAINE'S statistics at the National Telephone Co.'s staff dinner last Friday showed that the competition in store for the company has not decreased the magnitude of its business. The company now owns 968 exchanges, representing upwards of 176,000 subscribers' telephones, which is one for every 214 of the population of the United Kingdom. During the year the net increase of subscribers has been 21,000, and 617 million messages have been sent (reckoned on the basis of one conversation = two messages). In view of the steps which are being taken by the Post Office and by certain municipalities, it would have been interesting to have heard how the advance in London itself, and, say, Glasgow, Manchester, and Huddersfield, compared with that of previous years, exclusive of other districts in which no more serious competition than hitherto has been announced. Mr. GAINE gave no indication of what the future policy of the company is to be with regard to the competition with its licensor, but he could not restrain himself from directing one poignant shaft towards this august Department. Every day delays of from half-an-hour to two hours in obtaining trunk connections were complained of owing to the insufficiency of trunk lines. If, said Mr. GAINE, the two millions which the Post Office has had voted for needless competition in London had been applied to improving the trunk service, it would have been spent to better advantage.

MUCH was said as to the complaints made by ignorant critics, and they were likened—hardly with justice—to the criticisms levelled at our generals in South Africa and at the War Office. Lord KELVIN attributed everything unsatisfactory to the unbusinesslike arrangements of the users, and placed a large proportion of the blame on the *genus* office boy. Yet there is no doubt that, whether we are better or worse off in that respect than other countries, many of the complaints made are justified; and, from what we know of the excellent efficiency of the system from an engineering point of view, we do not doubt that cases of negligence of the operating staff cannot be so infrequent as is desirable. This is no doubt inseparable from a huge business employing a staff of some 10,000 or 11,000, but we cannot but think that it would be minimised if more attention were given to the organisation of the complaints department. Cannot the subscribers themselves be taught to make their complaints in such a specific way that the cause of the deficiency can be arrived at in each case? With an organisation as complete as that of the National Telephone Co., a complaint made by a *calling* subscriber, giving the time and the details of his ineffective demand, should enable the company to trace the negligent operator. On the other hand, complaints by the *called* subscriber are, in consequence of the switching arrangements of every large telephone system, much more difficult, if not impossible, to trace, and they should be discouraged, the subscriber being asked to devote the maximum of businesslike method to the complaints of failures to obtain connections. By thus lessening the number of complaints to be sifted, and increasing the accuracy of each one, an amelioration in the service should result.

The Royal Society.—Among the Papers down for reading yesterday was "The Radio-Activity of Uranium," by Sir W. Crookes, F.R.S.

Electrical Standardizing, Testing and Training Institution.—Prof. C. A. Carus-Wilson will commence a special course of lectures upon "The Construction and Use of Motors" to the students of this institution on Monday, 28th inst.

Municipal Trading as a Financial Risk.—We note that the Epsom Urban District Council have been unable to raise a loan of £16,100 at 3½ per cent. for their proposed electricity works, with the result that they have decided to offer 3½ per cent.

An Automobile Race in America.—According to the *Electrical Review* of New York, a 50-mile automobile race took place recently in Long Island. There were in all nine entries, the winner proving to be an electric automobile, the only electric vehicle competing, which covered the whole distance in 2 hours 3·5 minutes.

Personal.—At a special meeting of the Council of the Society of Arts, held at Marlborough House, on Tuesday last, the Prince of Wales (president) presented the Albert medal of the Society to Sir W. Crookes, F.R.S., "for his extensive and laborious researches in chemistry and physics, researches which have in many instances developed into useful, practical applications in the arts and manufactures."

Institution of Electrical Engineers.—Before Mr. H. M. Sayers read his Paper at the meeting of the Institution on May 3, the President informed the members that the Council had, according to the Articles of Association, which allow of the election of one honorary member each year, elected Mr. J. W. Swan, F.R.S. (past president), as honorary member, and that Mr. Swan had kindly accepted his nomination.

The National Physical Laboratory.—In reply to a question in the House of Commons on Monday last, Mr. Akers-Douglas (the First Commissioner of Works) stated that the new National Physical Laboratory would be situated quite outside the Kew Gardens, on Crown lands. The building will be so placed as not to interfere with the views from the gardens of the Old Deer Park. It will be used only for delicate scientific work, which will not disturb the seclusion of the neighbourhood of the Queen's Cottage.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899	—
Cayenne—Pinhieros	Oct. 11, 1899	—
Tangier—Tarifa	Jan. 3, 1900	—
Paramaribo—Cayenne	Feb. 16, 1900	—
Ceara—Maranham	Feb. 20, 1900	—
Para—Maranham	Mar. 2, 1900	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900	—
Trinidad—Demerara	Mar. 30, 1900	May 8, 1900
Manila—Iloilo	April 9, 1900	—
St. Dominguez—Curaçao	May 6, 1900	—

American Storage Battery Decision.—The United States Circuit Court of Appeals for the First Circuit recently declared that the Hatch battery, owned by the Hatch Storage Battery Co., was "clearly an infringement" of the Brush patents, owned by the Electric Storage Battery Co. This decision secures to the latter company the monopoly in the United States, during the life of the patent, of batteries composed of "a plate or

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suitable support primarily coated or combined to a chemically-applied oxide of lead or equivalent lead compound," without which a commercial storage cell is impossible.

The German Atlantic Cable.—The laying of the shore end of the Borkum-Fayal section of the German Atlantic cable, and about 100 miles of a lighter type, was successfully accomplished by the cable-ship "Britannia," on the 4th and 5th inst. The cable steamer "Anglia" was to leave London yesterday for the purpose of joining up the shore end and proceeding direct to Horta-Fayal, so that the completion of the whole section may be expected before the end of the month. Congratulatory telegrams were exchanged between H.I.M. the Emperor of Germany and the Directors of the Company, Mr. O. Moll and Mr. C. W. Guilleaume.

Australasian Cable Position.—Reuter, under date May 4, announces that the Postmasters-General of New South Wales and Victoria have come to an agreement on the disputed points in the proposed agreement with the Eastern Extension Telegraph Co. The arrangement is made subject to the approval of the company and the ratification by the Victoria and New South Wales Parliaments, which will not meet for two months. Tariffs in the meantime will remain unaltered. The agreement now arrived at stipulates that the two Governments shall have the option of purchasing the Eastern Extension Co.'s cables. No other company is to be allowed to open offices in the colonies until after the refusal of the Eastern Extension Co. to do so.

New Water-Power Scheme in America.—According to the *American Electrician*, the Susquehanna Electric Power Co. is contemplating the erection of a power-house on the Susquehanna River, in Maryland, about three miles south of the Pennsylvania line, for the purpose of converting the power of the river into electrical energy. It is proposed to build a dam across the river above the Pennsylvania border line, and construct an embankment from this dam to the power house, where the available head will be 40ft. It is estimated that the normal flow of the river will give an output of 40,000 H.P., and that the development of the plant will cost $7,000,000. We understand that it is intended to transmit the power electrically to Baltimore and Philadelphia, where, the promoters assert, the cost will not exceed one-half of the amount paid for steam power in these cities.

Obituary.—We deeply regret to announce the death of Dr. Edmund Atkinson, F.R.S., on the 4th inst., after a very short illness. Dr. Atkinson was born at Lancaster in 1831, and was a student of Owen's College in the early days of that institution. He was for some time the assistant of Prof. Edward Frankland, after which he left to continue his studies on the Continent. On his return he became assistant to Sir Benjamin Brodie at Cheltenham College, and subsequently Professor of Experimental Science at the Royal Military College, Sandhurst, and at the Staff College. He was one of the founders of the Physical Society, of which he was treasurer until the last general meeting. He is, perhaps, best known to physical students by his able translations of Ganot's "Elements of Physics," Mascart and Joubert's "Electricity and Magnetism," and Von Helmholtz's "Popular Scientific Lectures."

Glasgow Section of the Institution of Electrical Engineers.—A meeting of the Glasgow Section was held in the Glasgow and West of Scotland Technical College on April 27, the Vice-President, Prof. Magnus McLean, in the chair. The chairman announced that, this being the annual business meeting, it devolved upon the members present to elect the office bearers for the ensuing session, and he stated that it was the unanimous opinion of the committee that with one exception the provisional office bearers (a list of whom appeared in *The Electrician*, Vol. XLIV., p. 470) should be elected *en bloc* for the next 12 months. The one exception mentioned was the case of the hon. secretary, whose duties had been so ably carried out up to the present by Prof. Watkinson, but who now found that he was unable to devote sufficient time to them; in his place, therefore, the committee proposed that Mr. E. George Tidd be elected, retaining Prof. Watkinson on the committee as an extra member. This resolution was duly approved. A letter from the president, Lord Kelvin, was then read, expressing regret that, owing to other pressing engagements, he would be unable to deliver his presidential address this session.

The Generating Machinery at the Paris Exhibition.—The daily papers contain accounts of an unfortunate *contretemps* in connection with the generating machinery at the Paris Exhibition. For the illumination of the grounds on Sunday, owing to the non-completion of a great part of the generating plant, put down for the exhibition itself, an auxiliary supply had to be obtained from outside firms, notably the Western Railway Co. The German firms who have supplied part of the generating plant within the Exhibition were, on Friday, reported to have refused to start their machinery, although it was practically complete, asserting that it would be dangerous for the machinery, on account of the dust and dirt from the building operations in other parts of the same section. It appears, however, that notwithstanding this, some at any rate of the German machinery was put into operation but that the bearings of one of the 1,500 H.P. sets siezed. A statement has been made that gravel was wilfully placed in a lubricator, which was closed by two special screws, and the police are, it is said, investigating the matter, suspecting that one of the workmen engaged is the culprit.

Destruction of a Large American Power Dam.—The *Western Electrician* of Chicago reports the destruction, on April 7th, of the large dam which was built across the Colorado River at Austin, Texas, and furnished power for the municipal waterworks, electric light, and power plant of that city. A few days of heavy rain had caused the rapid rise of the river, the flood bringing with it a large quantity of wreckage. This mass bore too heavily on the dam, and finally broke out a section in the centre 25ft. high, 500ft. wide, and 8ft. thick. Above the dam was Lake McDonald, 25 miles long, 60ft. deep, and covering an area of 2,000 acres. This great mass of water poured through the break, destroying the power house just below the dam, drowning seven employés, and then swept through the city and down the river. The flood caused great destruction to life and property in Austin and for 200 miles below the city; 48 persons are known to have been drowned and seven missing, while more casualties are expected to be reported later. The damage to property is estimated at nearly £2,000,000. The dam which was wrecked was begun in 1890 and finished in 1893 at a cost, with the power house, of £290,000. It was built to take 15ft. of water over its crest. The total length of the dam, including bulkhead and headgate and a weir of 1,090ft., was 1,360ft. The width of base was 66ft. and the total height above the foundation was 68ft. The power house was equipped with turbines having a capacity of 5,000 H.P. Seven iron penstocks, each 9ft. in diameter, conveyed the water to the waterwheels. Four of these penstocks were used by the city for its electric light plant and waterworks, while the others were used by private manufacturers. As a result of the destruction of the dam and power house the city will probably be forced to remain without light and water for some time.

The Economical Disposal of Town Refuse.—At a meeting of the Society of Engineers, on Monday, May 7, a Paper was read on "The Economical Disposal of Town Refuse," by Mr. Brierley Healey. The author first referred to the imperfect results obtained with the methods of refuse disposal formerly adopted by sanitary authorities. He then explained the procedure to be adopted in the selection of suitable plant when the requirements of the case were known. The capital outlay and working expenses of various systems were dealt with in an elaborate table of results. The author then showed the great loss of calorific value when too many furnaces were connected to one steam boiler. The general arrangement of modern plant, the height and size of stacks, the dimensions of main flues, the pressures for forced draught, and the temperatures of furnace gases were then considered. The author observed that

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when using natural draught the temperature of the flue gases was considerably less than when using forced draught, the latter requiring about 2lb. of air per pound of refuse burnt, or say about 485 cubic ft. per minute, for a consumption of 10 cwt. per hour, whereas double that volume of air was usual for natural draught; hence the lowering of the temperature in the flues. The volume is doubled by an increment in temperature of 485°F., so that whether using forced or natural draught the same size of flues is necessary. The use of screened *versus* unscreened refuse was then discussed, the results, as stated, being in favour of the latter. Considerable stress was laid upon the importance of following up in practice every operation with regularity, particularly in charging and clinkering the furnaces. In conclusion, the author outlined what he considered might probably be the type of steam generator for future destructors. It may be termed a vertical water tube boiler set between a pair of furnaces or between two ranges of flues, the circulation being so arranged that all deposit would be thrown down in the upper drum.

A Balanced Multipolar Armature-Winding.—A recent number of the *Electrical Review* of New York describes the winding of the armature of a multipolar railway generator, the special feature of which is claimed to be the balanced condition of the magnetic circuits. Some difficulty is frequently experienced in the operation of large multipolar direct-current machines with parallel-wound armatures, owing to the difficulty of securing the same magnetic flux at all the poles. The potential generated in the conductors under one pole sometimes differed from that under another similar pole, and thus gave rise to waste currents between the brushes and between sections of the armature-windings. This difficulty is obviated by the following method of balancing. A number of points in the armature winding, which are normally of equal potential, are connected by leads through which currents may pass from one section to the others with which it is connected in parallel. The currents are alternating in character and lead or lag with reference to their respective electromotive forces, and thus magnetise or demagnetise the field magnets so as automatically to produce the necessary balance between them. The method of balancing is said to be of great advantage in eliminating the sparking at the brushes and other wasteful heating which occurs when an armature runs out of truth, due to wear of the bearings or from other causes. When, on account of the armature being out of centre, the air gap on one side is greater than that on the opposite side, the potential generated in the coils on the side having the smaller air gap is considerably higher than that generated in the coils under poles of the same polarity on the opposite side; consequently a current corresponding to this difference of potential flows from one section of the winding to another through the brushes and connecting leads. The pull exerted by one side of the field on a large armature, even if out of centre by only a small fraction of an inch, may become as high as seven tons if no method of balancing is used, and would result in the heating and rapid wearing of the bearings. By proper balancing, the induction under all poles is maintained practically the same, causing the magnetic pull to be equal at all poles and preventing an unbalanced pull.

Electrical Operation of Lock Gates.—The April issue of the *Engineering Magazine* contains a brief description of the mechanical arrangements for operating the lock gates at Ymuiden, in Holland, at the mouth of the Nordzee Canal. The description is taken from a Paper read before the Netherlands Royal Society of Engineers. As a result of experiments made with hydraulic and electric systems, it was finally decided to adopt the latter system. The feature which influenced this decision was the distance separating the several sets of gates. This would have involved the use of long systems of high-pressure hydraulic piping, or three separate pumping plants, while in the case of electricity the current could readily be transmitted to all points. In addition, the electric plant could be used for lighting purposes. There existed, however, the difficulty in the case of electricity that the rapid motion of the motors had to be converted into a slow, steady movement suitable for controlling such heavy masses; also the switching devices, especially in connection with automatic operation, became somewhat complicated; and moisture was everywhere present. Each gate is operated by means of a long connecting rod, attached at about the middle of the width, the inner end of the rod being connected to a travelling carriage to which motion is given by four endless chains passing over sets of sheaves. The chain sheaves are operated by a train of gearing driven by the electric motor, the speed being reduced by a worm wheel and pair of worms. The motor in each case is placed in a separate chamber from the rest of the mechanism, this room being carefully cemented to prevent the access of moisture, the motor shaft passing through a fitted bearing in the wall, and there being three doors in the passage communicating with the chamber containing the operating gearing. There is one 45 H.P. motor for each gate, and it is required that this shall open the gate in 1·5 minutes, against a difference of level of 4in., the motion being automatically arrested at each end of the travel. In addition to the mechanism for operating the main gates, the by-pass gates by which the lock chambers are filled and emptied are operated electrically, the whole being under the control of a single operator. The whole arrangement, including the connections, electric brakes, and wiring, appears to be remarkably well adapted to the peculiar conditions of the service, and it is probable that this installation will lead to the application of electric power to canal and reservoir locks elsewhere. The power station for the plant contains two steam engines and dynamos of 100 H.P. each, besides a large storage battery.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, May 11th.

INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, &c.

4 p.m. Meeting at the Society of Arts, John-street, Adelphi. Prof. Patrick Geddes will deliver an Address on the Nature and Aims of the Association and its forthcoming Assembly at the Paris Exhibition.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Chemical Society's Rooms, Burlington House. Agenda: (1) Discussion of Prof. Lodge's Paper, "On the Controversy concerning Volta's Contact Force"; (2) "The Heat of Formation of Alloys, by J. B. Tayler; (3) "On the Want of Uniformity in the Action of Copper-Zinc Alloys on Nitric Acid," by Dr. Gladstone, F.R.S; (4) An Electro-magnetic Experiment and Experiments illustrating the Aberration called Coma, by Prof. S. P. Thompson, F.R.S.

TUESDAY, May 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. Students' Meeting at the Finsbury Technical College, when a Paper will be read on: "Hertz Waves and Wireless Telegraphy," by R. G. Howgrave-Graham.

WEDNESDAY, May 16th

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "A National Repository for Science and Art," by Prof. Flinders Petrie.

THURSDAY, May 17th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture IV., on: "A Century of Chemistry in the Royal Institution," by Prof. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Institution of Mechanical Engineers, Storey's Gate, S.W. Paper to be read: "Alternating Current Induction Motors," by A. C. Eborall.

FRIDAY, May 18th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Ordinary Meeting at the Westminster Palace Hotel, Victoria-street, S.W., when a Paper on: "A Short Review of the Motor-Car Industry," will be read by Messrs. B. H. Joy and C. H. Rush.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Prof. J. A. Ewing, F.R.S., on: "The Structure of Metals."

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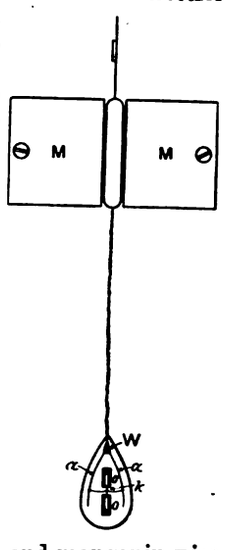
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Maximum Sensitiveness of Coherers.—According to A. Blondel and G. Dobkévitch, the increase in the sensibility of the coherer produced by Tissot by immersing it in a magnetic field is simply due to the increased cohesion of the particles, and is therefore a purely mechanical effect. The same increase of sensitiveness may be obtained by increasing the amount of filings between the electrodes, and thus increasing the mutual pressure of the particles. When the extra quantity of filings is contained in a reservoir connected with the coherer tube, the addition may be brought about by shaking the tube, though of course this not so convenient as increasing the magnetic field, as in Tissot's contrivance. For maximum sensitiveness a coherer should fulfil the following conditions: The E.M.F. of the battery should remain below the critical value; the E.M.F. produced by the impinging waves should exceed the critical value, the current established on coherence should be below a certain value (usually 1 milliampere) if the coherer is not to deteriorate; the current which traverses the tube after a shock should be a very small fraction of the preceding current. With a given height of mast, the sensitiveness is, therefore, increased by reducing the critical E.M.F. This may be done by employing filings which are slow to oxidise, and by putting the tube into circuit with a battery of feeble E.M.F. and a relay of feeble internal resistance. The authors use a battery of 0·5 volts, and a tube with a critical E.M.F. of about 1 volt. The relay has a resistance of 100 to 200 ohms. It is even better to substitute for the battery a potentiometer connected with a battery of accumulators.

[Blondel and Dobkévitch, *Comptes Rendus*, April 23, 1900.]

Radio-Micrometer for Electric Waves.—Klemencic first made use of the thermo-junction for the measurement of electric waves. His device consisted of two thin sheets of brass, having soldered to them a very fine platinum and a very fine platinum-nickel wire respectively, which were crossed in the middle between the two strips, and thence conveyed off at right angles and soldered at their other ends to the leads of a very sensitive galvanometer. This resonating system was fixed at the focal line of a cylindrical reflector. Electric oscillations between the two strips produced heating at the knot, which gave rise to a current through the galvanometer. G. W. Pierce has combined this principle with that of Boys' radio-micrometer. The arrangement is shown in the diagram, where MM arethe poles of a horseshoe magnet. The coil consists of a single loop of silk-covered copper wire. The resonating system consists of two copper cylinders, *o o*, 8mm. long and 1mm. apart, which have a thin constantan and manganin wire soldered to their ends. The resonators are sewn on to a mica vane, and the springiness of the copper leads *a a* keeps the thermo-junction in contact. To protect the latter from radiant heat, the apparatus is cased in wood.



[G. W. Pierce, *Am. Journ. of Science*, April, 1900.]

The Arc between Metals.—For the study of the electric arc as influenced by the surrounding gas, metallic electrodes are much to be preferred to carbon electrodes. Their composition is better defined, and they do not give out the great quantities of strange gases which render experiments in different gases worthless in the case of carbon electrodes. Leo Arons has therefore studied the behaviour of the metallic arc in various gases for several years, and although he has not succeeded in obtaining any results of a precise quantitative nature, the data so far obtained yield some interesting information. Measurements were made in nitrogen and in hydrogen. In the former gas, arcs were obtained between aluminium, cadmium, copper, iron, magnesium, platinum, and brass electrodes. Tin melted at once, and between silver electrodes no arc could be made to play in an atmosphere of nitrogen. This fact is all the more strange as silver yields a particularly brilliant arc in air. It is evidently connected with the difference of chemical affinity between the metal and the gas in the two cases. The author found that nitrides are formed of all the other metals, but not of silver. Aluminium electrodes are covered with a greyish-black crust, whose chemical properties identify it with the nitride discovered by Mallet. The brass electrodes acquire a copper colour, due to the greater consumpton of zinc. As regards hydrogen, it is found that copper and aluminium, which in nitrogen give very beautiful arcs, give practically none in hydrogen. Platinum, silver, iron, and lead require very strong currents. The best hydrogen arcs are obtained with cadmium, zinc, and magnesium.

[L. Arons, *Ann. der Phys.*, No. 4, 1900.]

Mechanical Action of Cathode Rays.—The rotation of little mill wheels under the action of cathode rays was for some time regarded as directly due to the impact of projected particles, and were indeed regarded as to some extent a proof of the corpuscular theory of cathode rays. But even in vacuum tubes such rotations appear long before there is any indication of cathode rays, and they cease at exhaustions at which these rays are still present in full strength. The argument from the absence of such rotations in the case of Röntgen rays also loses its force, by the discovery made by L. Graetz that light bodies made of dielectrics show under suitable conditions very lively rotations under the influence of Röntgen rays. Radiometers do not rotate, and Neesen has shown that they even experience a retarding action, evidently due to the electrostatic forces developed by the ionisation of the air. Graetz introduces small spheres, bells, and vanes mounted on needle points into an electric field traversed by Röntgen rays. They begin to rotate as soon as the radiation strikes them, and continue to rotate while the rays continue. The direction of rotation depends upon the initial tendency—at least, in the case of non-conductors. When a pair of copper vanes are substituted, the direction of rotation changes with the direction of the rays, when the axis of rotation is normal to the path of the rays. This is easily explained by the forces acting between the negatively charged wall of the Röntgen tube and the vanes immersed in the ionised gas between the condenser plates. The latter may even be dispensed with, and so the original conditions of Crookes' rotations are approximated to. The rotations are strictly analogous to those described by Quincke in the case of liquids, and are covered by Heydweiller's theory.

[L. Graetz, *Ann. der Phys.*, No. 4, 1900.]

Electrolytic Current Records.—Lichtenberg figures have been used by Koenig for obtaining some very pretty current curves, and these curves may be vastly improved by using Buerker's new Lichtenberg powder. But the method, which might be called the electrostatic method, is only available for strong currents. Moreover, the curves are not traced under the eye of the operator, but require "development" by the powder. These objections cannot be urged against the electrolytic method worked out more particularly by P. Gruetzner, who describes in detail the various applications of the method. He uses filter paper prepared with a potassium iodide paste, which he mounts on a revolving metal cylinder, the two electrodes, consisting of platinum springs, being lightly pressed against the paper. When a continuous current is used, the anode traces a brown line, due to the evolution of iodine, while the cathode leaves no trace. When an alternating current is substituted the two electrodes make alternate traces. The frequency may be as high as 400 per second without interfering with the clearness of the traces. The only disturbing factor is a short continuance of the production of iodine after the electrode has ceased to be the anode. The intensity of the current is approximately indicated by the amount of iodine evolved, *i.e.*, by the intensity of the line. The author reproduces some beautiful records obtained in this manner. Not only are continuous and sinusoidal alternate currents

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shown, but also more complicated current curves are represented, as well as the "extra-currents" of induction coils. The minimum E.M.F. required is about one volt.

[P. Gruetzner, *Ann. der Phys.*, No. 4, 1900.]

Automatic Coherer.—Last year T. Tommasina announced that a certain type of carbon coherer could be made to decohere by simply breaking its circuit. He has since found that there is a kind of carbon powder which does not even require this, but decoheres itself automatically. The kind of carbon powder in question is that used in the microphones of the Swiss telephone stations. The author introduces it direct into a telephone receiver. A hole 2mm. in diameter is drilled into a plate of ebonite. It is filled with the carbon powder and closed with plates of mica. Two German-silver wires are led in from the sides, and press against the powder, their ends being about 1mm. apart. The wire of the telephone magnet is cut and the coherer inserted. One dry cell suffices to work the coherer, the impact of each wave being indicated by a very audible click in the telephone. The inventor proposes to insert the coherer in the circuit of a Morse instrument, and so to solve the problem of the rapid transmission of wireless signals.

[T. Tommasina, *Comptes Rendus*, April 2, 1900.]

Energy of Cathode Rays.—Since cathode rays are capable of fusing such a very refractory metal as platinum, the determination of their energy is a matter of some interest. This determination is usually carried out by some calorimetric method, but the only successful measurements have so far been made with the thermo-element or the bolometer. A complication is introduced into the measurements by the fact that a portion of the cathode rays is reflected, and thus the thermo-element or bolometer does not indicate their total energy. W. Cady has therefore endeavoured to determine the proportion of cathode rays so reflected, and also the extent, if any, to which they lose their energy in the process of reflection. According to Merritt, reflection does not involve any loss of energy, but his experiments are not free from systematic objections. If i is the cathode current, V the difference of potential between the cathode and the thermo-battery, Q the quantity of heat absorbed by the latter per second, then we have, if there is no reflection, the equation $iV = Q$. But if r is the proportion of rays reflected, and r' the ratio by which the energy of the particles is diminished by reflection, then we have the amended equation:—

$$\frac{iV}{Q} = \frac{1-r}{1-rr'}.$$

The author has determined r and r^1 both by means of a thermo-battery and a bolometer. Assuming r to be 0·4 the average result would give $r' = 0{\cdot}7$. These values apply to platinum only. The cathode used was a copper cylinder cooled by a circulation of water.

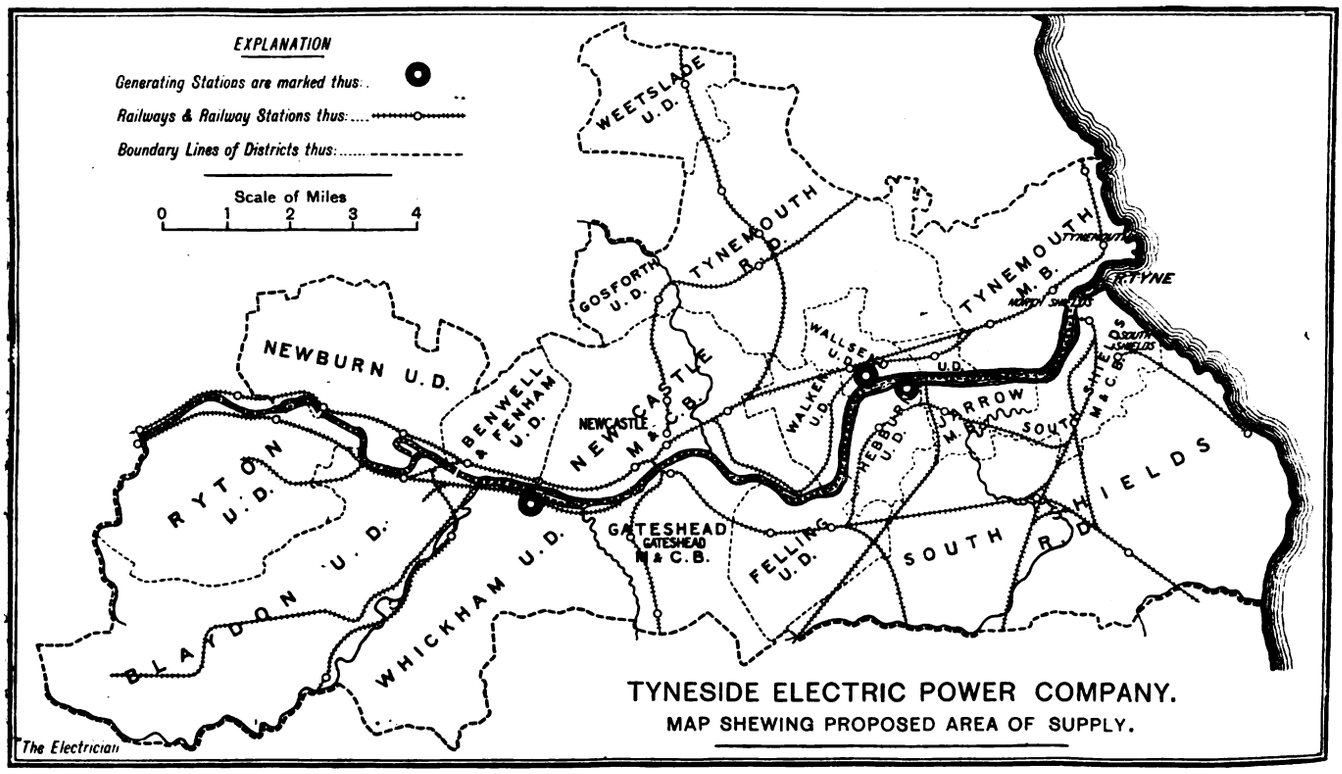
[W. Cady, *Ann. der Phys.*, No. 4, 1900.]

PROJECTED ELECTRICAL POWER SCHEMES.

(*Continued from page 59.*)

3. The Tyneside Electric Power Scheme.

The Bill promoted in the interests of this Company came before the Select Committee during the past week, and a full report of the proceedings is to be found in our "Parliamentary Intelligence" this week. The promoters are Sir William A. Noble, the Hon. C. A. Parsons and Messrs. N. C. Cookson, C. J. Leyland, J. D. Milburn, J. B. Simpson, E. Smith and A. A. Campbell Swinton. An outline of the proposed scheme is given in the opening speech by counsel for the promoters, and need not be reiterated here. The accompanying map shows the extensive area over which powers are sought to supply electricity. The area includes a portion of the area sought under the Durham scheme, as also the contentious districts of Hebburn and Felling. We deal in our leading article this week with several aspects of this scheme and of the rival Durham scheme, the map of the area for which latter appeared on page 58 of our issue last week.



Map of the Tyneside Electric Power Co.'s Proposed Area of Electricity Supply.

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4. The Lancashire Electric Power Scheme.

This scheme follows the Tyneside scheme before the Select Committee. It is a much larger scheme than either of those as yet heard, as will be seen from a glance at the accompanying map. Indeed, the area of supply includes the whole of that part of Lancashire which lies to the south of the river Ribble. The map also shows the position of the four power stations it is proposed to erect on the south Lancashire coal field, which is indicated by the shaded area. The promoters are as follows, the names with an asterisk before them being also first directors:—Messrr. *W B. Hopkins, *W. P. J. Fawcus, *F. E. Gripper, *N. Scott Russell, *G. B. Samuelson, *R. P. Sellon, G. Caldwell, H. Edmunds. W. H. Edwards, M. Guthrie, F. Kitchen, R. Matthews, J. E. Prestwich, and W. W. Rutherford. The capital of the Company is fixed at £3,000,000 in £10 shares, and borrowing powers up to £1,000,000. The promoters seek to distribute power only with the consent of the local authority, and they are willing to agree that they shall not supply either in bulk or otherwise except in boroughs or districts for which statutory powers have been obtained. The profits are to be regulated by a sliding scale on a 10 per cent. basis, but the Company are to be entitled to an additional 1 per cent. above 10 per cent. for each 5 per cent. charged below the maximum rate allowed.

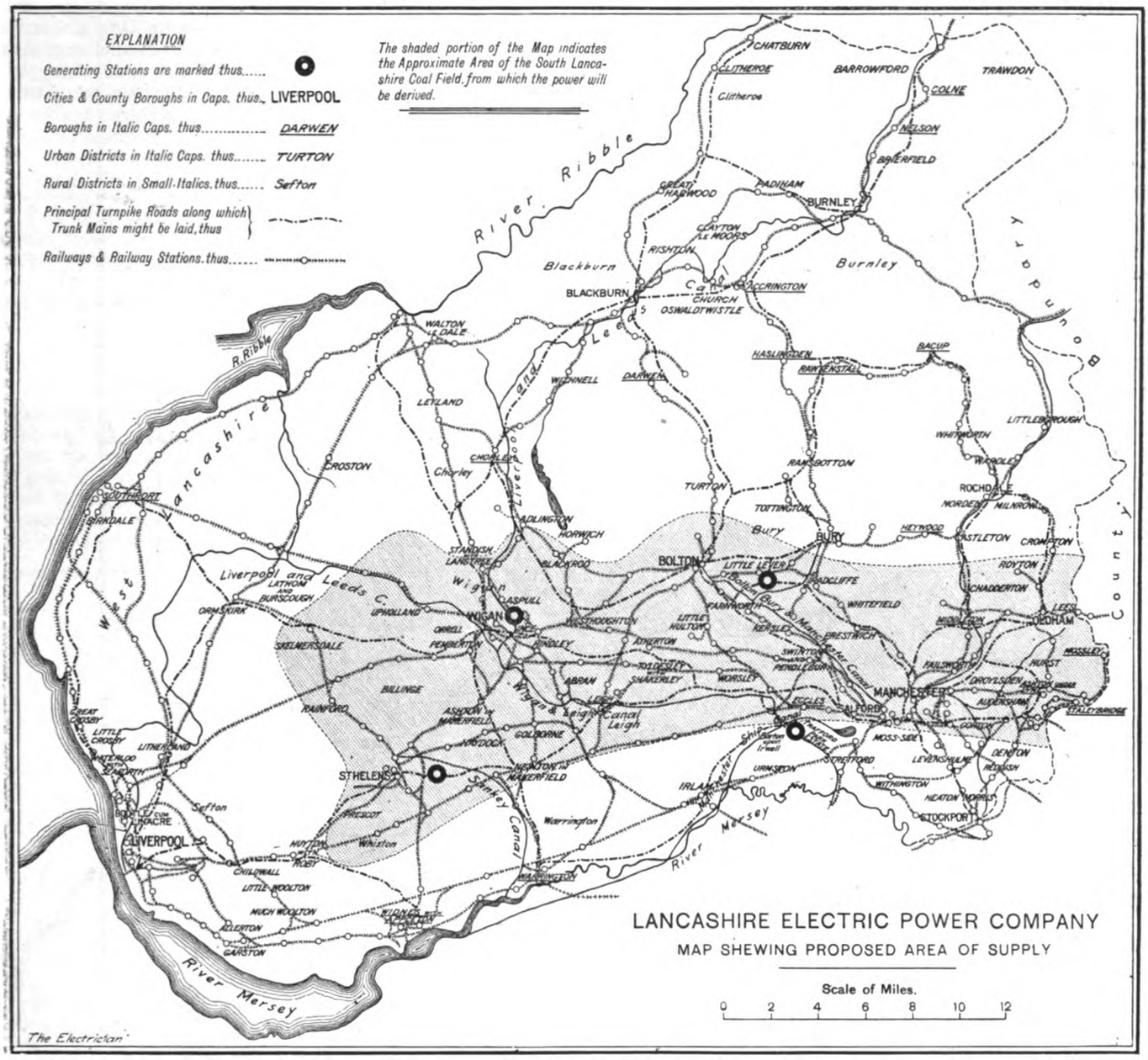
(To be continued.)

A MODERN GERMAN CENTRAL STATION.

BY JOHN R. DICK, B.SC.

(Concluded from page 45).

With regard to the network itself, the continuous-current distribution is arranged on the three-wire system, with 220 volts between the outers. The positions of the feeding points are shown in the plan of the mains (Fig. 4). The whole of the feeders are connected to the 'bus bars in the sub-stations, which are supplied directly from the cells. The excellence of such a system in giving uniformity of pressure is beyond dispute, as has already been amply demonstrated at Chelsea and elsewhere. It is essential to the commercial success of modern central stations to have absolute reliability of supply, and freedom from variations in the pressure at consumers' terminals. The capacities of these sub-stations are in the ratio of 8, 4 and 2 for the central station and sub-stations I. and II. respectively. From the first radiate 13 feeders, from the second 16, and from the third 9. Each group of feeders is divided into two sets of short and long, which are connected to 'bus-bars run at two different pressures. Although there is a multiplicity of feeders there is considerable economy of copper with such a method of distribution, as the maximum cross section of any



MAP OF THE LANCASHIRE ELECTRIC POWER COMPANY'S PROPOSED AREA OF ELECTRICITY SUPPLY.

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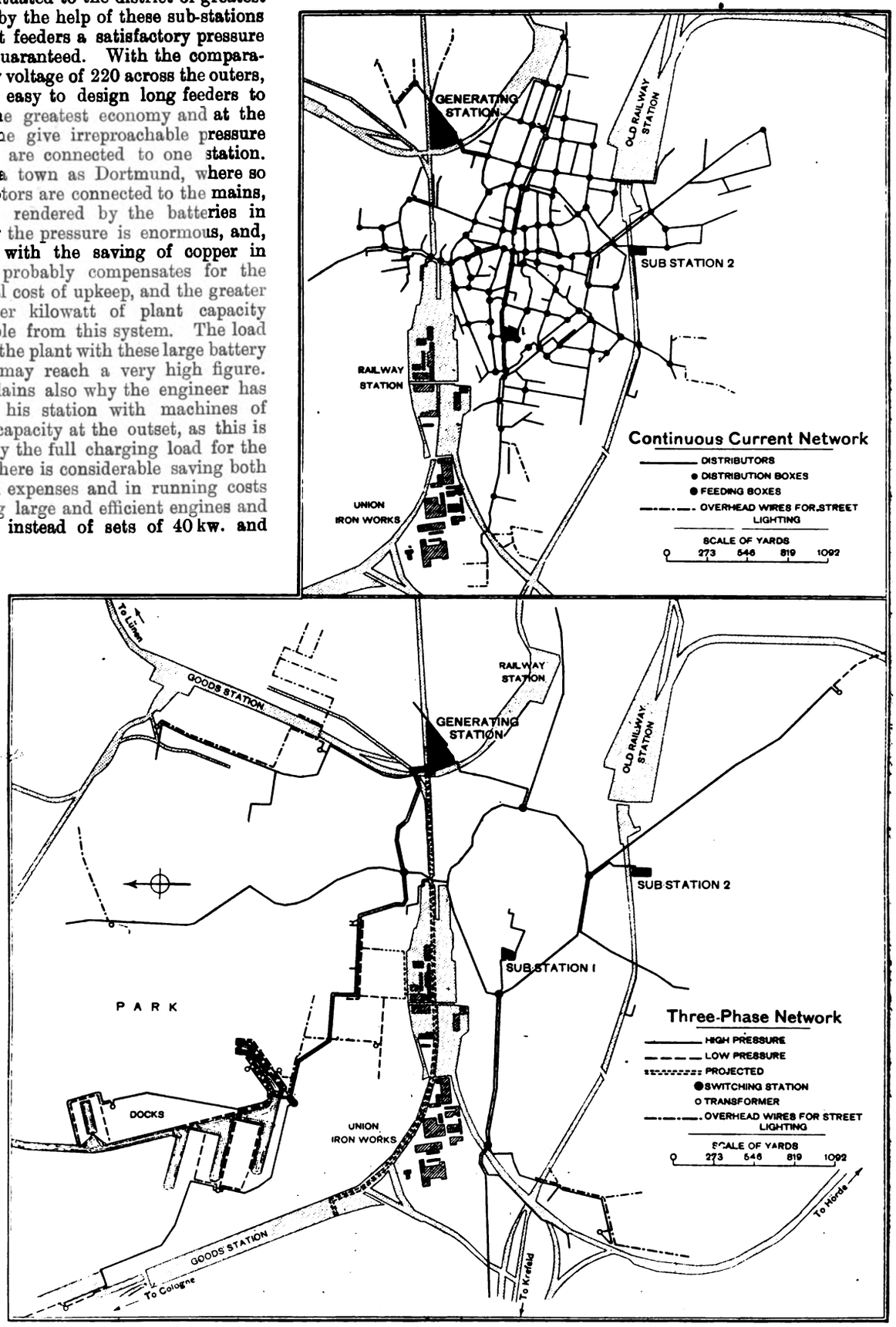
feeder does not exceed 0·3 sq. in., while by far the greater number have an average cross section of only half that amount. Thus, even when the generating station is eccentrically situated to the district of greatest demand, by the help of these sub-stations and short feeders a satisfactory pressure can be guaranteed. With the comparatively low voltage of 220 across the outers, it is not easy to design long feeders to secure the greatest economy and at the same time give irreproachable pressure when all are connected to one station. In such a town as Dortmund, where so many motors are connected to the mains, the help rendered by the batteries in steadying the pressure is enormous, and, together with the saving of copper in feeders, probably compensates for the additional cost of upkeep, and the greater outlay per kilowatt of plant capacity inseparable from this system. The load factor of the plant with these large battery stations may reach a very high figure. This explains also why the engineer has designed his station with machines of 400 kw. capacity at the outset, as this is practically the full charging load for the cells. There is considerable saving both in capital expenses and in running costs in having large and efficient engines and dynamos instead of sets of 40 kw. and 50 kw.



FIGS. 4 AND 5.—MAPS SHOWING CONTINUOUS-CURRENT NETWORK AND THREE-PHASE NETWORK.

The outer wires of the network are steel armoured, lead-covered, single cables, while the middle wire is of bare tinned copper. The feeders have no middle wire, as, with so closely connected a network and an earthed neutral distributor, it is superfluous. In order to avoid electrolytic troubles, and to reduce the difference of potential between the middle wire and earth at any point, the following precautions are taken: (1) The section of the middle wire is made equal to that of the outers; (2) All the three stations are connected by special cables. The main

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cables for charging the batteries are of similar construction to the distributors, and have a cross section of 0·5 sq. in. The charging leads are in duplicate to sub-station I., which has the greatest output.

The distribution for the external area, on the three-phase system, is effected entirely at a pressure of 3 × 2,600 volts without special feeders. The position of the mains is shown in Fig. 5. Single transformers are installed on consumers' premises which reduce the pressure to 3 × 120 volts. The cables are three-core, lead-covered, steel-armoured, and are laid direct in the ground. The sub-division and the fusing of each branch of main is carried out in small kiosks constructed of sheet-iron. These are also intended to be used as feeding points for the low-tension network. These kiosks where possible are much more convenient than the ordinary underground transformer chambers, as they are easier of access and offer better facilities for obtaining permanent insulation on the transformers and switching gear.

At the present moment six distinct high pressure lines are connected to the main switch-board, but provision is made for 12 in all. The farthest point to which a three-phase supply has yet been carried is four miles from the central station. On account of the extent of the area and the distance apart of the consumers it has been found the most satisfactory system to instal separate transformers in each house, but when the demand is sufficient it is intended to supply groups of consumers on a low-tension network, fed from local transformer centres.

The industrial conditions which prevail in Dortmund render a combined system of distribution with continuous and three-phase current highly suitable. In the older central portion of the town there is a greater field for light than power, and where the latter is required the maximum individual demand is not excessive. Continuous-current answers admirably for transmitting to these short distances, and the continuous-current motor is equally suitable for the usual loads. In the outer zone where the factories are situated, the demand for motive power is greatly in excess of that for lighting purposes, and necessitates larger motors than in the central area. Three-phase distribution amply fulfils these requirements, as it can go to any practicable distance with good economy, and gives the advantages of a motor which is simple in construction and easy to maintain in working order. It will be observed on the plan of the mains that, where there is an exceptionally large power user in the central area, a special service is laid from the three-phase system instead of connecting the consumer to the central current network.

The lighting of the factories is a very small proportion of the total polyphase load, and, therefore, variations of pressure are not of such importance as in the central district. No difficulty is found, however, by taking a little care in balancing the lights, in securing good results as regards pressure. The reliability of the supply and its adaptability to the requirements of the district have led to remarkable developments in the demand for motive power. Thus at the end of September, 1899, the total connected load was made up of 1,246 kw. for lighting purposes, and no less than 842 kw. for motive power. The figures showing the units sold are still more interesting and instructive. The energy consumed by the motors during the year 1899 was 660,400 units, while that for lighting was only 421,400 units. It must not be forgotten that no electricity is yet being sold for traction purposes. The curve (Fig. 6) illustrates the excellent manner in which the motor output is maintained in summer as well as winter, and how steadily the connected motor load increases from month to month. In the three-phase district the amount of electricity sold for motive power during the six months ending September, was 22 times as much as that for lighting in the same district. For the continuous-current network the motor output was three-fourths that of the lighting.

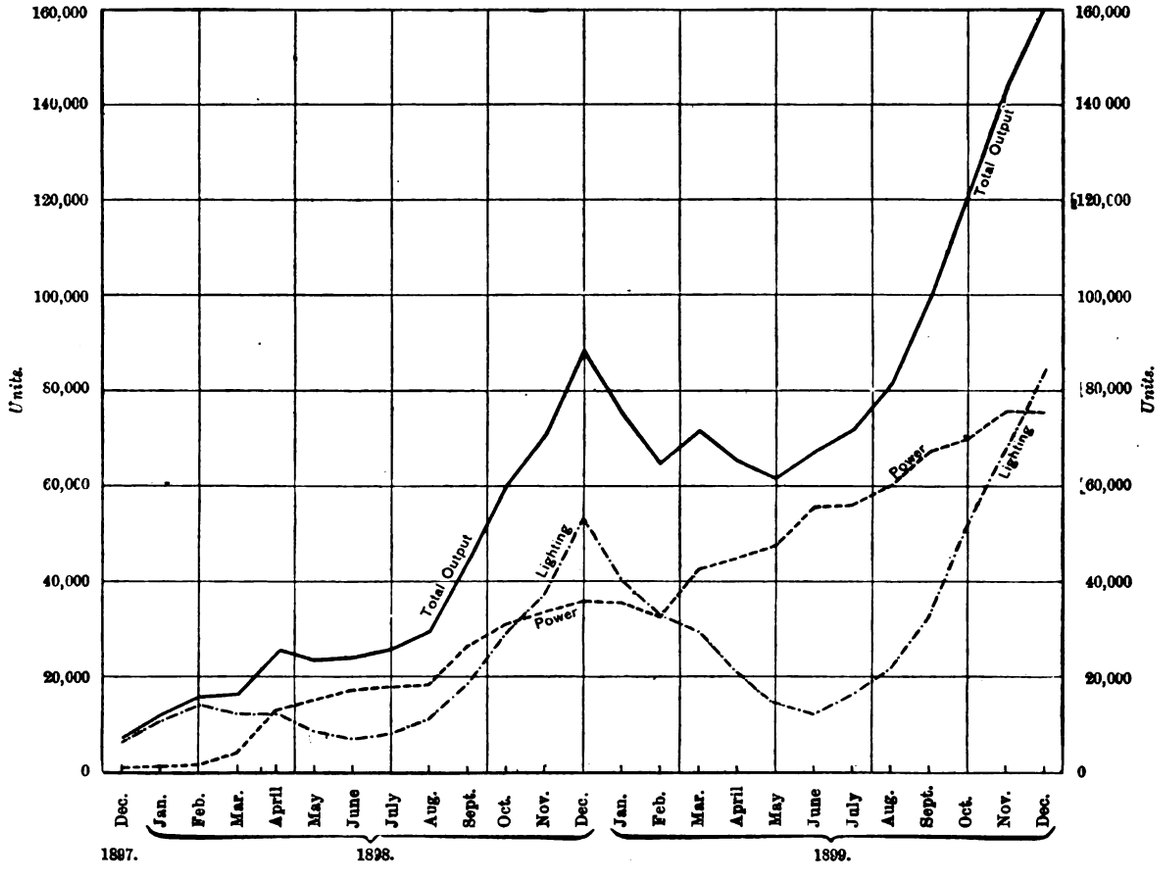

FIG. 6.—CURVES SHOWING UNITS SOLD PER MONTH.

The analysis of the consumers of motive power given in the list on page 84 shows how universal its employment has already become in Dortmund.

There were, on April 1, 1899, 93 consumers having 113 motors of a total capacity of 661·7 kw., and on October 1 these figures had increased to 148 consumers, with a total capacity in motors of 842 kw. The rapid extension of the use of motors for such a variety of manufacturing and busi-

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Power Users at end of March, 1899.

Class of consumer.	No. of consumers.	Power in kw.
Automatic machines	7	6·0
Lifts	15	62·7
Bakeries	4	25·6
Brewery	1	32·0
Printing works	14	76·8
Feather cleaning	2	1·1
Coffee grinding	6	18·8
Cooper's shop	1	3·0
Dairy	1	10·0
Butchers' shops	10	22·9
Cranes	4	29·7
Locksmiths	9	31·9
Joiners' shops	12	73·4
French polishers	2	4·1
Laundry	1	1·4
Fan	1	0·7
Engine and boiler works	14	193·0
Miscellaneous, heating, &c., including motors...	...	68·6

ness purposes is very striking, especially in view of the fact that the station has only been running for two years, and that there is no provision for the hire, or hire-purchase of motors. of space, convenience in starting, cleanliness, &c., than English consumers are. At all events a large motor load is characteristic of most of the chief central stations in Germany. In Berlin, for example, no less than 8,000,000 units were sold for general motive power last year, while for the tramways the amount sold exceeded 10,000,000 units. The sale of electricity to motors is strongly encouraged in Dortmund, and the business is developed by every possible means. The Welsbach gas burner is a formidable rival of the glow lamp all over the Continent, especially for stations just commencing supply, and in this town the rivalry is very marked. The progress of electric lighting being proportionately slow, attention is turned to the supply of electricity for power purposes, where the competition with gas is not so keen. If the necessity is not so immediate in England of endeavouring to obtain a large motor load, our central stations might surely do something more than at present to justify their dual designation of "electric light and power undertakings." The distinction of having an extraordinary demand for power is an empty one unless it is associated with corresponding profits.

At Dortmund the electricity department does not pay interest or sinking fund for the first three years, consequently a handsome surplus is shown on last year's working. The

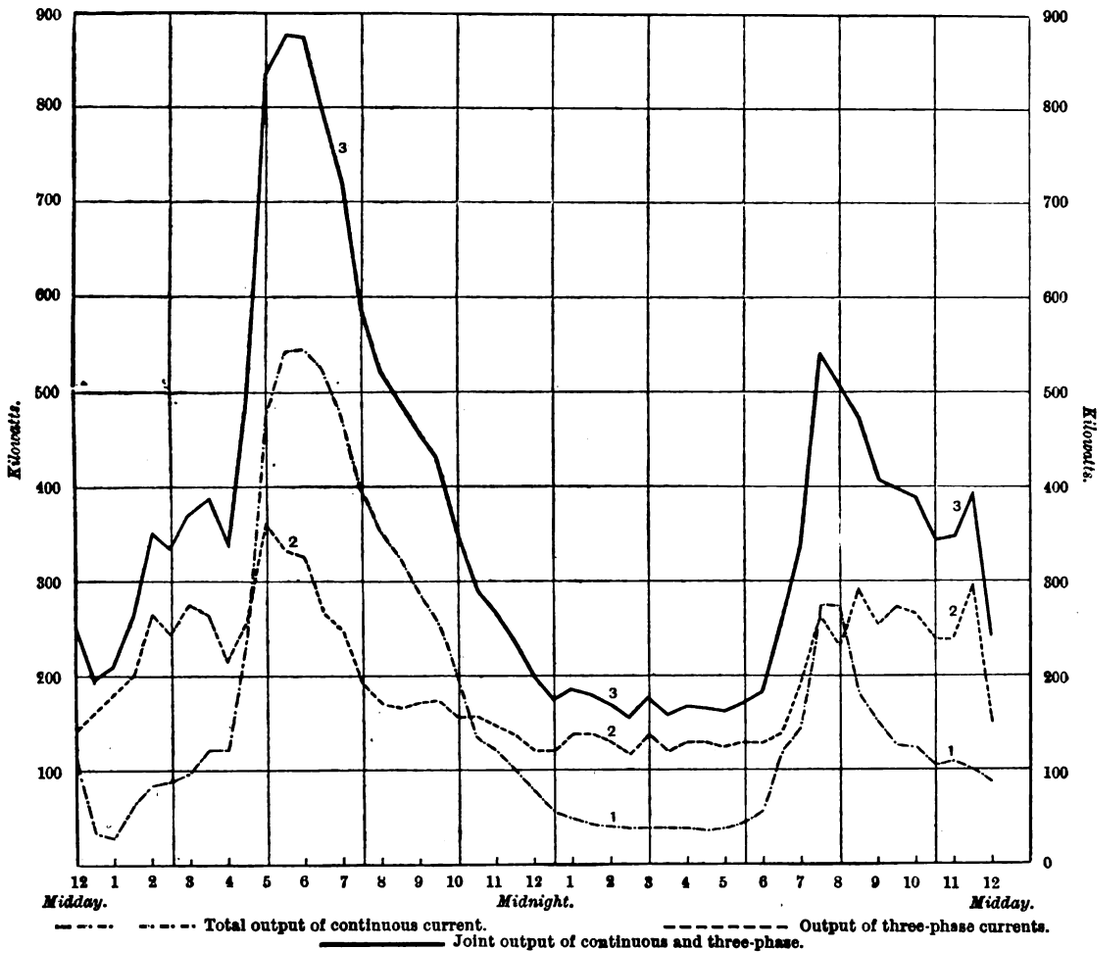

FIG. 7.—LOAD CURVES, 22ND—23RD DECEMBER, 1899.

In comparison with these results the corresponding figures of most English central stations are disappointing. In several of our largest manufacturing towns where the electric motor is the ideal prime mover for small factories the demand is less than 50 H.P. There are several conditions to be satisfied to secure success in the distribution of electric power. The principal are: (1) The current must be supplied in a form suitable for motors; (2) the supply must be absolutely reliable; (3) the price must not be too high. Many English stations fulfil these conditions admirably, yet the use of the electric motor for general factory work is very limited. It may be that the German consumers are more appreciative of the advantages of the motor in respect of working efficiency, economy prices are 6d. and 2½d. per unit for light and power respectively, with liberal discounts to large power consumers, based partly on the number of units sold and partly on the load factor of the kilowatts installed. The profit-earning character of the large motor load can be recognised by a glance at the load curve of the polyphase system, shown in Fig. 7, in which the lighting load may be practically neglected. It is remarkable how well maintained is the demand for power throughout the whole day; in fact, it is so constant as to make the average annual load factor of this class of business as much as 20 per cent. The almost exact coincidence of the peaks of the continuous and polyphase curves is worthy of notice. It is often asserted in bringing forward reasons for charging

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a very much lower price for motive power than for lighting that the demand for power is essentially greatest during the day, and diminishes or ceases at the time of the lighting maximum. Such an argument is not easy to refute because there are hardly any cases where the output for power can be differentiated from that for lighting. In the present instance, where the three-phase system is practically supplying a motor load only, there can be no doubt of the falsity of such a proposition. These curves show clearly that the motor load must rank equally with the lighting load in supporting its share of the standing charges of the station. The logical result is that the tariff for motive power should be the same as that for lighting, where Wright's system is employed, since basement lights burning all day are much more profitable than an electric motor used intermittently, and ought not to be less favourably taxed. Yet a central station may foster a motor load where basements do not exist, and may find it expedient to make certain concessions to bring the price low enough to compare well with gas in gas engines. The station will then be content with a profit on the low-priced units for motive power smaller than that for lighting—say, prices of 7d. and 1d. and 7d. and 2d. respectively. This method savours too much perhaps of the policy of opportunism, and is not so satisfactory as that suggested by Claude of giving considerable "trade" discounts on the number of profitable or low-priced units, whether sold for lighting or power. These methods are at the present moment under consideration at Dortmund, and probably in the near future a tariff based on the maximum demand will be established.

The system of distribution with bare earthed neutral, introduces some novelties into the regulations for house-wiring. In any house bare wires may be used for the neutral, but these must be of tinned copper, and not less than $\frac{1}{16}$in. in diameter, and, wherever possible, must be connected to earth. The two allowable methods of installing wires are: (1) to fix them on insulators, or (2) to run them in iron pipes. Woodcasing is absolutely forbidden. The rules are very voluminous, but scarcely call for further comment, with the exception of the rule for arranging installations on the three-wire system. Each consumer having more than 1 kw. (or 9·5 amperes) in lamps installed, must divide his lamps into two equal groups and connect them to opposite sides of the three-wire system. To have such a regulation for small demands entails an increased cost to the central station for service connections, and we are not accustomed in England to enforce it for consumers with a demand less than 3 kw. On the Continent generally such a regulation as at Dortmund is usual, and necessitates installing three wires in the premises of 50 per cent. of the consumers. The balance on both sides of the three-wire system is better, and consequently the pressure is more uniform than if there were fewer three-wire services. In addition, the less the current can be made in each individual section of the bare neutral the less likelihood will there be of injurious electrolytic action. A good balance in each section is for this purpose most desirable. In the case of central stations having large supply batteries the working is very much simplified if the daily discharges on + and − sides are approximately equal. The life of the batteries is prolonged, the charging is easier and the voltage regulation is more perfect. Also it must not be forgotten that there are practically no neutral feeders, and any excess of load on one side might cause a serious drop in pressure.

I cannot conclude this description of the central station at Dortmund without expressing my appreciation of the kind manner in which the engineer, Herr Döpke, placed at my disposal his very complete data and records. To him also my best thanks are due for providing me with the photograph, plans and curves which illustrate the text.

A 1,000-Mile Electric Tramway Ride.—A lady describes, in an American daily, particulars of a trip of 1,008 miles by trolley, which was as nearly continuous as the schedules would permit. The time spent on the car was 112 hours 25 minutes, and the money spent in fares over the electric lines was $12·05. This is at the rate of 0·59d. per mile. The total length of the breaks between successive lines was 54 miles.

ON DISTANT ELECTRIC POWER TRANSMISSION.*

BY PROF. GEORGE FORBES, F.R.S.

(*Concluded from page 51*).

I now turn to the second portion of this Paper, dealing with some of the problems which I suppose have been threshed out independently by each one who has had to carry out any large transmission scheme. I wish to draw attention to Lord Kelvin's law of economy, to the use of boosters and phase rectifiers, to the relative merits of different kinds of polyphase systems, to overhead and underground conductors, and to the use of aluminium.

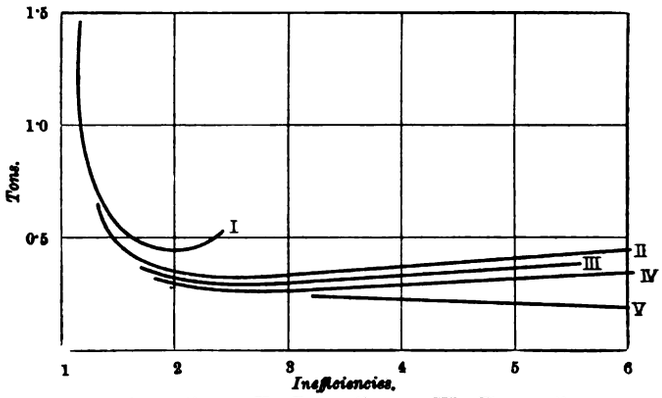
Kelvin's Law.

I should like to see an accurate volume published on the correct use and development of Kelvin's law of economy. Here I must condense. The data on which we choose our current density by this law depends on: (1) price of copper; (2) price per annum of the horse-power; (3) interest on price of copper. I desire to draw attention to the meaning of (2) and (3). When using water power which is unlimited compared with the demand, (2) is the price per annum of generating the power. When the water power is limited and the demand unlimited, (2) is the selling price of the power. If the copper be mortgaged, (3) is the interest paid on the mortgage, say 4 per cent. If the copper is paid for out of capital, (3) is the interest to be paid in dividends on the capital, say 15 per cent. I do not think that attention has been explicitly directed before to these points.

Boosters.

Lord Kelvin's law as he announced it was only true if the electric power measured at each end of the line was approximately the same; in other words, if the percentage drop in volts was small. Ayrton and Perry showed that Lord Kelvin, through neglect to notice this, was led to deduce wrong conclusions as to the economical current density to transmit power from Niagara to New York.

But by using boosters along the line the drop in volts can be corrected. Take as example an ordinary transmission line of 40 miles, in which the ohmic loss in power and volts is 40 per cent.



I.—One section. II.—Two sections. III.—Three sections.
IV.—Four sections. V.—Five sections.

Fig. 2.—Tons of Copper per H.P. Delivered. (100 miles; 10,000 volts).

Divide the line into four sections of 10 miles, with a loss of 10 per cent. in each. Now place alongside of it a booster line. At the 10-mile station increase the volts to the original amount by a booster at the expense of 10 per cent. of current. In the second section there is only 90 per cent. of the current, so if the conductor is the same sectional area throughout, the second section of the booster line may be 11 miles before losing the same as any section of the non-booster or ordinary line. The third section will have a length of $1{\cdot}1 \times 1{\cdot}1 \times 10$ miles $= 12{\cdot}1$ miles; the fourth has a length of 13·31 miles. Thus on the booster line the total loss of 40 per cent. is reached only after traversing a distance of

$$10 + 11 + 12{\cdot}1 + 13{\cdot}31 = 46{\cdot}41,$$

instead of 40 miles without boosters, and with the same sized wire. If instead of keeping the wire of constant section in the booster line we had kept the length of sections each of 10 miles, and had kept the current density constant, the sectional area of the conductor in the four sections would have been in the ratios 1·0, 0·9, 0·81, 0·729, whose sum is 3·439. The weight of copper on the booster system would be thus reduced in the ratio 3·439 : 4, while the efficiency would be 65·61 per cent. instead of only 60 per cent. without boosters; or, to put it in another way, the same loss at 40 miles would be obtained on the booster line with a reduction in weight of copper in the ratio of $34{\cdot}4^2 : 40^2$, which requires only 74 per cent. of the copper. In this example the loss in the booster has been neglected for simplicity of description, but would be taken account of in practice. If the efficiency of the alternating-current booster is 98 per cent. on $\frac{1}{10}$th of the power, the total loss in the booster is $\frac{1}{50} \times \frac{1}{10} = \frac{1}{500}$

* Paper read before the Institution of Electrical Engineers, April 26.

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of the power, which may well be neglected in a general statement of results. The effects of capacity and self-induction (if alternating currents be used) have also been omitted in this description, and if not nullified the usual corrections must be made.

Table I. gives the weight of copper per horse-power and kilowatt delivered at the receiving end of a transmission line 100 miles long, with 10,000 volts at the generating end, without boosters—*i.e.*, in one section. Tables II., III., and IV. give the results with boosters when the line is divided into two, three, and four sections respectively. Corrections must be made for capacity, self-induction, temperature, and sag.

Another way of working the booster system is to add to the distance already covered a new section of the same length as previous ones, with the current density calculated by Lord Kelvin's law. In this case the cost of power must include the cost of copper up to the commencement of the new section. We may start with one section and with power costing nothing. In this case Kelvin's law gives the economical inefficiency = 2 (see my Paper before the Society of Arts, November, 1898). The weight of copper for this section per kilowatt delivered $= 4 \times 1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2$. In any other section, the nth, let

e_n be inefficiency of that section.

$1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2 c_n$ be weight of copper for section.

E_n be accumulated inefficiency of n sections.

$1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2 C_n$ be accumulated weight of copper,

(In Table VI. I call c_n and C_n the copper factor.)

Then, $e_n = 1 + \frac{1}{\sqrt{c_{n-1}+1}}$; $c_n = \frac{e_n^2}{e_n - 1}$

$E_n = e_1 \cdot e_2 \ldots e_n$; $C_n = e_n C_{n-1} + c_n$.

Table VI. gives the values of these quantities for 24 sections of equal length, uncorrected for capacity and self-induction.

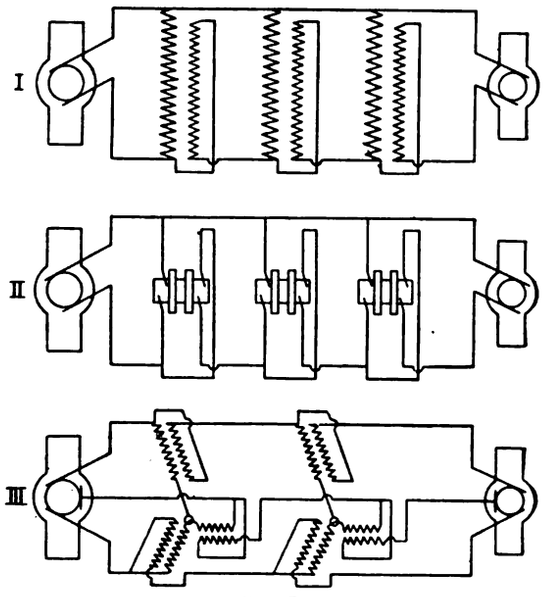

FIG. 3.

If now we wish to use this table for other cases where the cost of power is C_r, which corresponds in Table VI. to an inefficiency, E_r; then the economical inefficiency, say for eight sections, is $\frac{E_{r+8}}{E_r}$, and the economical weight of copper per kilowatt delivered is $1{,}571 \left(\frac{\text{miles}}{\text{volts}}\right)^2$. $(C_{r+8} - C_r)$. In this way Table V. has been computed.

Tables I. to VI. embody some of the best results of my study of the booster method from the year 1894 up to to-day. The curves on Fig. 2 show the tons of copper required for each horse-power delivered at different inefficiencies. It will be seen from them that by the booster method I am able to reduce the weight of copper (by putting in more turbines and dynamos) in some cases to less than one-half of what was possible by the old system.

The chief advantage of using boosters is to save copper at the cost of power generated where the latter is cheap and the distance very great. In a Paper before the Society of Arts in November, 1898,* it was shown that in the ordinary method of working there is no saving of copper when the efficiency is below 50 per cent. But if we wish it we can save copper still farther by making the efficiency still lower and using the method now indicated. Fig. 3 explains the

* [See *The Electrician*, Vol. XLII., pp. 143, 233 and 340.—ED. *E.*]

Table I.—100 *miles*; 10,000 *volts*. *One Section.*
e = Inefficiency. E = Efficiency.

e.	E.	Tons of copper per kw. delivered.	Tons of copper per H.P. delivered.	e.	E.	Tons of copper per kw. delivered.	Tons of copper per H.P. delivered.
1·00	...	...	...	1·46	0·685	0·72800	0·54309
1·01	0·990	16·0258	11·9553	1·47	0·680	0·72230	0·53884
1·02	0·980	8·1726	6·0968	1·48	0·676	0·71689	0·53480
1·03	0·971	5·5555	4·1444	1·49	0·671	0·71179	0·53100
1·04	0·962	4·2480	3·1690	1·50	0·667	0·70695	0·52739
1·05	0·952	3·4641	2·5842	1·51	0·662	0·70236	0·52396
1·06	0·943	2·9420	2·1947	1·52	0·658	0·69801	0·52072
1·07	0·935	2·5695	1·9169	1·53	0·654	0·69388	0·51763
1·08	0·926	2·2905	1·7087	1·54	0·649	0·68997	0·51472
1·09	0·917	2·0739	1·5471	1·55	0·645	0·68624	0·51194
1·10	0·909	1·9009	1·4181	1·56	0·641	0·68271	0·50930
1·11	0·901	1·7594	1·3125	1·57	0·637	0·67936	0·50680
1·12	0·893	1·6422	1·2251	1·58	0·633	0·67617	0·50442
1·13	0·885	1·5430	1·1511	1·59	0·629	0·67316	0·50218
1·14	0·877	1·4584	1·0880	1·60	0·625	0·67030	0·50004
1·15	0·870	1·3852	1·0324	1·61	0·621	0·66756	0·49800
1·16	0·862	1·3212	0·9856	1·62	0·617	0·66499	0·49608
1·17	0·855	1·2650	0·9437	1·63	0·614	0·66254	0·49426
1·18	0·847	1·2153	0·9066	1·64	0·610	0·66021	0·49252
1·19	0·840	1·1709	0·8735	1·65	0·606	0·65801	0·49088
1·20	0·833	1·1311	0·8438	1·66	0·602	0·65592	0·48932
1·21	0·826	1·0953	0·8171	1·67	0·599	0·65393	0·48783
1·22	0·820	1·0628	0·7929	1·68	0·595	0·65206	0·48644
1·23	0·813	1·0334	0·7709	1·69	0·592	0·65028	0·48511
1·24	0·806	1·0065	0·7509	1·70	0·588	0·64860	0·48386
1·25	0·800	0·9819	0·7325	1·71	0·585	0·64702	0·48268
1·26	0·794	0·9593	0·7156	1·72	0·581	0·64551	0·48155
1·27	0·787	0·9385	0·7001	1·73	0·578	0·64409	0·48049
1·28	0·781	0·9192	0·6875	1·74	0·575	0·64276	0·47950
1·29	0·775	0·9014	0·6724	1·75	0·571	0·64149	0·47855
1·30	0·769	0·8849	0·6601	1·76	0·568	0·64031	0·47767
1·31	0·763	0·8697	0·6488	1·77	0·565	0·63919	0·47684
1·32	0·758	0·8554	0·6381	1·78	0·562	0·638148	0·476059
1·33	0·752	0·8421	0·6282	1·79	0·559	0·637170	0·475329
1·34	0·746	0·8297	0·6190	1·80	0·556	0·636255	0·474646
1·35	0·741	0·8180	0·6102	1·81	0·552	0·635401	0·474009
1·36	0·735	0·8072	0·6022	1·83	0·546	0·633670	0·472867
1·37	0·730	0·7970	0·5945	1·85	0·541	0·632059	0·471889
1·38	0·725	0·7874	0·5874	1·87	0·538	0·631452	0·471063
1·39	0·719	0·7783	0·5806	1·89	0·530	0·630536	0·470380
1·40	0·714	0·7698	0·5743	1·91	0·524	0·629798	0·469829
1·41	0·709	0·7618	0·5683	1·93	0·518	0·629228	0·469404
1·42	0·704	0·7542	0·5626	1·95	0·513	0·628813	0·469094
1·43	0·699	0·7472	0·5574	1·97	0·508	0·628544	0·468894
1·44	0·694	0·7404	0·5523	1·99	0·503	0·628416	0·468798
1·45	0·690	0·7340	0·5475	2·00	0·500	0·628400	0·465766

Table II.—100 *miles*; 10,000 *volts*. *Two Sections.*

Efficiency.	Inefficiency.	Tons copper per H.P. delivered.
0·017	59·17	2·27
0·12	8·27	0·504
0·32	3·13	0·333
0·61	1·63	0·395
0·92	1·09	1·451

Table III.—100 *miles*; 10,000 *volts*. *Three Sections.*

Efficiency.	Inefficiency.	Total copper per H.P. delivered.	Efficiency.	Inefficiency.	Total copper per H.P. delivered.
0·07	13·5	0·488	0·36	2·8	0·280
0·09	11·0	0·435	0·40	2·5	0·285
0·11	9·2	0·393	0·45	2·2	0·295
0·13	7·7	0·361	0·51	2·0	0·311
0·15	6·5	0·335	0·56	1·8	0·336
0·18	5·5	0·315	0·62	1·6	0·375
0·21	4·8	0·300	0·69	1·5	0·437
0·24	4·1	0·290	0·76	1·3	0·545
0·28	3·6	0·283	0·84	1·2	0·766
0·32	3·2	0·280	0·92	1·1	1·441

Table IV.—100 *miles*; 10,000 *volts*. *Four Sections.*

Efficiency.	Inefficiency.	Tons copper per H.P. delivered.
0·10	9·8	0·344
0·21	4·8	0·267
0·38	2·7	0·260
0·63	1·6	0·365
0·92	1·1	1·435

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Table V.—100 *miles;* 10,000 *volts. Eight Sections of Different Current-Densities.*

Efficiency.	Inefficiency.	Tons copper per H.P. delivered.
0·53	1·9	0·396
0·50	2·0	0·348
0·45	2·2	0 330
0·42	2·4	0·303
0·37	2·7	0·273
0·31	3·2	0 241
0·23	4·3	0·207
0·13	7·8	0·141

Table VI.

Section.	Efficiency of section.	e_n Inefficiency of section.	c_n C'pp'r factor for section.	E_n acc'mulat'd inefficiency.	C_n Accumulat'd copper factor
1	0·5000	2·0000	4·0000	2,000	4·000
2	0·6909	1·4472	4 6832	2·894	10·472
3	0·7721	1·2952	5·6820	3·749	19·245
4	0·8181	1·2223	6·7223	4·582	30·245
5	0 8482	1·1789	7·7687	5·402	43·425
6	0·8696	1·1500	8·8147	6·212	58·754
7	0·8854	1·1294	9·8601	7·016	76·217
8	0·8978	1·1138	10·901	7·815	95·792
9	0·9078	1·1016	11·939	8·608	117·463
10	0 9158	1·0919	12·976	9·400	141·226
11	0·9226	1·0839	14·011	10·188	167·091
12	0·9284	1·0771	15·042	10·974	195·012
13	0·9334	1·0714	16·071	11·757	225·001
14	0·9376	1·0665	17·099	12·539	257·059
15	0·9414	1·0623	18·128	13·320	291·198
16	0·9447	1·0585	19·152	14·100	327·382
17	0·9477	1·0552	20·177	14·878	365·627
18	0·9504	1·0522	21·199	15·654	405·909
19	0·9527	1 0496	22·222	16·431	448·265
20	0·9549	1·0472	23·244	17·207	492·664
21	0 9569	1·0450	24·264	17·980	539·094
22	0·9588	1·0430	25·281	18·754	587·551
23	0·9604	1·0412	26·300	19·527	638·060
24	0·9619	1·0396	27·322	20·300	690·652

action of boosters: (1) for single or two phase; (2) for continuous current; (3) for three phase. I believe that Mr. Gisbert Kapp was the first to construct an alternating-current booster as here shown.

Mr. Scott, of Pittsburg, is the only person I know of who has published anything bearing on this; but his published statements are arithmetically erroneous, and so misleading, and he does not appear to have noticed the possibility of being able to save copper by reducing the efficiency below 50 per cent.

Induction Factors and Phase Rectifiers.

The low power factor of induction motors, which lies commonly between 0·6 and 0·8, must be carefully taken into account when designing any power scheme where these are used. Synchronising motors can be adjusted so as to be without either lag or lead. But they have not been so largely adopted as they might have been but for the necessity of this adjustment. The Oerlikon Co. have used synchronous motors, doing no work, in parallel with the inductive load to furnish what has been called the wattless current. In this case the synchronous motor is excited so as to act as a condenser, and is placed at the receiving end of the line. There are other methods by which idle synchronous motors may be used to overcome self-induction, and this becomes an important matter in long-distance transmission.

The self-induction of the line has to be taken into account, and I would have added to this paper the tables necessary for working out all the effects, and which I have used for many years, were it not that this would alter the character of the Paper. Table VII. has been inserted, however, to give some notion of the magnitude of the effect, and it shows at a glance the factor by which the ohmic drop of volts must be multiplied in order to give the true drop due to induction and resistance, with different frequencies, and with different diameters and distance of wires, with single phase. Distance of transmission does not affect this factor. I ought to state that an American wire gauge is used in Table VII. only because the table was completed when I was working in the United States on the Niagara scheme.

When dealing with parts of the world free from telegraphs and telephones, the beginner is apt to lay undue stress on the advantages of using an earth return with single or two-phase transmission, and overhead wires. So soon as he calculates the effects of induction he generally finds that the benefit is not what he thought. Take the case of the Niagara-Buffalo line, with cables 0·6in. diameter and 30ft. above ground, and using a frequency of 25 cycles per second. The impedance is the same as with similar cables (go and return) 60ft. apart and the factor is prohibitive.

Table VII.—*Impedance Factor.*

Dia.* and Gauge.	Distance 6in. Factor.	Distance 12in. Factor.	Distance 24in. Factor.	Distance 48in. Factor.	Dia.* and gauge.	Distance 6in. Factor.	Distance 12in. Factor.	Distance 24in. Factor.	Distance 48in. Factor.
	Frequency $f=15$					Frequency $f=40$			
1	1·842	2·182	2 535	2·904	1	4·2447	5·2661	6·2961	7·3302
¾	1·387	1·546	1·720	1·903	¾	2·7520	3·3072	3·8719	4·4428
½	1·111	1·154	1·210	1·267	½	1·6342	1·8480	2·0726	2·3050
0000	1·085	1·120	1·167	1·203	0000	1·5033	1·6753	1·8578	2·0480
000	1·057	1·081	1·108	1·137	000	1·3566	1·4808	1 6136	1·7553
00	1·038	1·054	1·068	1·090	00	1·2493	1·3371	1·4326	1·5354
0	1·0264	1·036	1·048	1·061	0	1·1747	1·2345	1·3023	1·3756
		$f=20$					$f=60$		
1	2·291	2·771	3·261	3·768	1	6 2681	7·8194	9·3778	10·938
¾	1·624	1·863	2 116	2·378	¾	3·9738	4·8334	5·6995	6·5698
½	1·190	1·263	1·351	1·441	½	2·1817	2·5365	2·9009	3·2718
0000	1·146	1·206	1·271	1·341	0000	1·9583	2·2505	2·5527	2·8614
000	1·100	1·139	1·184	1·233	000	1·7002	1·9194	2·1480	2·3838
00	1·067	1·093	1·123	1·155	00	1·5040	1·6651	1·8352	2·0134
0	1·046	1·063	1·084	1·106	0	1·3593	1·4763	1·6019	1·7627
		$f=25$					$f=80$		
2	7·7638	10·37	12·912	15 55	1	8·3108	10·387	12 474	14·557
1½	5·014	6·454	7·831	9·017	¾	5·2244	6·3840	7·5478	8·7161
1	2·7654	3·3826	4·012	4·642	½	2·7720	3·2649	3·7339	4·2722
¾	1·889	2·209	2·543	2·885	0000	2 4577	2·6683	3·2873	3·7119
½	1·285	1·393	1·513	1·637	000	2 0884	2·4024	2·7249	3·0536
					00	1·8011	2·0376	2 2825	2 5355
0000	1·222	1·3068	1·3996	1·498	0	1·5833	1·7597	1·9451	2·1373
000	1·152	1·2104	1·2763	1·345			$f=100$		
00	1·1034	1·1422	1·1876	1 235					
0	1·0710	1·0973	1·1277	1·160	1	10·362	12·919	15·573	18·182
1	1·0478	1·0676	1·0853	1·108	¾	6·4873	7 9445	9·4039	10·669
2	1·0324	1·0443	1 0583	1·071	½	3·3829	4·0118	4·6474	5·2874
3	1·0216	1·0293	1·0384	1·048	0000	2·9793	3·5060	4·0400	4·5787
4	1 0142	1·0191	1·0247	1·031	000	2·5004	2·9078	3 3225	3·7426
5	1·0094	1·0126	1·0162	1·0203	00	2·1227	2·4341	2·7528	3·0794
6	1·0063	1·0084	1·0107	1·0134	0	1·8316	2·0679	2·3130	2·5642
7	1·0042	1·0055	1·0070	1·0087			$f=130$		
8	1·0027	1·0035	1·0045	1·0056					
9	1·0018	1·0023	1·0029	1·0036	1	13·444	16·832	20·227	23·623
10	1·0011	1·0015	1·0019	1·0024	¾	8·3925	10·295	12·191	14·104
		$f=33$			½	4·3185	5·1487	5·9842	6·8233
					0000	3·7828	4·4814	5·1860	5 8942
1	3·51	4·381	5·221	6·081	000	3·1426	3·6878	4 2387	4·7939
¾	2·338	2·781	3·237	3·700	00	2·6316	3·0529	3·4808	3·9161
½	1·462	1·625	1·803	1·982	0	2·2328	2·5567	2·8898	3·2283
0000	1·362	1·495	1·634	1·780					
000	1·252	1·344	1·445	1·551					
00	1·173	1·238	1·311	1·384					
0	1·121	1·165	1·215	1·268					

To find true drop in line, multiply ohmic drop by factors in these tables.

Choice of Polyphase Systems.

In choosing a polyphase system, we may use two-phase, or three-phase star, or three-phase mesh. Three-phase star cannot well be used if any consumer's plant uses only one-phase, as was proved from actual trials in a Paper I read before this Institution in 1893.† For these cases two-phase or three-phase mesh must be used. Three-phase mesh subjects the transformers to 1·7 times the electric pressure experienced by three-phase star, or two-phase, each earthed at the centre of the electric system. The principal advantage of the two-phase is that the two circuits may be electrically disconnected, either always or else during tests. This facilitates the detection of troubles and gives far greater security, as I have convinced myself beyond doubt in actual practice.

It has been generally assumed that, using the same electric pressure, the three-phase system uses only three-quarters of the copper required for the two-phase. This is founded purely on the convention adopted in defining the electric pressure. In Fig. 4 a three-phase star and a two-phase system are represented, each with 10,000 volts between any one wire and the middle of the electric system, which may be conveniently earthed; and the two systems represented require the same weight of copper to give the same effect (though not the same number of insulators). The volts between neighbouring wires in these cases are 17,320 with the three-phase, and 14,142 with the two-phase; yet the convention is to speak of these cases as being 17,320 with three-phase, and 20,000 with two-phase. This might be an unobjectionable convention if the trouble arising from high electric pressure was due to risks of sparks passing from wire to wire. I doubt if anyone with practical experience of the troubles that do arise could support this view. Nine-tenths of the troubles come either from accidental or malicious short circuits, or else from leakage of two conductors to earth. The former cause produces a breakdown in any case. Hence leakage to earth is the only factor to be considered in this connection, and in the cases shown in Fig. 2 the

* Diameter in inches, Gauge Brown & Sharp.

† [See *The Electrician*, Vol. XXXII., p. 70, 98, 119 and 194.]

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security, as measured by electric pressure on insulation, and the weight of copper, are the same for three-phase and for two-phase.

Overhead and Underground Conductors.

The choice between bare overhead conductors and insulated cables underground has generally to be decided upon considerations other than economy or effectiveness. In this country insulated cables will generally be employed. In this case self-induction of the line, which we know how to compensate in any case, can be got rid of. But the effects of capacity, which are more troublesome to deal with, are much increased. The electric pressure to be selected on an underground transmission depends almost entirely on the financial side of the question regarding relative costs for insulation. The Rheinfelden plant was the first case where the electric pressure was selected solely with a desire to obtain the best economy. In almost all other cases the pressure has been chosen by rules which depend on the timidity or rashness of the engineer, and occasionally on his past experience. We have not yet reached such pressures as require account to be taken of electric air-convection or brush discharge from surfaces of small radius of curvature, except for temporary experiments.

Aluminium Conductors.

A few words must be said about the use of aluminium as a conductor. The weight of aluminium required is almost exactly one half of the copper which would produce the same effect. The diameter of cable is 28 per cent. in excess of one made of copper, and the cost of insulation for an underground cable is increased in about the same proportion when we pass from copper to aluminium.

Aluminium is not a pleasant metal to deal with, but its high conductivity will make it invaluable for overhead transmission. It is true also that the weight to be supported on posts is half of copper, but the surface exposed to the wind is greater, and its strength is not great. The chief drawback to its use, especially overhead, is its liability to become rotten. This defect does not exist if the metal be pure and especially if free from sodium. But exposure to the atmosphere, especially near the sea, induces deterioration. The fact that aluminium is easily oxidised ought not to condemn it. The same is true of iron and steel, and yet we do not hesitate to place structures of these metals in exposed positions. Only we paint them; so I propose that we paint or varnish our aluminium conductors wherever necessary. We have had little experience in this direction. I laid out a few hundred yards of ¼in. aluminium wire on a Scotch estate a year ago, and am watching the effects of weather.

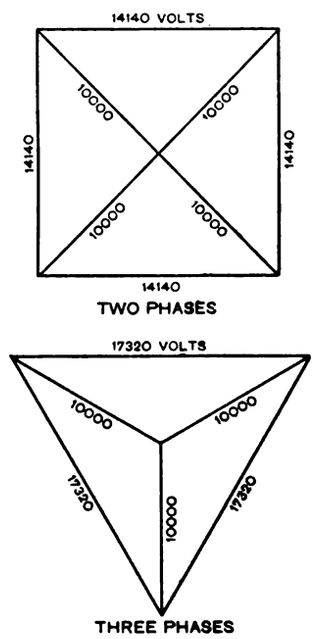

Fig. 4.

Having now dealt almost entirely with the work of foreign manufacturers, I should like to suggest that a British type of power transmission might be worked out differing in some details from what is becoming the normal arrangement. But it would be an impertinence on my part to appear to suggest to manufacturers how best to look after their own interests. The reason why I venture to broach this question is that I notice in the many tenders that come under my notice for power transmission a tendency to crystallise the proposals, and to settle into grooves which do not seem always to be the best. This stereotyped character has lately forced itself on my attention in connection with the proposed Mysore development of water power, and electric transmission over 90 miles. I received five tenders from the firms most experienced in this work in Europe and America. The most remarkable feature was their great resemblance to one another except in certain details. They all used three-phase alternating currents generated at an electric pressure between 2,000 volts and 3,000 volts. The units varied from 1,000 H.P. to 1,333 H.P. Three used mesh connections, and two used star connections. The frequency varied from 25 to 40. All used separate turbines for exciters. All had turbines and dynamos on the same horizontal shaft. The electric pressure used for transmission varied from 23,800 volts to 30,000 volts. Three preferred oil cooling for transformers, one air-blast, and one natural ventilation. The line construction varied considerably, so did the working of the distant transformer station. It is not desirable to go further into details, but it may be said that in every case two complete and independent sets of conductors were proposed. Also the loss allowed on the line was not determined by Lord Kelvin's law, but generally on the basis of enabling the proportioning of volts to load to be capable of adjustment without altering the speed.

Most of the arrangements now mentioned are admirable, and their similarity shows that there is a consensus of opinion in their favour.

I would suggest as subjects worthy of your consideration the following points:

1. The arrangement which suits a transmission line which is also a distributor of power does not necessarily yield the best results for a plant transmitting the whole power to a long distance.
2. The high-pressure continuous-current system is very suitable for certain cases, as worked out at Genoa.
3. The two-phase alternating current is to be preferred over the three-phase in many cases, and especially where an earth return can be used.
4. The horizontal shaft for turbine and dynamo which is so much in vogue, might well be replaced by a vertical shaft, as at Niagara, Rheinfelden, and other places.

I should like to mention other matters, but do not consider the time opportune. Some, no doubt, will be spoken of during the discussion, and any remarks from others who have had experience of these matters will be of value. Most of what has been said in this Paper has reference primarily to cases where water power is used, and generally to countries where bare overhead conductors are permitted. But generally the same considerations have a bearing upon cases where the power is generated by steam and where the cables are underground, although the distinctive characters of the two cases are very marked. With insulated cables the cost of insulation takes away from the superiority of two over three phases except perhaps when a common return is used. The same cause acts against the use of aluminium in place of copper underground. Again, in cases of generating power at the coal pits, the transmission line generally becomes also a distribution line and militates against the use of known methods for increasing the power factor. But the most important difference between an underground and an overhead transmission must be noticed—viz., that induction in one case, and capacity in the other, is the trouble that demands the most careful attention.

It has been my desire in this Paper to disclaim all idea of teaching the members of this Institution anything about their profession. This is not a class room. The object of this Paper is only to put down a few of the ideas about electric transmission that have occurred to me in practice during the last ten years, and which seem to be the most important at this date to draw attention to, and to ask other men of experience in this work to tell us some of the results that they have obtained.

LEGAL INTELLIGENCE.

Jandus Arc Lamp and Electric Co. (Ltd.) v. Johnson.

In the Chancery Division on Friday, Mr. Justice Farwell commenced the hearing of this action, which was for an account of royalties due (and the recovery of the amount thereof) under a licence to use two patents. The defendant, who counterclaimed for damages, pleaded, *inter alia*, that the articles he had made would not, even had there been no licence, have been infringements of the patents.

Mr. Moulton, Q.C., M.P., Mr. T. Terrell, Q.C., Mr. J. G. Graham, and Mr. A. J. Walter appeared for the plaintiffs; and Mr. Bousfield, Q.C., M.P., and Mr. J. Hunter Gray for the defendant.

Mr. TERRELL, Q.C., in opening the case, said that the licence to the defendant was dated March 24, 1898, and it was a licence to use two letters patent, No. 15,479 of 1893 and No. 437A of 1895. The substantial defence was that the goods produced by the defendant were not made under the licence and would not, if there had not been a licence, be infringements of the patents, and that no royalties were due in respect of them. The defendant also set up an extensive counterclaim for misrepresentation and for rescission of the licence.

Mr. BOUSFIELD raised a preliminary objection. What the defendant said was that at the time of the licence the plaintiffs did not possess the patents sued on and they were not mentioned in the licence. The plaintiffs said that if they made that representation or warranty, the patents were in fact the controlling patents, and that the plaintiffs became possessed of them shortly after the date of the licence. The defendant pleaded that the plaintiffs did not own those two particular patents at the date of the licence.

Mr. TERRELL (continuing) said that the patents were for arc lights, and the invention to which they referred was this: If one could enclose the arc in an envelope closed at the bottom, and the operating carbon, that was to say the moving carbon, coming in through an aperture at the top, and being almost sealed so as to prevent the circulation of air as much as possible, they got such conditions of things inside, such an intensely heated atmosphere within the glass envelope, and such a difficulty for oxygen to enter into the glass envelope and so consume the carbon, that they increased the life of the carbon from a few hours up to something like 200 hours. That was the invention, and all lamps which were used now practically involved the use of this invention. When the

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licence was granted the plaintiffs were possessed by assignment of the patent No. 437A of 1895. Then they had an agreement to buy patent No. 15,479 of 1893. The defendant's licence stated that in consideration of a royalty of 5s. for every lamp made by the licensee the licensors (the Jandus Arc Lamp and Electric Co., Limited) granted to the licensee full authority to make use, and vend enclosed arc lamps, for which the Jandus Co. possessed controlling patents, in so far as related to the enclosing of the arc in two or more globes, or the equivalent. The licence was to last during the term of the patents. The licensee was to affix on a conspicuous part of every lamp which he manufactured a royalty plate, furnished by the licensors, bearing a reference number and the inscription "under licence to Jandus patents." In the event of the licensors failing for a period of twelve months, after their attention had been called to the matter, to take proceedings against parties who made use of or sold arc lamps which were infringements of the patents, the licencee should be relieved of further obligation to pay royalty. The licensors undertook that they would not grant any licences to use the patents covered by the defendant's licence at a less royalty than that agreed to be paid by the licensee without making a corresponding reduction in the royalty to the licensee. He drew his lordship's particular attention to that, because defendant said that the plaintiffs or one of their officials had made a misrepresentation, and that the defendant had, acting on the faith of that misrepresentation, taken the licence. The suggested misrepresentation was that the plaintiffs had granted to somebody a licence upon better terms than those given to the defendant, and the better terms that the defendant complained of were that the plaintiffs had granted a licence to somebody, not at a less royalty, but for a shorter period, and that the persons to whom this better licence had been granted, if the licence were determined at a shorter period of time than the whole length of the patent, might thereafter dispute the validity of the patents, that the licence applied to all forms of double enclosure except that made with the particular arrangement adopted by the Jandus Arc Lamp and Electric Co.—viz., a fixed outer globe closed at the top and the inner globe removable through valve at the bottom—that was, at the bottom of the fixed outer globe. What the defendant was therefore licenced to do was to make every form of lamp with double enclosures with a single exception. The licence further stipulated that nothing contained in it should confer upon the licensee the right to use the carbon-feeding mechanism as described in the licensors' patents, and further that the licensee should not during the continuance of the licence nor at any time after the determination thereof dispute the validity of the patent on any ground. There was no question as to the plaintiffs title regarding number 437A of 1895. Then there was the agreement of March 23, 1897, made between the Electric Arc Light Co. and the Jandus Arc Lamp and Electric Co., which recited that by an indenture of assignment dated March 18, 1897, William Phillips Thompson (one of the parties) had assigned, at the request of the Electric Arc Light Co., Thompson's patent No. 207 of 1896 to the Jandus Co., and also recited that the Electric Arc Light Co. claimed to have certain rights in the patent known as the Howard patent (No. 15,479 of 1893), which rights the latter company believed to be the absolute right to ask for an assignment of the said Howard patent. It turned out afterwards that they did have that right. In addition to the £2,500 to be paid by the Jandus Co. on the signing of the agreement, they also agreed to pay to the Electric Arc Light Co. £1,500 further upon the latter company assigning or obtaining an assignment to them of the Howard patent. That assignment had been made, and the £1,500 paid. That document was dated March 23, 1897, and was therefore a good deal in advance of the licence which was dated March 24, 1898.

Mr. Justice FARWELL: What is the date of your assignment?

Mr. TERRELL: April 27, 1898. There was an antecedent assignment with the Electric Arc Co.

Mr. BOUSFIELD said that the point was, had the defendant on March 24, 1898, a licence under the patent of 1893?

Mr. Justice FARWELL: What you are granted is a licence for all the lamps for which the Jandus Co. possessed the controlling patents. Did they possess controlling patents?—They did in equity, because they had the contract.

Mr. TERRELL, resuming, said that under the licence the licensee was not bound to do anything. If he did anything, then the plaintiffs had to establish that he had done it; and if they did so, then they were entitled to an account of royalties. The patent of 1893 was the more important, but if they got the defendant within one, that would be enough for the purpose. The specification of No. 15,479 of 1893 was entitled: "Improvements in Electric Arc Lamps," and the sixth claim was for "an arc lamp having its arc enclosed in a transparent or translucent envelope, closed air-tight at all points below the arc, and provided with a plug at the top having a closely-fitting feed opening for the positive carbon." That was one of the things the defendant was licensed to do, and he (Mr. Terrell) would show that he had done it literally. Then there was a curious defence, to the effect that he did not want to dispute the validity of the patents because, being a licensee, he could not do so; but he would produce specifications against the plaintiffs, and he devised this scheme of quoting specifications, and said he would do so by way of construction, so as to limit and reduce the scope of the patents. But in Clark *v.* Adie it had been decided that they could not do that.

Mr. Justice FARWELL: It seems to me to be an indirect way of allowing a licensee to attempt the impeachment of the patents.

Mr. TERRELL submitted that the defendant had acted under this patent, and was estopped from questioning its validity. Then, with reference to the twelfth claim in the specification, the plaintiffs said that the defendant had also taken that. It was "an arc lamp, having its arc enclosed within a transparent or translucent envelope, an auxiliary transparent or translucent envelope, closed on all sides surrounding said arc-enclosing envelope, and feed openings in the envelopes, whereby the two sides of the arc-closing envelope are maintained at a comparatively uniform temperature, and fracture is avoided." The first claim was limited to the claiming of a combination of a transparent envelope provided with certain things. The twelfth claim dealt with two enclosing envelopes, one within the other. The defendant had taken both. Then, with regard to patent No. 437A, the claim which the plaintiffs said that the defendant had taken was claim 1: "In an arc lamp, prolonging the life of the carbon by enclosing the arc within two or more chambers, so arranged that the upper part of the outer chamber is made air-tight or nearly so, while the lower part permits some communication with the outer atmosphere, and the inner chamber permits a limited communication between its interior and the gaseous contents of the outer chamber or chambers, the combination of the chambers being so devised as to surround the arc with inert or non-oxidising gases and prevent or minimise the access of the oxygen of the air to the carbons as herein set forth."

Mr. Justice FARWELL: Does that differ from the other one; is it not the same thing very much?

Mr. TERRELL said it was practically the same thing, but with improvements. But he wanted, if he could, to avoid going into any science in this case. What the plaintiffs had done was that they had bought one of the lamps which the defendant had made.

Mr. DUGALD CLERK said patent No. 15,479 of 1893 was for an arc lamp. It had its arc enclosed in a transparent or translucent envelope and was closed air-tight at all points below the arc. It was provided with a plug at the top, having a closely-fitted feed opening for the positive carbon. The lamp had an auxiliary transparent or translucent envelope closed on all sides, surrounding the first arc-enclosing envelope. There were feed openings in both envelopes. By means of these feed openings, the two sides of the arc-enclosing envelope were maintained at a comparatively uniform temperature, and fracture was thereby avoided.

Mr. MOULTON: Look at Patent 437A of 1895. By the user of that lamp, is the life of the carbon prolonged by enclosing the arc within two chambers so arranged that the upper part of the outer chamber is made air-tight or nearly so?—That is the only point on which I cannot be quite certain. In this particular lamp—the defendant's lamp—the outer globe is so arranged as to retain the inert gases, the non-oxidising gases, to a large extent; but there is an opening at the top. It is made tighter at the bottom, and there is an opening at the top, but not in my opinion, a sufficient opening to prevent the inert gases surrounding the inner globe.

Mr. MOULTON: May I put it in this way? You consider it is nearly air-tight?

WITNESS: I think not, in the sense of air-tight. There is a great freedom of opening, but not sufficient to prevent the gases accumulating.

Mr. MOULTON: Is it sufficient to accomplish what the patentee describes in his first claim?—That is my view. The object of the patent is to get inert gases surrounding. In addition to keeping the inner vessel free from fracture, the object is to have inert gases surrounding the carbon. In other respects it complies with the description of claim 1 in No. 437A of 1895. The holes outside the cap of the outer globe of the lamp left it open, but there was a masking cap on the top which choked it considerably and restricted the outflow. There was no free circulation.

Mr. BOUSFIELD: This is a patent for "Improvements in Electric Arc Lamps"?—Yes.

Mr. BOUSFIELD: Now, let me direct your attention to four specifications for lamps of a similar type of which this is the improvement—Brewer, 3,713 of 1882; Lake, 5,050 of 1882; Beardsley, 265,737 of 1882; and Justice, 7,962 of 1884.

Mr. MOULTON objected. The Court had here to construe a document. A patentee might claim a thing which was old, and he ran the risk of his patent being challenged and found invalid, but a licensee could not challenge it. In the case of a licensee it was a mere question of construction, and the clause in the patent here was without any ambiguity at all. There were no terms of art in it.

The objection having been sustained,

Mr. BOUSFIELD: Now, Mr. Clerk, go back to page 1 of the plaintiffs' specification at line 16: "It has heretofore been proposed to enclose the arc in an air-tight envelope, but all such efforts have, so far as I am aware, resulted in failure"?—Yes.

In your view I suppose you agree that that would be the case, as he states: "If the opening through which the carbon feeds is made sufficiently large to admit a very free transit of the carbon through it, ingress of air is permitted which increases the rapidity of consumption of the carbon"?—It would be so, no doubt.

Mr. BOUSFIELD: Then at line 25 he says: "With my construction these difficulties are overcome?"—Yes.

As regards this particular difficulty I am speaking of, does this arrangement overcome it: "By making the feed opening a comparatively close fit around the carbon, and providing a valve or trap for the escape of heated gases when the tension becomes sufficient to endanger the envelope, the life of the carbon is prolonged to an extraordinary degree." Is that a fact?

Mr. BOUSFIELD: Now here is our lamp, and here is the hole at the top. I put it to you that that comes within the case that he puts—which he says results in failure—if the opening through which the carbon feeds is made sufficiently large to admit a very free transit of the carbon through it, and not within the case he puts, where the feed opening is a comparatively close fit around the carbon, and he has to provide a barrel or trap to provide for the escape of heated gases.

The WITNESS, having examined the portion of the lamp, said it was a very fair fit of the carbon. It was a long passage and a good fit.

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That carbon is supposed to be, I think, the accustomed size, 13 mm., and their lamps are extended for that size?—Yes.

I put it the hole is 14 mm. at the top, and 15 mm. or 16 mm. at the bottom?—That may be, but still it is a fair fit for all that.

Look at line 21, and I ask you whether this does not come within what is said here: "The opening through which the carbon feeds is made sufficiently large to admit a very free transit of the carbon through it?"—Yes.

Do not those words describe what we do in our lamp?—No, for this reason, that what he is thinking of here is quite obvious. You cannot test it in this way. You have to fix the carbon to the other mechanism of the lamp, and then it is rather difficult unless there is a wide opening to get it to move freely. This would be fairly tight when it was fixed—when the carbon is fixed, and the mechanism to which it is attached. It is not at all a slight fit. What he has here is a very narrow feed at the upper end, and it is slightly conical below. The object of that is to enable any little irregularity of the mechanism above to be adjusted, but that does not interfere with the accuracy of the fit at the entrance. What this man was thinking of at the time was what they had been doing before having very wide openings, quite a different thing to this.

Mr. BOUSFIELD: I put it to you that you are quite wrong with regard to that. First, do you admit the dimensions I gave?—I have not measured it, but I assume you are correct.

That is to say, the size of the area of the hole is 15 per cent. bigger than the area of the carbon?—Yse, that may be so. I hardly think it is in that case, looking at it.

He contrasts with that a feed opening having a comparatively close fit, and having a valve or trap provided for the escape of the heated gases?—Yes.

When you have a hole which is 15 per cent. bigger than your carbon, as you have in this case, it would be ridiculous to talk about providing a valve for the egress of the heated gases?—Quite so.

You have such a large opening round your carbon that the heated gas can get away?—You have sufficient opening there, but he includes that case simply.

At all events, he says as a method of getting over the difficulty he makes the feed opening a comparatively close fit, and provides a valve or trap for the escape of the heated gases?—That is one of his methods.

He provides a valve and a trap. I put it to you that this rod comes within the class that he says—the known class existing at the date of this specification, having an opening through which the carbon feed is made sufficiently large to admit a very free transit of the carbon through it, and not within the class where you have it packed so tight that you have to provide a valve for the escape of the heated gases?—I quite agree it is not within the class that is packed so tight as to have a valve, but I do not agree that it is within the class he is speaking of, because the opening there is not sufficiently free to do any harm. In that particular case there is not a sufficient opening to do harm.

The question is whether in what we are doing we are not doing what anybody is entitled to do, making a large opening sufficiently free for the carbon to pass freely up and down through it?—The openings before were larger than that.

Mr. BOUSFIELD, in answer to his lordship, said that he had put it to Mr. Clerk that a hole for such was in relation to the carbon as they had in theirs, was at this date a well-known thing, and when once it was known that that was the state of public knowledge you could only interpret a close-fitting feed opening as meaning one such as was here described with an asbestos lining, which made it fit so tight that you had to have a valve to let in the air.

The WITNESS, further cross-examined, said he did not remember any outside globe sealed.

Mr. BOUSFIELD: I may refresh your recollection with the meagre statement in this specification of the prior knowledge at p. 3, line 32: "I am aware that it has been proposed heretofore to operate an arc lamp in an air-tight envelope, but when the envelopes are sealed——" I think this passage is with reference to the inner envelope?—Yes.

"But when the envelopes are sealed an explosion of the cylinder is liable to result, and when not sealed a rapid consumption of carbons will result, and a smoking of the enclosing envelope." (I ought to have applied that to finish the former point.) When the envelopes are sealed then he does not want a sealed envelope?—No.

He provides a valve to let it out?—He here provides a valve or a sufficient space.

And he says: "When not sealed a rapid consumption of carbon will result, and a smoking of the enclosing envelopes?—Yes.

Again I put it to you that this is the class of envelopes which are not sealed, and which, according to him, would cause a rapid consumption of carbons and smoking of the enclosing envelope?—In a sense that is not sealed, but he gives you a case at Fig. 5, where he has done what you say.

And contradicts all he has said before, and apparently is what he has described as being the prior existing knowledge?—No. I think it is quite intelligible. I can explain it if you desire.

His LORDSHIP: I do not think it is open to you as licencee to say it contradicts all he said before.

Mr. BOUSFIELD: I have pored over this specification, and I can make neither head nor tail of these claims; they seem to be contradictory.

His LORDSHIP: You have taken a licence. It is all very well, but you are trying to make out that the patent is bad.

Mr. BOUSFIELD: No, what I am trying to show is that in doing this, which was done before the date of the patent, we are not, having regard to the knowledge and construction of the specification, making use of a globe having a hole in the top with a closely fitting feed in it.

His LORDSHIP: Assuming you proved it was done before the patent, if it comes within the words of the patent, as Mr. Clerk had said positively it does, you as a licensee would be bound.

Mr. BOUSFIELD submitted that it did not come within the words of the specification.

His LORDSHIP: Mr Clerk has said it does. At present I have only the evidence on one side, and do not see how you as a licensee can question it.

Mr. BOUSFIELD then referred witness to Clause 12 of the specification: "An arc lamp having its arc enclosed within a transparent or translucent envelope, an auxiliary transparent or translucent envelope closed on all sides." The description of lamp in Clause 12 can only be novel on the supposition that an envelope closed on all sides means an envelope completely closed on all sides?—I will not say sufficiently closed on all sides. You have his object here and he has it, in a sense closed on all sides, but if you examine minutely, in a sense he has not.

I put it, if it means sufficiently closed small on all sides, it is simply describing what was known and done before?—I do not think so.

While if it were completely closed on all sides, it may be new, but we are not doing that?—I do not agree with you. He is describing a combination there which did not as I understand exist before, and he has given the object very completely, and that object did not exist in previous lamps.

In answer to further questions as to the licences, WITNESS said the idea of a controlling patent was a patent which gave practically the control of the market.

I put it to you as a matter of fact these patents do not give you the control of the market with reference to enclosing the arc in two or more globes?—I think they do. There are many difficulties, but it seems to me they were the first people to suggest a double enclosure and I think they would be supported.

That is a matter which has to be decided by looking at the novelty of this patent.—It depends on the validity of the patents.

And depends on the state of knowledge at the date?—The validity depends on the state of knowledge.

His LORDSHIP: You cannot contest the validity.

Mr. BOUSFIELD: As a licensee your lordship sees this, that the present objection to validity comes at a point of date prior to the time of the licence. I say "you have cheated me into a position in which you have made me licensee by telling me you had got controlling patents, whereas the fact is that you had got patents which are for the merest trifles and details, and do not prevent the world at large or give any monopoly at all with regard to this manufacture." That is my position. They have induced us to put ourselves in the position of licensees by telling us they had patents. They were never named to us and we did not know what they were. We had to take it on trust from them—which would enable a monopoly of these double enclosed globes to be maintained. It turns out that the idea was quite an old one; that they can only maintain these patents for very trifling details and that they are not controlling patents, because on the then existing state of knowledge, whether this patent be good or bad, there were a number of forms of double enclosed gas lamps which were known and open to anybody to make. That is my position. All I want to succeed upon is to show that these patents are so narrow that no monopoly could be given by them at all. They are only good for something which is very narrow indeed.

Mr. TERRELL said there was a claim and counterclaim. On the claim the plaintiffs had to establish that the defendants had done something that was within the patents. On the counterclaim they claimed rescission of the whole agreement, and to claim rescission of the whole agreement would go to the root of the action on the claim as well as the counterclaim, because if the Court rescinds the agreement there is no royalty due at all.

After some further discussion his Lordship said it occurred to him that they ought to take the counterclaim first.

Mr. TERRELL felt that that would be the best plan. He wanted Mr. Clerk to go out of the box, and for his learned friend to open his claim and establish that the plaintiffs made the representation, and that he acted on the faith of that representation. When he had done that he would be entitled to call witnesses to prove the representation was untrue and there were not controlling patents, and then he would be entitled to cross-examine Mr. Clerk.

Mr. GRAY then proceeded to open the defendants' counterclaim. His lordship, he said, would notice in the recital that the plaintiffs guaranteed that they possessed controlling patents. If he could satisfy his lordship that the defendant acted upon the representation in executing the licence, of course he was entitled to rescission. But there was another ground in the amended pleadings, which he submitted was a separate ground for rescission even if he failed on that particular ground. He thought it would be desirable at the present stage to call his lordship's attention to the letter to show exactly what the plaintiffs undertook. Paragraph 5a of the amended defence said that "while the negotiations for the said licence were proceeding one Bernard Drake, acting as agent for the plaintiffs, wrote to the defendant a letter dated March 15, 1898." This letter ran: "I send you herewith the clauses accepted by the other licensees to which you refer, and trust you will now get the licence signed with these alterations—I give you my assurance that those terms are the best we have allowed to anyone, with the exception of course of the Stewart Company, who as you know were the first people." The rest of the letter was not important. That letter of March 15, 1898, was in answer to a letter dated March 10, 1898, from the defendant to Mr. Drake. In that letter defendant wrote "give me your assurance that the licence you ask me to sign is precisely the same as that signed by the other licensees." Counsel asked his Lordship to say that the intention of that paragraph in the letter of March 15, 1898, was to convey to Mr. Johnson the impression that the terms were, if not identical, the best that had been given to any licensee.

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His LORDSHIP: Certainly the best, but I do not think it was intended to say they were the same.

Mr. GRAY, continuing, said that his Lordship would see that if his construction was right, if the undertaking given by Mr. Drake was one that went beyond clause 6 of the licence as regards the amount of the royalty, then any clause which enabled any other licensee at any time or under any circumstances to dispute the validity of the patent or patents was a clause better than the one the defendant had got.

His LORDSHIP: I understand your suggestion to be this—a licensee cannot dispute the validity of the patent, it is beneficial for a licensee to be able to dispute the validity of a patent, and therefore the shorter the licence the more beneficial it is, but the result of it would be: no licence, most beneficial. That cannot be the meaning of it.

Mr. GRAY said after the expiry of the licence the licensee was, of course, entitled to dispute the validity of the patent unless he had undertaken not to dispute the validity, not only during the term of the licence, but afterwards.

His LORDSHIP: Do you say that some other licensee had got a licence without the terms "nor at any time after the determination thereof?"

Mr. GRAY: I say that he had not only that, but that he had power to determine the licence within three years after the licence had been granted, and he could dispute the validity of the patent if he chose.

His LORDSHIP: Very well then, there are two points on misrepresentation: the one is as to "on best terms," and the other is as to their being controlling patents.

Mr. GRAY: Yes.

His LORDSHIP: Of course you have to call Mr. Johnson to show that he believed they were controlling patents, and that he relied upon it.

Mr. GRAY: I had better call Mr. Johnson at once.

Mr. WALTER CLAUDE JOHNSON, examined by Mr. GRAY, said he was the defendant, and traded as Johnson and Phillips. He was probably the largest manufacturer of arc lamps in the country. He entered into negotiation with Mr. Drake, the agent of the plaintiff company, in connection with the licence. The negotiations were carried on partly in writing and partly verbally. He obtained a draft of the licence some time before Feb. 9, 1898. It contained the words that the Jandus Co. owned controlling patents. The form was printed. Before signing the licence he had not seen the licences given to any other licensees. He expected that the patents were controlling patents. If he had known that the patents were not controlling patents he would not have executed the licence.

Mr. MOULTON: Your connection with the Jandus patents, both English and foreign, was a very intimate one, was it not?—Well, I think you possibly know to what extent I was interested.

His LORDSHIP said that he did not.

The WITNESS replied that he was a shareholder in the English Jandus Co. He was engaged in forming a company to work the patents in France, and was one of the vendors. He received a quantity of shares fully paid up. He did not personally see the prospectus with regard to that company. He might have a copy of it at home. The French company was formed in February, 1897. He might have manufactured 500 lamps for the English Co. The company had more orders than they could compete with, and asked witness to assist them. He knew Mr. Drake well and had gone into the matter with him and at the time of forming the company. He was aware that the company were getting the Howard patent at the time. It might be that he knew they were getting it early in 1898. He thought that Drake told him at the time they were in negotiation with a man named Marks about the Howard patent. He knew it was a question of getting it from Marks. He knew that the plaintiff company had the Barton and Jandus patents and knew they were getting the Howard. There were no others they possessed so far as he knew. He knew it was to be a combination of the Howard, Barton and Jandus patents. He was chiefly concerned in the actual turn out and sale of the lamps. He would not go so far as to say that the plaintiffs practically monopolised the market at the time. They had certainly the lion's share of the trade. He doubted very much whether they had a monopoly of the trade now. He thought they were losing it very rapidly.

Will you tell me a single big maker who is not a licensee of theirs?—I shall have to refer you to my commercial assistant. I cannot go into matters of that kind. I manufacture other things besides lamps.

Further cross-examined, Mr. JOHNSON said he could not mention the name of a single large maker of enclosed arc lamps who was not a licensee of the plaintiffs. The question whether a patent was a controlling patent or not was a matter of opinion. His cause of complaint was that his licence was not what Mr. Drake represented it to be.

Your licence was for the whole period?—Yes.

You have got all we can give you, have you not?—Yes, too much. He did grumble about having the licence given for the whole term. He wanted to be on the same terms as everybody else. The licence to the General Electric Co. was better than his because they could escape being bound by it and he could not. He of course knew what was in the document before he signed it. He had spoken to Mr. Drake about the royalty. He (witness) was concerned that no one should have a lower royalty than himself. There was a clause that the royalty should cease in the event of the patents being declared invalid by a court of competent jurisdiction.

Re-examined by Mr. BOUSFIELD: If the patents had been controlling patents it would, in his opinion, have been a profitable thing. In his view the licence was a burden to him. He thought the majority of the licensees considered it to be a burden. The General Electric licence was a licence for the full term, but there was the option to terminate it after three years on six months' notice. In his view that was a material difference. If he had known that some other licensee had a licence for a full term with an option to terminate at the end of three years he would not have signed the licence which he did sign. In his view it was an important advantage to have the option of terminating the licence at the end of three years, and if he had that advantage now he would be very well content with his licence.

After the re-examination of the witness was concluded his lordship asked Mr. Bousfield to point out the misrepresentation.

Mr. BOUSFIELD replied that he had not quite finished his evidence and called,

Mr. WUNDERLICK, who said he was formerly in the employ of the Jandus Co. but subsequently was employed by Messrs. Johnson and Phillips. He had had a great deal to do with enclosed arc lamps and became very expert with regard to the subject. When he entered defendants' employ his knowledge was at their disposal. He had himself made some inventions with reference to double enclosed lamps, and had made investigation in the field of patents and so on, and he gave defendants the results of his investigations. He first informed Mr. Johnson as to the validity of the Howard patent. He had studied that patent and compared it with others. He came to a conclusion adverse to the validity of that patent. He thought he first informed Mr. Johnson of his conclusions on the point in July or August, 1898.

This closing the evidence on the counterclaim,

Mr. BOUSFIELD said that his first point was that misrepresentation was embodied in the contract itself.

His LORDSHIP: Mr. Bousfield, may I ask you a question. Omitting the word "controlling," do you say that there is a representation that the patent is a valid patent then?—It is a grant of the use of existing patents. There is no misrepresentation there. They are merely descriptive words.

Mr. BOUSFIELD observed that a controlling patent need not necessarily be a valid patent. He pointed out that Mr. Johnson's memory with regard to the interviews and conversations was extremely weak and feeble; but he submitted he had given his evidence with the greatest fairness. At the time the licence was granted the matter was an important one to him. As a matter of fact his firm did not go into the matter of these lamps for 12 months after the licence. Messrs. Johnson and Phillips were very large manufacturers, and made a great many things, and one could quite understand that this would be a very trifling thing at the time to Mr. Johnson, and he would not try to charge his memory with the conversation which took place. The impression, however, that he got from the conversation with Mr. Drake was very clear.

Mr. Justice FARWELL said that the onus lay on Mr. Bousfield to prove misrepresentation, and he had not done so.

Mr. BOUSFIELD said that although Mr. Johnson could not speak with certainty as to the details, yet he was certain that the basis of the whole negotiation was that he was to get "controlling patents," and there came in the importance of the draft agreement. That confirmed the defendant's view, because the words therein defined the patents as being controlling patents. It was a description of what the defendant was purchasing. This was the sale of rights by description just the same as the sale of goods by description, and the description was the result of the prior negotiations. The whole basis of the thing was that the defendant was to get rights under controlling patents. He was not able to give the details of interviews upon the subject, but defendant was able to give the general result. If this licence could have given the defendant valid protection he would not be there fighting now to get rid of it.

Mr. GRAY, following Mr. Bousfield, submitted that the words "controlling patents" meant something more than a mere adjective applied to the word patents. The plaintiffs could have said that they possessed "patents," but by the qualifying word they implied that their patents could control the market, and prevent any other other double-enclosure lamp at all. Then the terms were to be the best given to any other licensee.

His LORDSHIP, after pointing out that the defendant himself had disclaimed any imputation of fraudulent intention in the representations made to him by the plaintiffs' agent, said that the counterclaim sought to set aside this licence on the ground of misrepresentation. It was said that at the time of the licence being entered into the plaintiff company did not possess controlling patents. What controlling patents there were perhaps not altogether plain; but however that might be, that was the only representation alleged, or that it had been open to the defendant to allege; and it was reasonably plain on the evidence of the defendant himself that he did not remember any other representation having been made to him. He (Mr. Justice Farwell) held, as matter of construction, that there had been no misrepresentation at all. The fact was that the defendant knew a great deal about these matters, and it appeared plain to him that what he was dealing with were patents merely described as controlling patents, meaning the Howard patents and nothing else. He understood that some one else could make enclosed lamps in this country, which showed that he held these patents to be valid patents. As to the letter asking an assurance for a licence which should be on precisely the same terms as those given to other licensees, it was only fair both to Mr. Drake and to Mr. Johnson, to say that there seemed to have been no intention on either part to deceive. Mr. Drake gave the assurance that the terms he was offering were the best that his company gave to anybody except Stewart's, who, as he informed the defendant, were the first people. The General Electric Co. could, at the end of three years, put an end to their licence, and they were freed from the condition put upon other licensees that they should not contest the validity of the patent on the termination of the licence. The defendant now complained that while he had to run the whole term of the licence, he had not a similar provision; but it was quite plain that at the time when he took that licence he was anxious to get it for as long as he could, because he thought it was a good thing. He knew as much about the matter as Mr. Drake did; and the suggestion that if he had known about that proviso in the licence to the General Electric Co. he would not have accepted the licence his lordship could not adopt. His lordship was therefore of opinion that the licence was

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given on the best terms, and therefore he must dismiss the counterclaim with costs. His lordship then took further evidence on the plaintiffs' claim in the action.

Mr. DUGALD CLERK, recalled and further cross-examined by Mr. Bousfield with reference to Howard's patent, said that precautions were taken in the specification for enclosing it air-tight by means of a washer, which was nipped in with screws and other equivalents.

Mr. BOUSFIELD: Now I put it to you that, having regard to the knowledge at the time, "enclosed air-tight at all points below the arc" means closed air-tight in the manner described in this specifiation?—I think it means closed air-tight in any way.

Mr. JAMES SWINBURNE, examined by Mr. Moulton, said he had read the Howard patent. With reference to the sixth claim, the arc lamp had got its arc enclosed in a transparent or translucent envelope. It was closed air-tight at all points below the arc, and was provided with a plug at the top, having a closely-fitting feed opening for the positive carbon. In his opinion, it fulfilled the description of claim 6. In claim 12 the arc lamp had obviously got "an auxiliary transparent or translucent envelope enclosed on all sides surrounding said arc enclosing envelope." It had got feed openings in the globes and the whole arrangement gave that affect.

Therefore was made in accordance with the claim?—Yes.

His LORDSHIP: You do not ask about the other specification?

Mr. MOULTON: No, I do not rely on that.

Cross-examined by Mr. BOUSFIELD.

I put it to you that what this specification means by "closed air-tight" is such air-tightness as you would get by the insertion of a washer?—No; that is what the patentee describes; but as it is comparatively open at the top, it is obvious that what he means is really that it is closed so that there shall not be an in-and-out draught of air at the bottom, so that the communication with the outer air shall be practically all at the top. It is not necessary to close the bottom so as to stand pressure or make it contain water or anything of that sort.

I put it to you that the same interpretation of these words "closed air-tight" and "a closely fitting feed opening" which justifies you in saying that it is within their claim, would equally justify you in saying Beardlee also, which is before, is within the claim?—I do not remember Beardlee's lamp.

With regard to claim 12 WITNESS said he did not think it chokes in the sense of preventing any pressure inside the globe. The only result of that communication being along through the top of the lamp would be that you would not get much convection. If the air expanded inside, it would get out perfectly freely, but you would not have draught in-and-out.

Mr. BOUSFIELD: Do you say in your view that our envelope is, within the meaning of that claim, an envelope closed on all sides?—Yes; I think so.

Mr. MOULTON: Tell us what the object of the air-tightness at the bottom of the envelope is?—The inside of the envelope when the lamp is working is full of exceedingly hot gas and if you gave it a chance it would act like a lamp chimney, the cold air would get in at the bottom and the hot air go out at the top, but by closing it at the bottom you prevent any circulation through it.

For that purpose is the lamp of the defendant practically airtight at the bottom?—I think so; certainly.

Are you speaking of the outer globe?—No; the inner globe.

Is that for the purpose of substantially preventing air passing through?—I do not know what its purpose is, but it does prevent it, and if the grinding is not absolutely true, if you look at the lamp you will find that the top and bottom can move slightly so as to fit any untruth there may be in the grinding.

So that, aye or no, it is practically airtight?—Yes.

Now with regard to the space at the top. Kindly look at page 4 of the specification, the last words before the claims: "The narrow opening before the positive carbon, between the latter and the metallic plug or thimble permitting egress of heated gases." Does that point to a narrow opening between the carbon and what contains it?—Yes, I think he has no valve there. He wants an opening, and he either has it through a valve or has it round the sides of the carbon.

He says you may have it round the sides of the carbon, or through a valve?—Yes.

Considering that, is the space that there is round the carbon excessive, so as to be out of harmony with the description in the specification?—No, I doubt whether it is as much as is shown in Fig. 5.

And if you look at page 3, "In my lamp, however, the enclosure, although practically tight against ingress of air, allows a steady outflow of gases from the lamp." Does that accurately describe what this does?—Yes.

Mr. BOUSFIELD: But that is a reference to the action of the valve.

Mr. MOULTON: Yes; but he says at the end it is instead of the valves.

Mr. Justice FARWELL: Yes.

By Mr. MOULTON: The narrow opening had to do what the valve did, or nearly so. They both were amply sufficient to prevent any convection—that is, any gas flowing in and out at the same time.

This ended the examination of plaintiffs' witnesses, and a long legal discussion followed as to the formal proof of documents supposed to be in *de bene esse*. After which,

Mr. HERBERT JOHN MARCUS proved the execution of an agreement of March 23, 1897, between the Electric Arc Light Co. and the Jandus Arc Lamp and Electric Co.

This closed the plaintiffs' case.

Mr. BOUSFIELD said that with reference to this claim of title what they had to look at was what was the position of things on March 24, 1898, and the question was of course what controlling patents they then possessed. At the date of the licence the maker was taken entirely on trust. They were getting certain patents which were to be controlling patents. They asked the defendant to take a licence, and he did so on the assurance that he was going in with the rest of the trade, and was going to get it on the same terms. They had a remarkable form of licence, and the plaintiffs were no more entitled than they were to go outside its terms. At the date of the licence he should say that as to the Howard patent they had not got it and had not the right to get it, and on this question of title he should submit the plaintiffs had made no case.

Mr. Justice FARWELL: If you satisfy me that they had not got it either in law or equity then I should be with you.

Mr. BOUSFIELD said the agreement of March 23 recited that the vendor company claimed to have certain rights in the Howard patent. What had become of those rights?

Mr. Justice FARWELL: The legal title being in Marks, and an assignment being duly registered, that would be conclusive, would it not?

Mr. BOUSFIELD said that was *prima facie* evidence of the title, but it came after the date. They could have no further fact after the date of the licence. In this document there was a clear notice to all the world and to the parties that it was the vendor company which claimed the right to the Howard patent. Marks' agreement was a personal agreement, under seal to carry out the provisions of the agreement so far as related to matters within his control. He took it that meant that he would make a struggle to get the patent for the Electric Co.

Mr. Justice FARWELL: It meant if he got the patent he would convey it according to the agreement.

Mr. BOUSFIELD said the two points he would put were first that on the face of the document the Electric Arc Light Co. were owners of the patent, and it must be shown that their rights were discharged before a title could be shown, especially when it was an equitable title his friend was relying upon. The next point was that the title they were relying upon was a title which came through the personal agreement of Marks, which personal agreement did not appear to have anything to do with the arrangement of the patent, but appeared to be an agreement for services—a personal agreement. Then he said it was *nudum pactum*, and that it could not be enforced. Then there was a further point, and it was that, assuming that Marks and the Electric Arc Light Co. were the same persons, and assuming, therefore, that on the 19th Feb., 1898, not merely Marks but the Electric Co. had got this patent, he contended that even then there was no equitable title with the licensors. Even if the Electric Arc Light Co. had got the patent instead of Marks the Jandus Co. could not have enforced specific performance.

Mr. Justice FARWELL: It really goes to the root of the whole matter if you are right. Assume that you could not have specific performance of an agreement to do the best you can to get because it is too vague or it is personal service. Suppose he did get it. Cannot you after that get specific performance?

Mr. BOUSFIELD said that was a point for his Lordship to decide. Counsel then directed his Lordship's attention to the specification, and pointed out differences which he contended existed between the plaintiffs' and defendant's apparatus. The specification spoke of "the enclosed air and gases between the outer and inner envelope make the difference of temperature on the two sides of the arc enclosing envelope less and thus protects it." It was wanted therefore to have an enclosed space which was got by what was called a closely-fitting conical reflecting hood. Now the defendant found if he enclosed his like that he cracked the outside globe and therefore what was done was this. First of all he had not got that conical hood business and that feed opening in it, and what he had was a globe, as he was entitled, and as everybody was entitled to have, a globe to keep draughts off and he provided for the free escape of the heated air from the globe for the practical reason, not merely because he did not want to do what was done by the specification, but for the very good reason that if he did not do it it was found by experience that the top screw of the outer globe cracked off.

Mr. ADOLPH WUNDERLICH, re-called, said he was quite familiar with what had been done in reference to enclosed arc lamps. These lamps had been practically his design.

In your lamps when they are put together can the inner envelope be properly described as "closed air-tight at all points below the arc?"—No, because that is not what I consider air-tight.

Supposing the envelope was sealed air-tight without any provision of a valve, the expansion of air would tend to break the envelope?—Tend to fracture it.

Or an accumulation of gases might tend to an explosion?—Yes.

Having regard to the way in which this lamp is put together with these loose joints of glass or metal, would a valve be of any service in your lamp?—It would be entirely unnecessary.

Is it, in fact, air-tight?—No.

How is air-tightness secured in the specification?—It is secured by asbestos washers in every particular place where it is mentioned.

What is the practical result when you make a lamp practically air-tight with asbestos washers?—You do not consume any carbon whatever, and the result is you do not get the result that I care to attain.

What is the result of making them practically air-tight as regards the decomposition of carbon?—The carbon is deposited on to the negative, so that it would fly off on to the globe, which blackens rapidly and therefore you lose all transparency.

Is the admittance of air by joints in the lamp an advantage or otherwise?—A great advantage.

We have got a certain standard given us of what the Howard lamp is going to do. It tells us two things; first of all, it tells us the consumption of the carbon is so slight that the negative carbon actually gets longer instead of shorter. Is that the case in your lamp?—No. It gets much shorter.

Next it says "a carbon of less than 12in. in length will maintain the arc and its gaseous envelope in continuous operation for more than 100 hours with a consumption of 270 watts." Taking that as a standard, does

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your lamp come up to anything like that as regards the consumption of carbon?—No; taking into consideration the watts that it mentions.

Supposing you packed the joints with asbestos, what difference would it make in the consumption of the carbon?—If packed tightly I should get about 100 per cent. longer life of the carbon.

Now with regard to claim 12, We are told in the specification that it was not a novelty to enclose the arc in an air-tight envelope?—No.

The term "enclosed arc lamp" means a lamp with one air-tight envelope, or more or less airtight envelope, to enclose it. Had it ever before been proposed to use a second envelope, closed at the top to keep draughts off the inner enclosing envelope?—No.

Cross-examined by Mr TERRELL: He had had experience in lamp making before he was in the employment of Mr. Johnson. Speaking as an arc lamp maker, he should say Howard wanted to describe in his specification something which was absolutely air-tight in the inner envelope, or something that was sufficiently air-tight to serve the purpose which he described.

In your lamp have you not got practical air-tightness?—Not in the sense that you speak of it as an arc enclosure.

You get actual pressure inside resisted, do you not?—Yes.

When the lamp is burning there is no vacuum inside?—No.

Therefore the pressure of air outside and the pressure of air inside are pretty nearly balanced when the arc is burning?—Yes.

Now as to the 6th claim. The lamp complained of as being within the licence is an arc lamp, with its arc enclosed in a transparent or translucent envelope?—Yes.

That is closed, but you say not absolutely air-tight at all points below the arc?—Not in the sense that is here described in the specification.

When you started devising the lamp that you are making DC, did you have the specification handed to you?—Not that I can remember, but I have had the specification.

What year did you start devising this arc lamp?—About 1898.

Did Mr. Johnson tell you to devise a lamp?—Yes. He told me he thought there was a large scope for enclosed lamps, and that there was no reason why we should not make one.

Did he tell you he had a licence under Howard's?—Not that I remember.

Did you have Howard's lamp before you when you made your lamp. I put it to you that in devising this lamp one of the objects you had in view was to try to get outside Howard's if you could?—No. I did not attach any value whatever to Howard's specification at any time.

Prof. SILVANUS P. THOMPSON (examined by Mr. Bousfield): Taking defendant's lamp, are the joints air-tight in the ordinary and common meaning of the word air-tight?—The bottom is certainly not. As to the top joint it depends which way you put the glass in. One end of the glass makes a better fit than the other.

I have asked you to answer the question with reference to the word "air-tight" in its ordinary and natural meaning. Now I will ask you as to a modification which has been suggested. Having regard to the purposes of this specification, in which you described how to make an air-tight joint, and how to provide against its keeping in too much air by the use of a valve which is to let the air out, are the joints in ours practically "air-tight," having regard to what is described in the specification as the purpose of the joints?—As I read the specification the word "air-tight" is used in two slightly different senses. It is used with reference to a joint, and it is also used with reference to a vessel. A vessel may be practically tight against ingress of air by being absolutely closed at one end and narrow at the other.

I want to refer you to the claim. The plan apparently here is to make it closed air-tight at all points below the arc, and then to have a closely-fitting feed opening above. I suppose the feed opening above, with a sliding contact with an asbestos washer, could hardly be decribed as an air-tight opening taking that point by itself?—I should not so describe it.

Taking the two points, does the lamp of defendant's conform to the method of getting an air vessel tight?—I do not think so.

Mr. JOHN IMRAY gave evidence on some points. Taking the defendant's lamp, he did not think it could be described as air-tight, using that word in its ordinary and natural sense.

Mr. GRAY summed up the plaintiffs' case. He contended that the two claims must be construed for the purposes of infringement so as not to exclude mechanical equivalents, and if that was so he submitted they were entitled to succeed.

JUDGMENT.

His LORDSHIP, in giving judgment on Monday, said: I think the defendants in this case have raised every conceivable objection that could possibly be raised. The first point made by Mr. Bousfield was on the construction of the agreement. He says that there is an interest there recited to be believed to be in the Electric Arc Light Co., and that is not got rid of. It seems to me the short answer to that is that I have here the Patent Office register. It shows that the Jandus Co. are registered as sole proprietors under an assignment from Marks, and were so registered on May 16, 1898. The second point which he takes is that that argument is *nudum pactum* because in effect the Jandus Co. took from Marks and from the Electric Arc Light Co. I can only say, so far as *nudum pactum* is concerned, I really do not follow it. Marks executes a memorandum at the end of the agreement, in which he says: "I personally agree to carry out the provisions of this agreement so far as relates to matters under my control as though I had been an original party to this agreement." That agreement contains, amongst other things, a provision that "the purchaser company will pay to the vendor company a further sum of £1,500 upon the vendor company assigning or obtaining an assignment from the purchaser company of the said Howard patent." How could that be said to be a *nudum pactum* when it is in effect an agreement by Marks in consideration of the payment at his request to the Electric Arc Light Co. to procure to be assigned the patent I fail to see. That point seems to me to come to nothing. Then there was an ingenious point suggested that this was an agreement of which you could not get specific performance, and therefore it was said if you could not get specific performance you did not get the equitable title at the date of the licence, because it is by reason of your being able to get specific performance that equity considers that as done which ought to be done, so that the equitable title passes. Mr. Bousfield pressed upon him (his Lordship) that this was really an agreement to give services, and not an agreement to assign a patent. But he could not shut his eyes to what was the true intent of clauses 2 and 3 (which Mr. Bousfield read) of the agreement, although there was this to be said in Mr. Bousfield's favour, that the parties had some inscrutable reason for not going on *in termo* to say that if and when the Electric Arc Light Co. did get that Howard patent they would assign it. But, continued his Lordship, I find these words by implication in clauses 2 and 3. The argument pressed upon me was that it would be only damages, and not specific performance. That argument in itself assumed a contract to assign, because you could not get damages for breach of a mere agreement to do the best you could, if you had actually done the best you could to get the assignment, and therefore the only matter for which damages could be recovered would be for not assigning the patent when you got it. That is to my mind the true meaning of the agreement. And if that be so, if it be the effect, as Mr. Bousfield put it, that you could only get damages, it is fatal to him, because whether the remedy be damages or specific performance the right of action is the same. That leads me to the point of substance in the case, which is a question whether the article made by the defendant infringes the invention of the plaintiffs so as to be really made within the licence. Now I have heard an argument which would have had very considerable force if it had been addressed to the validity of the patent, but that is not open to the licensee, and the whole of the struggle was to get in evidence by putting in former specifications, and the struggle to put in evidence which I have overruled, and to which Mr. Bousfield returned again and again, is entirely with a view to show that the patent was not good. Over and over again in the course of the witnesses' evidence and in the course of Mr. Bousfield's address it plain that what he was striving for was to do that. Now this is not open to him. He is bound to admit that the patent is good, and that being so I am proposing to construe this patent simply and solely by the words the parties have used contained in the four corners of the specification. What I have to consider is whether in the fair meaning of this patent the defendant's lamps are an infringement or not. On the evidence as it stands—leaving out Mr. Wunderlich's, as to whom I have already made some comments, and I do not like to say a thing of that sort twice—it seems to me that there is no dispute really. First of all it is "an arc lamp having its arc enclosed in a transparent or translucent envelope enclosed air-tight on all points below the arc." His lordship went on to say that everybody agreed there that "closed air-tight" did not mean hermetically sealed, inasmuch as he had had explained to him the object on one side of preventing a current of air arising and avoiding as far as possible contact with the carbon, and on the other side to allow some escape of the hot gases which otherwise might cause an explosion. He had got what was reasonably plain on the face of the specification, a provision by which you could not have a hermetically sealed enclosure, nor could you have one nor did you desire to have one which was open to all the winds of heaven. The invention was of something which gave a mean between the two. He was invited to say that "closed air-tight on all points" was so air-tight on all points below the arc as to necessitate the provision of a plug at the top. He did not think that was a fair construction. The recital part of the specification showed that, although the inventor dealt with arc lamps with enclosures and with valves, he also dealt with those where there may be an opening not by means of a valve. It was said, moreover, by one of the witnesses, that provided with a plug at the top would not apply to DC1. On the evidence I find it does. I disregard that particular item of evidence, and I understood Mr. Bousfield to admit it—at any rate, whether he did so or not, I think it is so. Then we had some little light thrown on the meaning of "closely fitting" by the next words: "Having a closely-fitting feed opening for deposit of carbon." It was plain to his Lordship, as Mr. Bousfield pointed out, that "closely-fitting feed," there referred back to the closely-fitting feed mentioned on p. 2, line 25, of the former specification, which was a "comparatively close-fitting." So he had words which under the rules of construction allowed him to read as "comparatively" close-fitting. All the witnesses agreed that it meant comparatively close fitting. To his mind DC1 came within claim 6, and it was said to come within claim 12. He did not propose to go through the evidence in detail. It would be convenient to refer to it in another place if necessary, but he should like to point out that Prof. Thompson agreed with his lordship's views. It seemed to his lordship to be a plain case of infringement, and therefore there must be the order as asked.

Mr. MOULTON: There will be judgment for the plaintiff on the claim for the account and for payment of the royalties?

His LORDSHIP: Yes.

Mr. GRAY: I do not think the form of your account is quite right when it says you seek an account of all lamps made under the licence.

Mr. MOULTON: Made or sold.

His LORDSHIP: The Registrar points out to me that that is not the common form, "all lamps made or sold."

Mr. GRAY: Then, my, lord, they sued us on two patents and they have only proved infringement of one.

His LORDSHIP: I do not think that has made any difference as to costs. I am not favourably impressed with the honesty of your defence. I am not disposed to give you any favour at all. I see no reason for making any difference.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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THE TYNESIDE ELECTRIC POWER BILLS.

During the past week the Select Committee of the House of Commons, presided over by Sir James Kitson, has heard the evidence in favour of and against two electric power bills, which are included in the category of six important bills discussed in general terms in our leading article last week. It seems probable that by the time this issue is in the hands of our readers the Committee will have progressed no further with its laborious task than to have heard the opening of the case for the third bill on the list—viz., the Lancashire Electric Power Bill, a map of the area relating to which will be found on another page this week. At this painstaking but tardy rate, the Committee will probably require to sit throughout another entire week or more before arriving at the conclusion of its work. This strong Committee, however, is doing its work so carefully and well that all who are interested in the progress of electrical power industry may patiently await the final issue with good ground for hoping that the claims of the electric power schemes will receive just consideration and treatment at its hands.

The two schemes which have occupied the attention of the Committee are: the County of Durham Electric Power Supply Co.'s scheme, and the Tyneside Electric Power Co.'s scheme. The hearing of the former occupied from Friday last until Monday evening, and the evidence for the Tyneside scheme was commenced on Tuesday morning. These two schemes, as is made clear by reference to our maps, are to some extent competitive, inasmuch as each includes within its area the districts on the south bank of the Tyne. So far as the Durham scheme is concerned, this region has been the principal centre of opposition—partly on account of the competitive scheme of the Tyneside Co., but also because of the remarkable hostility of two petty local authorities at Hebburn and Felling, about which we say more further on. But the Tyneside Co.'s scheme met with far more formidable opposition, not only from the rival Durham Co. and a large number of local authorities within its proposed area, but also from the Newcastle-upon-Tyne Electric Supply Co., who are owners of large electricity works doing a considerable electric lighting business with single-phase alternating currents.

It would be superfluous here to review the entire evidence presented in connection with these two schemes, for our readers will find a *resumé* of the evidence in the columns of

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our "Parliamentary Intelligence." We shall devote the remainder of our space in this article to consideration of one or two salient points. In the first place we wish to traverse the view which has been advanced that these schemes are unjust because they will pick out the plums from among the consumers and leave the local authorities the task of supplying all the less profitable consumers. It is alleged that to allow this would be to raise the price at which the small consumer for lighting purposes would have current offered to him, because it is the big consumer who helps most to pay for running the electricity works. If this is held to be a grievance of the small consumer, is not the converse an even greater grievance on the side of the man who is anxious to take power wholesale for the purpose, say, of manufacturing goods cheaply? The power companies offer him electricity at a low price; but the local authority steps in and declares that this low price is an injustice, for the manufacturer, it asserts, ought to be saddled with a portion of the cost of supplying electric light to all and sundry. The injustice of the contention is palpable. We ask, are schemes which are being fostered mainly for the encouragement of power-consuming industries to be defeated because they are framed in such a way that power for such purposes will be supplied at a much cheaper rate than a local authority could supply it from its lighting works? Moreover, it must be borne in mind that this outcry about the grievance of the small consumer is only a myth; for, inasmuch as the power companies can always supply current wholesale to a local authority as cheaply as, or even cheaper than, the local authority could generate the current for itself, it will be easy for the local authority to provide for the small consumer just as cheaply as it would be able to do if it had its own electricity works. If it is said that the presence of the power supply company in any area would prevent the local authority from erecting its own works, because it could not secure the manufacturers as consumers, the obvious answer is that such a local authority would not require to erect its own works; the conditions obtaining would unmistakably indicate that it could obtain its current more cheaply by buying it wholesale.

This brings us to the attitude adopted by the petty districts of Hebburn and Felling towards the two Tyneside power schemes, an attitude which directly illustrates the foregoing remarks. Hebburn and Felling do not want to be included in either of these schemes. Both by learned counsel, and by the less learned but not less authoritative voice of the chairman of the Felling Urban District Council, they have emphatically declared this to be their position. Not even if electric power were to be offered cheaper than they could possibly generate it themselves under the most favourable conditions would they move one inch from that position. They mean to keep the electricity business in their own hands: if there is any profit in it for a company they are convinced—such is their simple-minded credulity—there must be a profit in it for themselves. This is the typical attitude of the petty local authority; we may therefore examine further the action of these two District Councils. We have before us copies of the reports of the consulting engineers engaged by these councils. In our leading article last week we expressed a hope that no member of the electrical profession might be found who would be willing to contest the principle of these power bills. But the occasion, apparently, has produced the man—or, rather, the men—in the firm of Messrs. Handcock and Dykes, of Westminster. The reports presented by these gentlemen are calculated, in our opinion, to give a most misleading impression as to what these two Urban District Councils could accomplish for themselves in electricity supply. Alas, we suspect that their clients were all too willing to be led into the false belief that they could accomplish it. Thus have the blind led the blind. For brevity sake, we shall confine ourselves to the Felling report; that to the Hebburn Council is its twin brother. The population of Felling is but 22,000, and the district boasts of 405 street lamps. It is proposed to erect a power station of 500 kw. capacity, and to equip it with plant of 110 kw. capacity—with all necessary mains for street lighting with glow lamps and 1,500 private lamps—for a total capital outlay of £15,510. This modest expenditure is to provide for an annual output of 162,000 units sold—an astonishing feat, to be accomplished, it appears, by the really delightful estimated load-factor of 25 per cent., and a maximum demand of only 70 kw. Where can these sanguine consulting engineers point to any station of the same small size, and doing the same class of business, which has so large an output or so small a maximum demand? We have searched in vain, not for an example, for that would be waste of time, but for anything approaching these results. The nearest example we can find is Dewsbury, where an output of 161,154 units last year involved a maximum demand of 190 kw., the capital expended on the works being over £26,500. Taunton furnishes another instance, the output, maximum demand and capital expended being 171,083 units, 220 kw., and £28,800 respectively. Ayr, Richmond and Whitehaven also furnish examples of works with approximately the same output as is estimated for Felling, but with enormously greater capital outlay. To proceed with the report. On this modest outlay of about £15,000 there is to be an annual gross revenue of £2,150, made up of items, £1,053 for street lighting, £972 for private lighting, £100 only for power consumers, and £25 for meters. It will be seen that practically all the business is to be electric lighting, and the bulk of that is the street lighting, which the District Council will do on its own behalf. The tariff is to be 5d. for the first 100 hours, 2d. for the second 100, and 1½d. for subsequent consumption; so that on this tariff it is expected to derive from this little undertaking a gross revenue of no less than about 14 per cent., or £22 per kilowatt erected at the works—more than twice as much as is realised with existing works of the same output as that estimated. And these eminently satisfactory results are obtained—on paper—with an annual expenditure of only £1,220, which, be it observed, is at the rate of only 1·8d. per unit sold. We invite the attention of the District Council of Felling to the following particulars of what electricity has cost at works of the size it proposes to erect. At Guildford, with 3,000 lamps connected and a station capacity of 120 kw., the costs were 5·8d. per unit; at Harrogate, with 15,800 lamps and an output of 201,364 units, the costs were 3·34d. per unit; at Taunton, under similar conditions, they were nearly the same figure; at Whitehaven, with 8,267 lamps connected and an output of 206,364 units, the costs were over 2d. per unit. Instances might be multiplied, but the foregoing should suffice to prove that the estimated expenditures and results for the proposed municipal works at Felling find no justification in the corresponding figures for actual practice on any comparable scale. Indeed, we go further: we assert that these estimated figures are entirely misleading, and insofar as they have led the District Council of Felling into persisting in its hostility to the power bills, the authors of them are to be severely condemned. At the present juncture, reports of this description cannot be held up to too emphatic scorn. Like an election dodge, their purpose in defeating the opposing schemes may be accomplished long ere the hollowness of their pretensions

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can be realised. Our advice to Felling and Hebburn is to retract before it is too late; they may be sure they will never be able to run their own electricity works on the lines of these reports. And if these little local authorities persist in their obstinate opposition, we trust the Select Committee will refuse to remove them from the areas of the Tyneside schemes. Little local authorities who do not know what is best for themselves should be made to know by Parliament.

A CENTURY OF CHEMISTRY AT THE ROYAL INSTITUTION.

(*Continued from page 57.*)

LECTURE II.

The second lecture of this course was delivered by Prof. DEWAR, F.R.S., on Thursday, May 3rd, at the Royal Institution. The lecturer began by defining some of the terms introduced by Faraday, in connection with the phenomena of electrolysis. A question which considerably agitated the minds of physicists and chemists during the first half of the present century, was the condition of the solution in the space between the electrodes and in the line of the current. Faraday tried repeatedly, but always failed to discover any effects.

Davy was the first to propose a theory of electrolysis which sought to explain the phenomena by the repulsion of similar charges on the corresponding parts of the molecule. The neutral behaviour of the intermediate liquid was thus ascribed to the superposition of equal and opposite charges. This is practically the same theory as that which Grotthus further developed in 1805. According to Grotthus' theory, every molecule consists of a positively and negatively charged portion; the molecule nearest the positive electrode is decomposed and the negative portion attracted, the remaining portion passing on to the next molecule, decomposing it and replacing the positive portion. And so on, through the solution, the effect is transmitted in much the same way that an impulse is transmitted along a series of elastic balls. Grotthus' theory had to be subsequently rejected because of its utter inability to explain the difference in concentration produced in the electrolyte in the neighbourhood of either electrode. This could only be explained by the "migration" theory, now generally accepted as true.

After some remarks on the changes which the form of chemical equations have undergone in recent years, in consequence of the ionic theory of chemical action, Prof. Dewar showed a number of experiments to prove that the pile was electrically active only when the conditions permitted of chemical activity. Thus, a pile immersed in alcohol at ordinary temperatures, will produce a considerable deflection on a galvanometer; if, however, the alcohol be cooled to near its freezing point by the aid of liquid air, so as to render it chemically inert, no deflection whatever can be observed.

On Oct. 19, 1807, Davy succeeded in decomposing potash, thus performing one of the most important experiments in modern chemistry, proving the possibility of the compound nature of every substance believed to be elementary. Lavoisier and others had conceived the possibility of the compound nature of the alkalies, but the use of electricity to prove this was first appreciated by Davy. After some similar experiments proving the elementary nature of phosphorus, sulphur, and other substances, in which he did not allow himself to be carried away by appearances, he carried out his brilliant research on chlorine. Berzelius and Scheele both believed this to contain oxygen, but Davy satisfactorily disproved this hypothesis. Again, on the discovery of iodine, Davy immediately suggested its relation to chlorine, and showed the similarity in behaviour of hydriodic and hydrochloric acids. The lecture concluded with an account of the investigations leading up to the final form of Davy's safety lamp for use in mines.

(*To be continued.*)

CORRESPONDENCE.

MATTHIESSEN'S STANDARD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Dr. Everett has clearly shown, the "Committee on Copper Conductors" have only added to the confusion at present existing with regard to Matthiessen's standard. It seems to me that, before a new value of an *arbitrary* standard is adopted, it should fulfil the following conditions. It should be (*a*) Simple; (*b*) Clear; (*c*) Universal; (*d*) Easily remembered.

Now, the proposed standard fulfils none of these conditions.

(*a*) It is not simple, since it requires for its description such numbers as 0·150822 and 0·153858!

(*b*) It is ambiguous, since it has two values where one is amply sufficient. The retention of both a hard and a soft standard is both unnecessary and confusing; the ambiguity might even lead to fraud.

(*c*) The proposed standard, in its present form, cannot be accepted by the nations who use rational weights and measures, for it is based on the Fahrenheit scale. (The standard density suggested is practically incommensurable in scientific units.)

(*d*) The definition of the new standard is not easily remembered.

In contrast with all this I may mention the value of the copper standard which I have used for some years—viz., "0·1500 international ohms at 15°C. for 1 metre 1 gramme." This is *simple*, *clear*, *universal*, and *easy to remember*; besides it agrees closely with the value given by Matthiessen for soft copper, though one can hardly admit that this agreement is of any real advantage.

ALBERT CAMPBELL.

London, May 8.

NATIONAL TELEPHONE CO.'S ANNUAL STAFF DINNER.

The seventh annual staff dinner of the National Telephone Co. was held at the Trocadero Restaurant, London, on Friday last, Mr. WM. E. L. GAINE, the general manager, presiding. The company present numbered about 200, and included Lord Kelvin, Sir Albert Rollit, M.P., Sir Cuthbert Quilter, Bart, M P., Lieutenant-Col. C. B. Clay, Prof. Silvanus P. Thompson, F.R.S. (President of the Institution of Electrical Engineers), and a large number of gentlemen well known in electrical circles.

The toasts of "The Queen" and "The Navy, Army, and Reserve Forces," having been proposed by the chairman, and Sir Cuthbert Quilter, M.P., respectively, and very cordially responded to,

The CHAIRMAN (having first read letters from Mr. J. Staats Forbes, regretting his inability to be present on account of his state of health, and from Lord Harris owing to his being embodied in the Yeomanry) proposed the toast of "The National Telephone Co." He said: I find this is the seventh year in which I have had the privilege to propose this toast. Seven years ago the company was somewhat smaller, somewhat less important, than it is to-day. We then wished health and success to it, and, so far as we can see, health and success has followed our wishes. We have now 968 exchanges working throughout the United Kingdom, and we have been engaged, as you know, not only during the past year, but for several years past, in remodelling our system without regard to cost, except on grounds of reasonable economy, in order to bring it in every respect entirely up to date, so that it may be second to none throughout the world. I am glad to say that great progress has been made in this direction during the past year, and out of our 968 exchanges no less than 840 would compare with any exchanges in any part of the world. We are accustomed to a great deal of abuse as having the most inefficient and the most inadequate system to be found, but still the year 1899 was a record year in the history of the company. We added to our list of subscribers no less than 21,000 people, after allowing for those who, from one cause or another, had occasion to leave us—we had, I say, 21,000 net, so to speak, added to our *clientèle*, so that now we have upwards of 176,000 subscribers. This number of subscribers to the telephone is equal to one in every 214 of the entire population of the United Kingdom, and that compares most favourably with almost any country in the world—it is certainly better than in the great countries of Europe. The figures I have now to give you are interesting. My millions are greater in number than those of the Chancellor of the Exchequer. How many messages pass over these wires of ours? Last year we passed 617,000,000 messages between people in the United Kingdom, and I think some measure

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of comparison may be found in this, that Her Majesty's Government passed over their wires, in the same period, 87,000,000 only of telegrams, including foreign telegrams. Now, one of the great charges made against the National Telephone Co. by what my friend Mr. Clay calls the uninformed—and I quite agree with him in that term—is as to price. The messages passed over our wires have been sent at an average cost of ½d. each, whereas Her Majesty's Government has required for each of theirs 7½d. These figures show that the most inadequate, the most inefficient service in this country—as we are told it is—is nearly seven times in volume the service conducted by the State, and is certainly infinitely cheaper. There is one other subject I should like to say a few words upon, and that is with regard to the manner in which the Post Office is conducting the trunk service of the country. Do I put it too high gentlemen, when I say that it is an inadequate service? I have, week by week, brought to me reports of all the district managers and superintendents with regard to the trunk delays which are taking place throughout the United Kingdom, and I say, without hesitation, that a very grave indictment can be framed against the Post Office for the manner in which the trunk service in this country is being carried out. I should be sorry to convey the impression that I am aiming my remarks at the *personnel* of the Post Office. It is not for me to say where the fault lies. The Post Office is a great department of the State, but behind the Post Office is another great department called the Treasury. Whether it is the fault of the Treasury in not finding the money, or the fault of the Post Office as a department, I do not know, but I am satisfied of this, that the *personnel* of the Post Office who are charged with the carrying on of this service are the men who, before all others, are dissatisfied with things as they are at present, and so it is not them whom I am aiming at in the few remarks I have made on this matter. I find that throughout the United Kingdom delays are daily experienced of from half-an-hour to two hours in duration, and I say this, that no trunk service is worthy of the name which requires a man to wait, upon an average, more than five minutes in order to have his message put through. Of course we must bow to the wisdom of Parliament, and I find that Parliament last year voted a sum of two millions of money to enable the Post Office to compete with its poor, unfortunate licencee in London. I cannot help thinking, and this is my individual opinion only, that if that two millions, and two millions in addition, had been voted by Parliament to enable the Post Office to properly conduct the service which it has undertaken it would have been very much better. I will not weary you longer. The toast I have to propose is that of "The National Telephone Co."—the health of the company. I cannot see much sign of either mental or bodily decay. I ask you to drink to the continued health and strength of the National Telephone Co., and with the toast I have to couple the name of Sir Albert Rollit, M.P.

The toast having been enthusiastically received,

Sir ALBERT ROLLIT, M.P., said: Mr. Gaine, my lord and gentlemen, I feel it a very high honour to be called upon to respond for the company. I regret the absence of our chairman under these circumstances. His silvery voice, his great eloquence, his wisdom in counsel, his strength in execution, all recall to my mind what is also suggested by the Greek name of the telephone, the many counselled Euphines, and I think the company owes to him a very great debt for that personal magnetism which he infuses into every gathering at which he is present. I also regret to-night that what my friend the chairman has referred to as the embodied "vice" of the company is absent, and has to be replaced by the personification of virtue in myself. Truly, gentlemen, no one takes more interest in the company than I do. It is the one resource left to me for, at times, a little of that scientific thought which I at one period studied at a distance under Lord Kelvin. I have played with electricity—it was the plaything of my boyhood—I have seen it just during my life become, instead of something which men fear, that which they have made their slave. The lightnings now do our errand and our bidding; they light our houses and are a source of power and energy for us in this world below; they are a great source of traction, and some people say that in the telephone they are driven to distraction. I think that those who are assembled here, and who are daily brought into contact with this marvellous instrument, should appreciate to the fullest extent the scientific character of the calling in which they are engaged, and when I see such men as Professor Thompson here I cannot but express the hope that there are many who avail themselves of his high teaching in London, and are induced to take a deep and great interest in science. Another absence that I note here to-night is one I deeply regret. At our previous gatherings we have always had Prof. Hughes, and when we speak of science we shall never forget, I think, that it was probably he who, through the microphone, made the telephone a commercial and practical possibility. It requires some courage nowadays to respond for any company. Lord Coke said they had neither bodies to be kicked nor souls to be saved. I am bound to say that the National Telephone Co. is, in this respect, no exception to the rule of the learned Lord Coke, inasmuch as we get, not only kicks and no halfpence at all, but not a *quid* for our many *pro quos*. The directors and officials of the company desire to consult, and it is our interest and duty to consult in every way the public convenience. It is for this reason we seek those underground privileges which are so constantly combatted by what I may call underground methods, and I would venture to suggest that now, under recent arrangements, we are more or less married to the State, through its trunk lines, that the more wiry twins we have as the result of that marriage the better it will be for everybody. I have spoken of the company and of the personality of the directors, but what, after all, is a company? It is a mere legal entity, a sort of incorporated impersonality. I should like to transfer from this incorporeal hereditament the thanks you have given to us to those who have done so much for the company—I mean the staff, the loyalty and ability and energy and hard work of which have enabled you to propose the health of the company with the certainty that that health will be maintained. The directors do some things, and they do them to the best of their ability. Here is my friend, the chairman, our general manager. I often think what the legal profession has lost in him and what the Telephone Co. has gained. I desire to acknowledge the great obligation under which the directors rest to Mr. Gaine. He is a man of breadth of view, of ability, and with determination in execution. Then, there is my friend, our secretary, Mr. Anns. Why, gentlemen, when we require figures to prove anything we always put the matter into the hands of Mr. Anns. Then, in Mr. Sinclair we have a most distinguished scientist—and, again, a gentleman who deserves from the directors the most public acknowledgment of the ability with which he serves the company. I might mention many more—Mr. Goddard, with whom I am frequently brought into contact, and those who have charge of the districts, and others; but I prefer to end by a general formula and say that when you drink the health of the company you drink in reality the health of the men who make the machinery of the company to go as excellently as it does go.

Mr. J. CHAMBERS, in proposing the toast of "Our Guests," said: Sir Albert Rollitt has reminded us that we miss to-night the face of one who, I believe, has been with us on all previous occasions at these our annual gatherings. The late Prof. Hughes devoted his life to science, and his memory will be kept green for a long time to come by electrical students. We have been always particularly fortunate in having the honour of the company of able and distinguished guests each year, and this year are by no means behindhand in that respect. We have with us men who have assisted and given of their best, not only for the development of electrical knowledge, but in many other directions for the good of mankind. We have with us Lord Kelvin, and I feel sure his lordship will not take it as a liberty if I refer to him as an old and greatly respected friend. He has been a friend to all electrical students, and to many others, but those of the National Telephone Co., who have had the privilege of personal communication with him, know how he has been always ready, in a kind, way, to give advice when asked. We have also Prof. Thompson with us. To him we are greatly indebted, and we are constantly referring to him, not personally, but we find him on our bookshelves, and when certain problems perplex us we go to him for their solution. We have other gentlemen with us who have done their share for the general good. I ask you to drink the health of "Our Guests," coupled with the names of Lord Kelvin and Prof. Silvanus P. Thompson.

The toast having been drunk with great heartiness,

LORD KELVIN, who was warmly received, said: I feel it a great privilege and honour to be allowed to speak for the guests of the National Telephone Co. I feel it a large responsibility to express the thanks of all the guests present for all that they owe to our entertainers, but this burden to me is lightened by my friend and colleague, Professor Thompson, being associated with me in bearing it, and it allows me to feel that we may go beyond the guests of the National Telephone Co. of this evening and thank the company for the still larger number of, I cannot say guests exactly, but grateful clients—clients who have daily experienced all the benefits that the National Telephone Co. confers upon Great Britain and Ireland. We have had some most interesting speeches to-night. We have even had a graceful and kindly tribute to the patience of the clients of the company from one speaker when he alluded to them as being sometimes driven to distraction. I must say that that is an experience not unknown to the users of the telephone, not merely in these islands, but throughout the civilised world, and a large part of the savage world, wherever the telephone is known. But who is to blame? If people would only make arrangements that somebody was at the telephone when called the complaints against the service would in ninety-nine cases out of a hundred be annulled. I read, to my astonishment, yesterday, in a report of a discussion in the House of Commons a statement that the National Telephone service in Glasgow was very bad. I think it was stated that the service there was worse than anywhere else in these islands. A more splendid tribute to the work of the Telephone Company could scarcely be paid, because, as a matter of fact, it is a very good service indeed in Glasgow, and I challenge anyone to say that the distractions which have been referred to, in more than an exceedingly small proportion of the cases, depend on anything but the unbusiness-like arrangements of the persons using the telephone. In Glasgow they are not more unbusiness-like or less prudent and sensible than people in other parts of the world. I have experienced the same thing in Philadelphia and, more or less, in many parts of the United States; and I have heard a good many people who have experience of the telephone in Norway, Sweden, Denmark, and in France and Germany, say just the same thing—that the telephone service is very good, but that the people who use it do not understand that they must know whether or not they have somebody or other at the other end, and if any delay, what the cause of it is. Twin wires will give great assistance, chiefly by helping you to hear the person you want to hear and not anybody else. In that respect the twin wire will be of very great value, and I think the same indication of the prosperity of a great organisation—biological organism—that it is very prolific in twins is sometimes an indication of good health in material prosperity and well-being. This company is at present very prolific in twins, and it is going to produce a vast number more within the next year. It is not only in Glasgow, with the, shall I say friendly, co-operation of the excellent Town Council, and in London, with the beneficent and sympathetic co-operation of the Post Office, that I believe there is a great and rising future for the Telephone Company. It will increase more and more with, and perhaps because of, threatened opposition. I do not like to be too optimistic, and certainly I cannot feel quite convinced that all the agitation for opposition is wholly in the public interest, and wholly in a spirit of friendliness to the company in the service of the public. I believe there is a certain leaven of the ugly side of human nature in what has been going on. I do not say that it is mere jealousy and dislike, and rivalry of an unkind nature that gives all the kicks which have been referred to. Sir Albert Rollit has said that the company gets

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more kicks than halfpence. If so, it must get 617,000,000 kicks per annum. The kicks are mere pin-pricks, and I believe the National Telephone Co. will emerge triumphantly from all the opposition, and that, if there should be a Parliamentary discussion on the same question 10 years hence, the company will be spoken of with admiration and respect even more than it is at present. And now I must do my duty by thanking you most warmly for the delightful evening we have had.

Prof. SILVANUS P. THOMPSON who was also loudly cheered, said: Lord Kelvin has already responded for the guests who have shared your hospitable board this evening and, therefore, I am relieved from making anything like a long speech. I presume that my having received an invitation to this dinner is due to the circumstance that I have the honour this year of holding the presidency of the Institution of Electrical Engineers. Therefore, in that representative character, I should like to say how glad I am to have been here and to have met face to face so many of our members in the great electrical profession. I am informed that the number of the company's staff is somewhere between 10,000 and 11,000 persons. That is a very large number, a very considerable fraction of the whole electrical industry of this country, and it adds to the estimation in which the electrical industry is held by the people at large to find that the telephone section of it has grown to such a large proportion. We have heard a note or two to-night of a suggestion that there are some things which are better managed by the company than by a department of the State, and, for my own part, it seems to me that, at the present time, that remark might be very well thought of in some other branches of the electrical profession than by yourselves. We are now in some danger of seeing private enterprise swamped by the ambitions, shall I say, of municipal authorities, local authorities, and of the departments of State themselves. Well, I should be the last man in the world to suggest that municipalities had no rights, that the municipalities were not perfectly in their proper place in desiring to be prosperous and self-governing, and in desiring to be, to a large extent, locally independent, but I maintain that there is room for private enterprise, and we should be careful in so progressive a thing as the electrical industry that we do not strangle or maim the chances of progress by too early putting enterprises under the wing of what we may call administrative bodies. Perhaps the threatenings which have been heard from time to time in the last few years with regard to the telephone service have not been without their influence upon the National Telephone Co. They have been, perhaps, a warning that things must be kept up to date, that matters must not be allowed to drift, and that the progress we see made in other countries must be equalled, if not surpassed in our own country; and surely that is so, for if the progress, the development, the perfection of instruments, the introduction of new improvements and new inventions were to be stultified by the maladministration of a company, then that company might just as well hand itself over and become a pure piece of Governmental administration. But so long as you have your individual capacity, and exist as an industrial enterprise, not fettered by red tape, it behoves you to be alive to the possibility of improvement. In the 10,000 or 11,000 members of your staff are not there many, possibly, possessed of original ideas, men who can say what is wanted and suggest how to do it? Is not a company more likely to take up improvements and push them forward than an administrative department of the Government? I venture to believe that the telephone industry can be improved by new inventions. Here we are only about 21 years old as a branch of the electrical industry. Here is this century closing and the telephone industry developed to the extraordinary extent that we see to-day, and that in 21 years. I trust to live and be present at the next 21st occasion of the company's staff dinner. If that be so, what may we not then expect to see? Among them many things yet to be attained. Wide is the field for invention. We have yet to realise the dream of speaking across the Atlantic—above the Atlantic or under the Atlantic—to America. When I think of all that has been done and may be done by the wise administration of a company like this to foster progress—the members of the electrical profession in all parts of the world are trying to do someting to surpass us, they are trying to make electrical inventions subserve national uses—when I think of all these things, surely I am entitled to hope that some of the future improvements and inventions will come from inside the National Telephone Co. I am glad to be here and to have the opportunity of saying this to you, and I am glad to encourage you in the good progress which has been made during the past few years. Some people are, perhaps, a little afraid of new inventions. For my own part, I am glad to be young enough to rejoice in the chances of seeing something futher in the way of inventions and discoveries.

Mr. T. A. PROUT, in feeling terms, proposed a toast not in the programme, "Our Chairman, the General Manager," whose fairness and kindness had endeared himself to all the staff, whose universal wish it was that he might be long blessed with the best of health to preside, not only over the business of the company, but at their festive gatherings.

The toast was enthusiastically responded to.

The CHAIRMAN, in responding, said: I am very proud, as I have said before, to be at the head of a staff such as the National Telephone Co. possesses. I believe it to be second to none, as I do not think that any great organisation, any company, possesses a better staff than does this company. I believe it is a loyal staff; and in the times that are, perhaps, before us, loyalty will be worth a great deal to the company.

This terminated a very pleasant evening's proceedings, and the large company shortly afterwards separated.

The Prussian Academy of Science.—Among the items included in the Prussian Budget is a sum of 7,800,000 marks, for the purchase of lands in Berlin, on which is to be erected a building for the Academy of Sciences and the Royal Library.

PHYSICAL SOCIETY.

An ordinary meeting was held, by the invitation of Sir Norman Lockyer, F.R.S., in the Solar Physics Observatory, South Kensington, on Friday, April 27th, Mr. T. H. Blakesley, Vice-President, in the chair.

Sir NORMAN LOCKYER gave

"A Short Account of the Physical Problems now being Investigated at the Solar Physics Observatory, and their Astronomical Application."

The chief work carried on at the observatory is the comparison of stellar spectra with spectra obtained from lights emitted by laboratory sources. The light from a star (or the sun) and from an arc (or a spark) are focussed alternately upon the slit of a spectroscope, and the two spectra are photographed side by side upon the same plate. The number of lines in the arc spectrum depends upon which part of the arc is focussed on the slit. The image of the centre is rich in lines; the image of the edge gives a few single lines. Changes in spectra are also dealt with. The thickening and thinning of lines depends upon several things. In the first place, it depends upon the density of the substance, and thus the hydrogen lines in the spectrum of Sirius are much broader than those in α Cygni, the hydrogen being denser in the former star. Changes may also be produced by variations in quantity. A $\hat{c}$ reduction in the quantity of a substance generally simplifies its spectrum, the longest line disappearing last. The motion of a luminous body to or from the spectroscope alters the wave length of the light emitted, and produces a shift in the lines of the spectrum. The amount of deviation is a measure of the velocity of approach. In the case of Nova Aurigæ we have dark and bright lines of the same substance side by side. This shows that there are two bodies involved moving with different velocities, the one giving a radiation and the other an absorption spectrum. Another change in the lines depends upon temperature. In general, an increase in temperature produces a greater number of lines, a notable exception being sodium, which gives its full number of lines at the temperature of an ordinary Bunsen flame. The spectra of metals obtained from the arc and by sparking are often quite different. Those lines, which make their appearance or are intensified in passing from the arc to the higher temperature of the spark, are known as enhanced lines. The comparison of stellar spectra with laboratory spectra is often easy. For instance, the presence of iron in the sun and hydrogen in Sirius is easily seen. Several lines in the spectrum of Bellatrix have been shown to be due to helium, the position of the lines being exactly the same as those due to the gases from clevite. In many cases it is possible to build up the spectrum of a star from the spectra of its constituents taken at the proper temperature. For instance, the spectrum of γ Orionis can be closely imitated by means of oxygen, nitrogen, and carbon together with the well-marked lines of hydrogen and helium. We can roughly estimate by the character of the spectra of stars, the temperature of those stars, and thus arrive at a stellar thermometry. Starting with a hot star like Bellatrix and passing through β Persei, γ Lyrae, Sirius, Castor, Procyon to Arcturus, a cold star, we have a gradual change in the character of the lines which appear in the spectrum of any constituent. The widening of the lines in the case of spectra of sun spots enables us to trace changes in temperature of the sun, and we can compare these temperature changes with a variety of terrestrial phenomena such as variation in latitude. The extraordinary number of lines exhibited by many metals suggests that, what we are accustomed to call chemical elements are really complex bodies which are made up of simpler ones. Attempts have been made to build up the spectra of metals by superimposing simple sets of lines upon one another. In many cases a great number of series would be required to represent things completely. In the case of hydrogen it would be necessary to have at least 27 series to give the structure spectrum only. Taking the atomic weight of hydrogen as unity, the atomic weight of the little masses which might give use to any one of the series would be about 0·0019. This is of the order of magnitude of the small bodies whose existence has been suggested by Prof. J. J. Thomson from his work on ions.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Le Fluor et ses Composés." By H. Moissan. (Paris: G. Steinheil.) 15fr.

"Thermo-Geographical Studies." General Exposition of the Analytical Method Applied to Researches on Temperature and Climate. By C. L. Madsen. (London: Williams and Norgate.)

"Elementary Lessons in Electricity and Magnetism." By Prof. S. P. Thompson, F.R.S. 1900 edition. (London: Macmillan and Co.) 4s. 6d.

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LEGAL INTELLIGENCE.

(*Continued from page 93*).

Chamberlain and Hookham v. the Corporation of Bradford.

In the Chancery Division of the High Courts of Justice, on Tuesday, Mr Justice Farwell commenced the hearing of the action by which the plaintiffs, Messrs. Chamberlain and Hookham, seek to restrain the Mayor and Corporation of Bradford from infringing a patent for electric light meters held by Mr. Hookham, and numbered 4,225, of 1885. Mr. Moulton, Q.C., Mr. A. J. Walter, and Mr. Gray represented the plaintiffs; and Mr. Cripps, Q.C., Mr. Bousfield, Q.C., and Mr. Graham represented the defendant Corporation.

Mr. MOULTON, in opening the case, said that the action was brought by the plaintiffs on letters patent No. 4,225,* of 1885 (twice amended), which were granted to Mr. George Hookham,† and the defendants were the Mayor and Corporation of Bradford. The patent was for an electric meter —that was to say, an instrument which registered the amount of electric energy supplied on an electric lighting circuit to a house or to any other establishment. This patent had stood the test already of an action before Mr. Justice Wills,‡ who supported, and all the defences, conceivable and unconceivable, were raised in the present case, including some which were decided by Mr. Justice Wills. He did not propose, in his opening, to deal particularly with those defences because he had the certificate of validity already, and he did not know on what particular portions of the defence his learned friends would rely. Many of the points raised were points of law, and on these this court would follow the decision of a court of co-ordinate jurisdiction. The essence of a useful system of supply was that it should be kept at a uniform pressure, and well-managed companies kept their supply within one or two per cent. of the proper pressure. What he had to deal with was the measured quantity. "Quantity of electricity" was an idea which, although necessary for theoretical purposes, was most unhandy for practical life, and so they reckoned total quantity of electricity by the current running for an hour, and thereby took the standard of current. They reckoned it by ampere-hours—that was to say, the amount which one ampere would carry along in a whole hour. So far he had been dealing only with the current, and current told them very little about the amount of supply. Now, the Board of Trade unit was one of 1,000 amperes at 1 volt pressure. If the standard pressure at which all these systems were worked was 100 volts, the Board of Trade unit corresponded to 10 ampere-hours at that pressure. They therefore had to measure the quantity supplied in ampere-hours. If they had that they had an accurate measure of the energy that was passed in. Edison's electrolytic meter worked very fairly, but only as a pioneer idea. There therefore remained a hopeful field for designing a proper meter. The learned counsel then explained to the Court a rough model of a dynamo. When the brushes were connected to a source of electric current the armature tended to turn round, and the strength with which it tended to turn round depended clearly on the magnitude of the current which went into the armature. If they kept the outside magnet quite constant, and measured the twist to see how much it was attracted then they could get an indication of the current at the moment. The next step taken was for measuring the amount supplied over a long period. The twist was proportional to the current, and it was necessary to balance this twist by making the armature of the motor, in turning, do work against a resistance which increased with the speed of the meter until it balanced the twist. Some people had employed paddles in a liquid for this resistance or brake, but true proportionality to the current was not attained by this means. This could be done by a copper disc rotating between the poles of a magnet, and such a brake was explained to the Court with the assistance of a model. Mr. Hookham was the first person who used the principles in the combination now before the Court in such a manner as to make a practical meter, and that was practically the judgment of Mr. Justice Wills. He (Mr. Moulton) had pleaded on this subject before Mr. Justice Wills with some earnestness because when he had his first installation at his own house he had found that his first account was 95 per cent. wrong. But, to proceed, the meter ought to start very willingly and with little force, otherwise there would be a supply which would not be recorded, and therefore it would not be accurate. The meter must also rapidly take up its steady rate. There must be little mechanical friction of the pivots because that would blur the accuracy of the registration. Mr. Hookham early recognised that what they had to do was to increase, as far as possible, the supremacy of electrical forces and diminish, as far as possible, the interfering forces. He was the first to discover how to produce a practical meter of this kind, and the success of it had been very great indeed. His lordship had before him the meter exactly as it had been drawn in the specification. The principle was still the same. Any changes were changes of detail or of greater perfection of workmanship, and the meters had won for themselves high estimation as exactly accurate registers of the total amount of electricity supplied. He would now have to refer to the provisional specification, because, notwithstanding the decision of Mr. Justice Wills, the question of disconformity was being raised by the defence in this case.

Mr. CRIPPS said he did not raise disconformity in the ordinary sense of the term, but on the construction of claim 3, and in connection with that, the provisional specification was important.

Mr. MOULTON then read portions of the provisional and complete specification, and, with the help of Mr. SWINBURNE, explained to his Lordship the various parts of the meter on a model constructed by the plaintiffs according to the specification. Mr. Moulton then read the claims from the specification. The first claim, he said, really claimed the type of meter now before the Court, and so it had been held by Mr. Justice Wills. The plaintiffs alleged the infringement by the defendants of that claim and of the third claim (in the amended patent). As to disconformity that only turned on the question of whether a man had put in a claim for one invention and produced another. But a man had time to improve upon the claim that he put in originally. He had nine months during which to work out and improve upon what he claimed in his provisional specification. The provisional specification was merely a kind of enlarged title. The title improvements in electricity meters might have become to be too vague, and something more definite might be wanted. The defendants said that if having got this specification anyone went over the field of electrical literature and picked out a bit here and a bit there and a bit elsewhere they might find possibly that people had previously held the ideas of Mr. Hookham. Well, that was very likely. But Mr. Hookham was the first to make a practical affair of this meter and had rightly claimed it. The Bradford Corporation in their character as electricity supply dealers were the defendants in this case, and he would produce now to his Lordship one of the meters which they used. It looked very different from that of the plaintiffs. They had chosen the arrangement in which the current went through the field instead of the armature and they must have an armature which had a constant current. (Mr. Swinburne here again mounted to the Bench and explained the apparatus to his Lordship.)

Mr. MOULTON, continuing, said that what the Bradford Corporation had done was that they taken the vertical spindle which his patent claimed. Their brake disc was revolving between the poles of two permanent magnets with large polar ends close together. The plaintiffs said that the Bradford Corporation instrument infringed both the first and the third claims for large and permanent magnets. Mr. Justice Wills had realised that Hookham was the first person to make a meter of this kind; that he was justified in claiming it and although the question was very different it was only a variant—only taking one of the alternators just as in this case the defendants were taking one of the alternatives set out in the specification.

Mr. Justice FARWELL: But how far can you monopolise principles which are known?

Mr. MOULTON said they could not do so, but if one took certain principles and made a practical meter then he could claim for that and within that claim he was entitled to prevent another from infringing.

Evidence was then called.

Mr. GEORGE HOOKHAM, examined by Mr. Walter, said he had devoted a good deal of time to the study of electricity, and he was the patentee of 4,225* of 1887, relating to this electric meter. At the time of his taking out that patent there were only two practical meters in use, or on the market (the Edison electrolytic and Aron). So far as he knew there was no meter of the character described in his specification. The meter which was before his Lordship (referred to throughout the case as G.H. 2) was constructed in accordance with the drawings in the specification. That was one of the first meters constructed by him. The drawings were made from such a meter. (The Witness pointed out and explained to his Lordship the different portions and other devices of the machine). In order that the apparatus should meter correctly the field or armature had to be constant. In the apparatus in question whether constancy could be maintained depended upon the whole construction of the magnetic circuit. He found when he came to work on the subject that he could get a powerful field with steel which was absolutely permanent. It was necessary to have a practically closed magnetic circuit.

Mr. WALTER: May I put it that until you pointed out the conditions of a powerful permanent magnet such things had never before been made?—So far as I know they had not been made before nor the possibility of them believed in.

It is alleged that that specification is insufficient to enable a person to produce the required result. What is your view?—I think it is perfectly sufficient.

Examination continued.

He had sold a considerable number of the meters in the actual form described in the specification. So far as he knew they gave satisfaction as meters of electricity. He did not think he had submitted that form of meter to the Board of Trade.

Mr. WALTER: It is suggested that your invention is not new. So far as you know was your invention as described in the specification new at that date?—Yes, so far as I know.

What is the nature of the current supplied upon the Bradford circuits?—It is continuous or direct current at a constant voltage between 200 and 250 volts, but I am not sure.

Cross-examined by Mr. Cripps.

On the circuit such as the Bradford it made no difference whether it was a current meter or an energy meter.

Mr. CRIPPS: When you have a current meter it is specially designed not to take any notice of change of pressure?—Oh no; it is not specially designed for that. It is designed on the assumption that changes of pressure need not be taken any notice of.

Cross-examination continued.

It was not quite true to say that if the potential varied at any time his current meter would not chronicle it in any way. The object of the energy meter was to chronicle differences in pressure as well as differences in current, whereas his meter chronicled current only. In order to have a correct current meter, it was necessary to have an electromotor with constant, or nearly constant, field.

Assuming you want to measure variations in energy, it would be destructive to that to have an electro-motor with constant, or nearly constant, field?—The Witness said that would be so.

The WITNESS, continuing, said that he did not claim to have discovered eddy currents or the saturation of the magnets. He did discover

† An abstract of this patent will be found on page 101 of this issue.
‡ *The Electrician*, Vol. XXXVIII., pp. 601, 617, 622, 665, and 839.

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how to make a powerful and constant magnet. In 1887 witness took out a specification for an energy meter. It was subsequent to his specification for a current meter.

Mr. CRIPPS; Supposing the electromotive force did not vary, the only force they had to measure was the current force. But if you wanted to measure the electromotive force, the defendants' meter would do it and yours would not?—Yes; that is so.

Cross-examination continued.

The defendants only passed the shunt currents through the commutator, and witness passed the whole current. He had permanent magnets. It was necessary to have the magnets powerful. The same form of magnet would be powerful whether it was applied to the motor or the brake. It depended upon the shape of the armature and the shape of the brake. In his case he had the armature and brake moving in the same field.

Is not the form of magnet which you refer to in your specification the form known as the built up or compound magnet?—I am not familiar with those names.

Cross-examination continued.

What he referred to was a magnet with added pole pieces.

Mr. CRIPPS: Just look at the following passage in your specification: "In place of electromagnets, as described and represented, I prefer using for smaller installations permanent magnets, a number of bar magnets being substituted for the electromagnets represented in the drawings, though I may use magnets of other shape or configuration." Now, is not this model which I have got in my hands a model of what you call there a number of bar magnets with iron pole-pieces, which are represented by the black wood (handing the model to the witness)?

The WITNESS: Yes. That would produce the result that mine produces.

Cross-examination continued.

No magnet of that form was used by the defendants. The defendants' was another shape or configuration. The term "pole pieces" used in his specification meant pole pieces, or added pole pieces, as distinct from the magnet itself. There was nothing in his specification which showed that he contemplated a magnet without an added pole piece.

The WITNESS stated that the principle of having an electrical generating machine "having a constant field and working on constant resistance, or, stated generally, by any arrangement involving the motion of a conductor relatively to a magnetic field, the strength of the field being maintained constant and the current in the conductor being proportional to the rate of rotation" had already been explained and described by a great number of people. The merit he claimed was applying the principle to the electric meter. His first claim was for an electricity meter for measuring currents, consisting of an electro-motor with constant field. For the purpose of measuring currents a constant field was necessary. If you wanted to measure energy, a constant field was destructive.

Mr. CRIPPS: What I want to call your attention to is that there is no arrangement in the defendants' meter which is anything like the arrangement that you have adopted in the motor part of it?—I am afraid that is hardly for me, but if you ask me I should say it is covered.

Cross-examination continued.

The meter as used at Bradford had a practically constant field.

Mr. CRIPPS: Do let us consider. Supposing there is a variation in energy, the meter would show it because the field would be inconstant?—Certainly.

But if you have no variations in your electromotive force and do not want to measure it, then you might get the same result with one machine as with another?—That is our case.

But if you want to measure energy, and have to measure it, then the defendants' field is a field machine and it is essential that it is inconstant?

The WITNESS: Yes, but Bradford does not want to measure energy.

Now in order to get constancy of field you either have a saturated magnet or a permanent magnet?—Yes, or I give a third method: "In electrical circuits in which the electromotive force is practically constant this degree of saturation in electro-magnets is not essential." Then I go on to say what I prefer.

Cross-examination continued.

So far as the defendants are concerned in connection with the motor part of their machine they neither had a saturated magnet nor a permanent magnet. He could not agree that they had no device whatever for obtaining a constant field. Bradford took the device of putting it upon a constant-pressure circuit; the meter itself, he agreed, had no such devices.

I am taking the meter itself?—But you see we only attacked it where used at Bradford where the field is practically constant.

Cross-examination continued.

An electric brake with a permanent magnet was in no sense new at this time. He knew of a case where a disc was used with an electro-magnet brake, but he did not remember one with the permanent magnet.

The witness was next questioned as to Siemens' energy measurer.† The brake power there was given by a fan revolving in some fluid. There was a series motor in connection with that fan.

I am putting to you that the motor there, as far as the motor is concerned, is exactly the same as the defendants'—there is no difference?—Yes. I believe that is so.

Mr. CRIPPS: Could not anyone taking Siemens' energy measurer and putting in the electric brake for the fan have produced an energy motor like the defendants?—Well, apparently Siemens could not. Of course it seems easy when it is done.

I put it to you: Was not the practical difficulty simply the invention of a suitable form of commutator?—Oh, dear no. Certainly not; there were other difficulties.

† Described by M. Deprez in the *Lumière Electrique*, Vol. II. (1884), pp. 223 and 224. For an abstract of this article see p. 103 of this issue.

Your attention has been called to Ayrton and Perry.† Now I put it to you that every feature in the defendants' energy meter is found in Ayrton and Perry, and the only difficulty that Ayrton and Perry did not get over was the friction point?—I should say that almost every possible form is mentioned in Ayrton and Perry, and of course the defendants make a selection, but I think it has almost logically exhausted all the possible forms in theory.

The WITNESS stated that he took exception to the learned counsel speaking of the Ayrton and Perry meter. There was no Ayrton and Perry meter.

Then take the Ayrton and Perry specification. Does not that describe everything that is necessary and describe it accurately for the energy meter, except that it does not show a way of getting over friction? I should have read it through from that point of view. I do not remember that it shows how to get the constant field from the brake in practicable form. I do not remember that, but that is the first point that occurs to me.

I am putting to you that in Ayrton and Perry you find everything that we have in the defendants' meter, except they did not get over the difficulty of friction which has been got over in the defendants' meter?—You find a sort of suggestion of everything. I do not think you find anything that helps you towards making a meter, except a bare theory of the Foucault brake, which of course was a great thing to point out from the point of view of theory, I am not diminishing from the value of that from the point of view theory, but it did not help people to make a meter.

Cross-examination continued:

Speaking from momory he should have said that in 1887 Ferranti's was hardly a practical meter.

Shown Munro's specification‡, WITNESS said that as regarded the theory of a meter, apart from the point of constancy of pressure, the theory was in that specification, but there was a great absence of detail. It did not even refer to the element of friction as a disturbing element, and probably the patentee there did not know of it at the time. The friction in the instrument, which was made under that specification, was fifty times greater than in his (Mr. Hookham's) meter.

Questioned as to Handford's (Edison)§ specification, WITNESS said that as regarded the motor part of that, the principle was the same as his.

Mr. BOUSFIELD: That is to say that you have to have a suitable electro-motor rotating in a constant field?—I do not see any provision for procuring a constant field. He believed that Handford wanted to have a constant field. So far as he had a constant field he would have the driving force proportionate to the current.

The WITNESS stated that the brake portion in Handford was quite different to his.

Mr. BOUSFIELD then referred witness to an American specification of Weston. This he said was a current indicator, and instead of metering ampere-hours, it indicated by a pointer the number of amperes passing at the moment. There was a little cup in the middle in mercury. Instead of the current being able to rotate that cup continuously, it was only able to turn it until the resistance created by a spring was sufficient to balance the turning force of the current. For that he wanted a highly constant field. In a second specification of Weston's there was what was called an electrical meter, and his plan of measuring the current passing was to cause a flow of mercury from one vessel to another. In order to get that he wanted to have a powerful and constant magnetic field. The witness added that a motor with an armature working in a constant field was not his (witness's) invention. That was found in two or three of the prior apparatus. Weston had the idea of large pole pieces closely fronting, and the idea of winding his electro-magnets so that they were saturated. It was true that Handford wanted a constant field. His objection was that the winding such as Handford had shown would not give him a constant field.

Supposing I wanted to make a Handford meter, and for the purpose of getting the field constant I wind the magnets to saturation, thereby simply using the knowledge open to the world, and outside my specification, do you say that your second claim would prevent my doing that?

The WITNESS replied that he did not think the saturation had occurred to this patentee. He thought it was a question of mere law. As a matter of fact he did think that his second claim would prevent it.

Mr. BOUSFIELD asked the witness what he thought would be the result if he took a Siemen's energy meter with a disc and used a known magnet to brake it?

The WITNESS replied that if it turned out to have a constant and powerful field substantially in the way or according to the instructions he gave, he should say it would be an infringement.

Mr. BOUSFIELD: Here is a known type of magnet, and it turns out to be strong enough and constant enough to do it. You say it comes within what you taught the world?—Yes, that is what I say.

Cross-examination continued.

There was no instruction in Deprez for producing an absolutely and powerful magnet. He thought there was a great deal in putting the pole-pieces close together. To preserve the strength of a magnet it was necessary to keep the magnetic circuit closed. The closer the poles of a magnet were together the more complete was the magnetic circuit, and the less loss took place.—That was common knowledge.

In answer to his lordship, Mr. BOUSFIELD said that the defendants' case was that magnets of the dimensions of the plaintiffs' were used for similar purposes before date of plaintiffs' specification.

Mr. BOUSFIELD said that the makers of the defendants' meters had had considerable research as to the different and best processes of manufacture for the magnets. They relied upon the ageing process for the purpose of getting the magnets constant. They had them magnetised up to the highest point. Then they were put on some rotating instrument

† See Abstract on page 103 of this issue.

‡ *See* page 103 of this issue.

§ *See* page 103 of this issue.

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which passed through boiling water and out of it again and again. That let down the magnetism some 15 per cent. In the ageing process the plaintiffs found that they got the magnets practically constant. (To the Witness). In doing that we are not borrowing from anybody.

The WITNESS: No; on the contrary, I think you are doing what is absolutely unnecessary. I have had very large experience in this subject.

Mr. BOUSFIELD: Is it possible to make a meter for alternating currents according to the description given in your specification?—I think so.

The WITNESS added that he had never made a meter for alternating currents according to this specification. He could make such a machine on another plan, and more cheaply.

Mr. BOUSFIELD: I put it to you that there is no sufficient description here, combined with the common knowledge at the date, to enable you to make an alternating meter which would work?—Yes, certainly it would. Take a Siemens meter, and put on a brake disc, and if you follow my directions you well have a perfectly suitable meter for alternating current. Do that, and the thing is done.

Mr. FLETCHER MOULTON re-examined the witness, dealing first with junior specifications. There were, he said, two classes of meters, those which measured current and those which measured total power.

A spur wheel can be used for measuring current, can it not?—If I understand properly what a spur wheel is, it would have no break at all.

Suppose you have a spring applied to resist rotation, then Monro's apparatus is capable of indicating current?—Witness agreed. That could be done either by a spur wheel or a disc. That was, however, a case of indicating current, not adding up supply.

In reply to the judge, the learned counsel said he was suggesting that Monro was dealing with an indicator of current, and not with a meter at all.

WITNESS explained that the angle through which the wheel was turned was a measure of the current passing at the moment.

Mr. Justice FARWELL suggested that it would be better to take this evidence from an expert, which the witness did not represent himself to be.

In further examination, the WITNESS said that neither Monro, Handford, Ayrton and Perry, nor the two Weston's specifications, would have enabled persons in their day to make a practical meter. He did not think that Jamin's paper would put people in the way of making constant strong magnets, such as he himself referred to. For suitability for use in a meter the union of constancy and power was necessary. To the best of his knowledge, no one had before pointed out how suitable permanent magnets for an effective meter could be obtained. In his own specification he might have two magnets, of which one was strongly magnetised and the other not so strongly magnetised. With regard to reversal of function of the armature and the field it was, generally speaking, quite possible to take your choice whether, you had the current through the field or through the armature.

Does that apply to a circuit of constant potential, such as an electric light circuit? Is there then any difficulty in using either?—No.

WITNESS considered that in the case of a current which would vary greatly, the small current would be through the armature. In that case the saturation would be of the stationary part. Apart from the cost of energy there would be no difficulty in that at all. Supposing for any reason it was desired to get saturation in the working part it was by no means impracticable. A person reading the Hookham specification would, he believed, be able to do it if he chose to.

Mr. MOULTON intimated that he would only examine the witness on a few points, and the others would be taken in detail from subsequent witnesses.

The WITNESS declared that Ayrton and Perry had not within his knowledge made a meter at the time of witness's publication.

How many years was it before they succeeded?—One of them, Prof. Perry, made a meter I think in 1890.

WITNESS said that in the same year he took out a specification for an energy motor, but that was before the publication of his first specification. The two were convenient, and were at the same time in the Patent Office.

In regard to the infringing meter, was it an infringement inasmuch as the current passing through the armature is with a constant potential?—Yes. There was a shunt coil in the field. A little current ran through that quite independent of the lamp circuit.

So there is a complete motor apart from the lamp circuit?—Certainly.

If, said the WITNESS, in order to get a good contact so as to have no resistance at the commutator brush you had excessive pressure, that gave friction. It was so important to get good contact that it had to be sought, even though it gave friction. He could not see that it made any difference whether the pole pieces were cast in one or joined on. His original meter was a practical meter in its time, and not surpassed in accuracy by any motor meter, though surpassed by the Edison deposit meter, and possibly by the Aron meter, which worked by clockwork, but not by any self-containing meter.

Mr. JAMES SWINBURNE, examined by Mr. Walter, was the next witness. He said the importance of meters was fully realised long before 1887, though actual demands for instruments were small. As early as 1884, inventors were endeavouring to find a meter. The essential requirements of a meter were that it would measure electric energy, or in practice the electric current; it must have a proper range, and of course be accurate throughout that range. It was useless having a meter which was useful for ten lamps and useless beyond 12 lamps, and the meter must start with one lamp. In those days there was difficulty in getting a meter which would start with one lamp when there was a large installation. As regards the use of magnets, he knew of no one before Hookham who designed permanent strong magnets, although fairly strong and fairly permanent magnets might be found in various places. Hookham's use of mercury he thought was new. Mr. Hookham was right in pointing out the advantage of having a constant field, and, if he might respectfully say so, took a very intelligent means of carrying it out.

Do you know what meters were, in fact, in existence at the date of Hookham's specification?—Ferranti's; I remember working at his meter from 1884 onwards. I do not know whether the Aron meter was at work at this time. I do not think there was any meter in actual use.

There was the Edison deposit meter. That, said the WITNESS, was not in use in this country, though in extensive use in the United States. The Ferranti meter was not of the Hookham type at all. The motor part should have followed the square law, and the brake part of it ought to have followed the square law, but neither followed any law accurately. Ferranti's meter had a fairly good range. It worked on entirely different lines than Hookham's meter.

The witness was taken *seriatim* through the specifications prior to Hookham's. Munro employed a Barlow's wheel. There was nothing in his Paper to show that he knew anything about the action of a brake. Munro, in his opinion, did not teach anything as regards the operation of a meter, and would not enable a person to produce a practical meter. Ayrton and Perry pointed out the use for a meter of a motor, and their specification gave a full explanation of the theory of what he would call a straight line meter, but it did not carry the matter beyond theory.

I think we learnt from the patentees in the witness box at the last trial that they had not produced a practical meter?—We did hear something of the kind, I believe.

In your view would this enable anyone to make a practical meter on the lines laid down?—I do not think it is necessary to go into hypothesis at all; it did not. There is not enough disclosed.

As regards Handford's specifiation, the WITNESS said he found no instructions given respecting the saturation of the magnets. It taught the manufacturer of a meter nothing. Abel's specification was not for an ampere-hour meter, but was a meter recording the flow of current at any particular moment. This gave no indication as to the strong magnetisation of the magnet. Yeatman's specification of 1885 concerned the motor only, and not the brake, and told nothing about the brake. It did not teach the world how to manufacture a meter that would mete. Weston had got the field-magnets. It did not teach Hookham's invention; of course, it went in that direction, but, in fact, the knowledge was not Weston's. It was common knowledge at that date that saturated field-magnets could be used as instruments. Weston, in his other specification of 1885, might have had a pious wish to obtain an ampere-hour meter, but it did not work. The apparatus would not work at all unless it had a very considerable current passing. As regards meter construction, it contained nothing to lead anyone to a successful meter.

Constancy of field had been used in measuring instruments before, but not in meters?—Yes.

WITNESS said Siemens had suggested for purposes of a brake a device of fluid friction. Deprez gave to the world nothing more as to the constructional part than Ayrton and Perry; no direction as to how the strength and permanence of the magnets should be obtained. Deprez did not disclose plaintiff's invention. There was nothing to be learnt from Rankin and Siemen with reference to powerful constant magnets. In his opinion the researches of Jarmin did not disclose the Hookham invention. He also thought that Dredge's specification did not disclose Hookham's invention. He was acquainted with the meter used at Bradford. The motor was a straight line motor, and the brake a straight line brake—permanent magnets from permanent magnets—It followed the straight line law and gave strength and constancy to the field. That followed in his view the instruction indicated by Mr. Hookham. At Bradford there was a constant pressure supply upon the mains used at Bradford; the character of the field would be constant, and the little auxiliary force would be constant. The meter could not work properly without a constant field. The meter in use at Bradford measured ampere-hours.

This closed Wednesday's proceedings.

Yesterday Mr. Swinburne was cross-examined by Mr. Cripps, and as a third witness for the plaintiffs Mr. Dugald Clerk was called. After he had been examined by Mr. Walter and cross-examined by Mr. Graham, Mr. FLETCHER MOULTON said that he had Prof. Boys in Court, but as he had already called three witnesses he did not wish unnecessarily to increase the bulk of the evidence, and asked whether the defendants on their side would limit their evidence to three witnesses. Mr. Cripps, however, would give no such undertaking.

Mr. WALTER then read the *verbatim* report of Mr. Justice Wills' judgment in the case of Chamberlain and Hookham *v.* Johnson and Phillips (see *The Electrician*, Vol. XXXVIII., p. 839) in which the validity of the Hookham patent was upheld. This closed the plaintiffs' case.

Mr. CRIPPS then opened the case for the defence, and was speaking when the Court adjourned. A full report of yesterday's proceedings will be included in our next issue.

We give below an abstract of the Hookham patent, No. 4,225 of the year 1887, which is alleged to have been infringed.

An interesting point, though it may have no direct bearing on the case, is that the patent which was applied for in March, 1887, has been amended twice by the patentee during its life; once in 1889, and then again in 1895. To show where the alterations have been made we print the first additions between asterisks, the later additions in italics, and the corresponding deletions in square brackets.

The title of the patent is "Improvements in Electricity Meters, Parts of which Improvements are applicable to Dynamo-Electric Generators and Motors."

The PROVISIONAL SPECIFICATION is as follows:

"My invention consists of the improvements hereinafter described in electricity meters, parts of the said improvements as hereinafter pointed out being also applicable to dynamo electric generators and motors. I

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will describe my invention as applied to an electricity meter. My said electricity meter consists essentially of an electro motor with constant or nearly constant field, the armature carrying the current to be metered and an electric brake, consisting of a mass of metal in the form of a disc, cylinder or other figure of rotation rotating in a magnetic field in such a manner as to have "eddy" or so-called "Foucault" currents generated in it. When all other work done by the motor is negligible compared with that done against "eddy" currents the speed of rotation of its armature is directly proportional to the armature current.

"The electro motor may be of any convenient kind or form.† It may, for instance have a drum, ring, or disc armature. Or it may consist of a simple solid disc or cylinder rotating between magnetic poles. In the latter case, however, I prefer to‡ use two thicknesses of metal in the disc or cylinder, the one carrying the current to be measured to be insulated from the other except near the centre. And in order to confine the current to a narrow field the said disc or cylinder may be slit in directions at right angles to the motion in the field, or instead of a disc or cylinder so slit insulated wire or metal strips may be used.

"The electric brake may be formed by the armature itself or it may be attached to the armature so as to rotate in the same field, or it may be independent of the armature and rotate in a separate field or a separate brake may be used in addition to an armature brake. In order that other work done by the motor may be very small compared with the work done on the electric brake, special means to reduce friction are adopted. If the axis of the motor armature is horizontal the spindle is supported on friction§ wheels and if vertical or nearly vertical on hardened points, and in both cases I use mercury contacts or commutators where practicable.

"If the spindle of the motor is horizontal, I form a double‖ commutator, consisting of two sets of insulated spokes or projections placed side by side, each set dipping into a mercury trough, the mercury troughs being connected, one with each terminal of the machine. Each commutator spoke is put in connection with the one opposite to it on the other half of the double commutator, so that the mercury troughs, though both on the same side, act as ordinary brushes act when placed on opposite sides of the commutator. If the spindle is vertical, I take the advantage of the high surface tension of mercury in virtue of which it may be made to stand above the level of the vessel containing it. The ends of wires or metallic strips from the vertical armature can thus cut the mercury without touching the vessel.

"When I use a motor consisting of a simple solid disc or cylinder, I may, in order to economise magnetising force, corrugate the disc or cylinder in concentric rings, and form the magnet poles to correspond in a manner analagous to that described in the provisional specification of the application for patent made by me on January 6, 1887, No. 187, and thereby not only lessen the resistance of the non-magnetic space, but in this case also increase the efficiency of the driving current.

"If in any case it is found impracticable to render friction or other disturbing causes inappreciable I may 'compound-wind' the magnets of the motor, or if they are separate, of the electric brake, or both.

"In cases where iron is used in the armature or the electric brake, I may so dispose the magnets as to counteract gravity, and thereby lessen friction, or if the spindle is vertical I form it of iron, and place it in the axis of a solenoid having a similar action.

"For alternating currents the magnet cores, and if of iron the armature core, must must be be finely divided into wires or metal strips.

"The revolutions of the meter are registered by means of counting apparatus of an ordinary type.

"The double commutator, and the corrugation of the disc or cylinder hereinbefore described, are applicable to dynamo electric generators and motors."

The commencement of the COMPLETE SPECIFICATION is identical with the first four paragraphs above (to the word "vessel"), except for the slight alterations mentioned in footnotes. It continues:

"When I use a motor consisting of a simple solid disc or cylinder I may, in order to economise magnetising force, corrugate the disc or cylinder in concentric rings, and form the magnet poles to correspond, and thereby not only lessen the resistance of the non-magnetic space, but also increase the efficiency of the driving current. If in any case it is found impracticable to render friction or other disturbing causes inappreciable, I may 'compound-wind' the magnets or armature of the motor, or, if it is separate, of the electric brake.

"In cases where iron is used in the armature or the electric brake, I may so dispose the magnets as to counteract or partially counteract gravity, and thereby lessen friction. For alternating currents the magnet cores, and, if of iron, the armature core, must be finely divided into wires or metal strips.

"The rotations of the axis of the armature of the meter are registered by means of counting apparatus of an ordinary type.

"The double commutator and the corrugation of the disc or cylinder and pole pieces hereinbefore described are applicable to dynamo electric generators and motors."

The way in which the "said invention is to be performed" is next described, with reference to drawings. The armature consists of a series of metallic sectors, making up a circular disc with radial slits, the sectors being insulated from one another by these slits. These sectors do not extend to the axis of the machine. They are carried by a circular disc which is mounted on the axis, and constitutes the brake referred to above; but the sectors are insulated from this disc. The method of interconnecting these sectors is next explained; and then the commutator and the mercury troughs, in order to avoid the friction of a brush or spring upon the two opposite sectors and to effect the transmission of the current through mercury which is practically frictionless."

The specification continues: "If for any reason I desire to make the axis of the meter vertical, I may make use of the high surface tension of mercury to form a nearly frictionless commutator by means of two cisterns of mercury, filled so completely that the surface of the mercury at a little distance from the side of the vessel stands higher than the edge of the vessel. In such case the segments of the commutator will revolve horizontally, and then the commutator need not be divided, but may consist of horizontal sectors moving in one horizontal plane."

The Foucault brake is then described as follows:—

"The brake consists of a metallic disc, *b*, preferably of copper, fixed on the axis *a*, and consequently rotating with it. As the said disc *b* travels between the pole-pieces *f*, *g*, electric currents (commonly known as 'eddy' or 'Foucault' currents) are generated in the said disc *b*, the resistance they cause to the motion of the disc being proportional to its velocity. It is of importance to increase as far as possible the magnitude of these eddy currents. In order to do this I form the pole-pieces *f* and *g* with grooves in them radial or nearly radial to the axis of rotation of the armature, as shown in Figs. 1, 2, and 3. The said grooves increase the retarding action of the brake disc *b*. They may be either made in both of the pole-pieces *f* and *g*, as shown, or only in the pole-piece *f* nearest the brake disc *b*. Though these grooves are advantageous, they are not essential, as both the pole-pieces may be without grooves."

Next, the method of reducing the friction of the axis on its bearings by an arrangement of "anti-friction wheels and adjuncts" is described. Methods of standardising the meter by varying the resistance of the shunt-circuit, or by using a bar of iron to partially short-circuit the magnetic field, are mentioned; and it is added that the latter idea is applicable when permanent magnets are used.

The inventor does not limit himself to the use of an armature divided into sectors, as a continuous disc may be employed in which the current travels only between the axis and periphery. The latter arrangement, he says, although inferior in sensitiveness to the former, may be conveniently employed when heavy currents are to be measured. The specification then goes on:—

"In the meter described and represented the main current passes through the armature and the shunt through the field magnet, but similar results may be obtained by reversing this arrangement, in which case the use of iron in the armature is preferable.

"In order to enable the meter to measure current the field must be constant, or else the armature must be of constant magnetic power, and the current to be measured must in such latter case pass round the field magnets. To obtain this constancy in electro-magnets they must be saturated, and the magnetising force and the dimensions of the core must be so proportioned as to secure this. The constancy of the field in which the brake moves (in the case in which it moves in a separate field) may be secured in an analogous way. *In electrical circuits in which the electromotive force is practically constant this degree of saturation in electromagnets is not essential.* But I prefer to have as field magnets both of the electro motor and of the brake permanent magnets, as they can be made to be very powerful and very constant by the following means.

In place of electromagnets as described and represented I prefer using for smaller installations permanent magnets, a number of bar magnets being substituted for the electromagnet represented in the drawings, though I may use magnets of other shape or configuration; but in all cases in which I use permanent magnets whether for the field of the motor, or of the brake, the pole-pieces should have their surfaces very large compared with their distance apart as represented in the drawings, so as to form a narrow slit in which the disc armature revolves. When this is done the permanent magnets are practically constant, and this arrangement is essential to the constancy of permanent magnets unless the disc is of iron, which is objectionable on other grounds. The power and constancy of these permanent magnets are increased by magnetising them when in position, which is easily done by wrapping wire round them and passing a powerful current through the coil so formed. *I prefer to make the ratio between the area of the pole-pieces and the distance apart of the said pole-pieces at least 70 times as great as the ratio between the sectional area of the steel magnets and the length of the said magnets.* . . . . Although I have described only that form of electric brake which I prefer to employ, yet I do not limit myself to that form, as it may be replaced by any electrical generating machine having a constant field and working on constant resistance, or stated generally by any arrangement involving the motion of a conductor relatively to a magnetic field, the strength of the field being maintained constant, and the current in the conductor being proportional to the rate of rotation. The armature itself may be made to act as an efficient brake, and the brake disc dispensed with by making the sectors of thick copper and of considerable breadth as compared with the teeth or projections of the pole-pieces. Although I prefer generally to use only one pair of poles, I may use a second pair of similar poles symmetrically disposed on the opposite side of the axis.

The following are the claims, the amendments being shown as stated above:—

First.—An electricity meter for measuring currents consisting of an electromotor with constant field arranged substantially as hereinbefore described and illustrated in the accompanying drawings, the said electromotor being combined with an electric brake also moving in a constant or nearly constant field, preferably the same field as that in which the armature rotates, substantially as herein described and illustrated in the accompanying drawings.

[Secondly, Compensating for magnetic drag or friction, or both, by compound winding either the armature or the magnets.]

[Thirdly] *Secondly*—In electricity meters the obtaining a constant field either for the brake or the armature or both by the use of electromagnets of such construction and dimensions that they become saturated while in

† The complete specification has "of any of the ordinary forms now in use."

‡ The complete specification has "may" instead of "prefer to."

§ "Anti-friction" in the complete specification.

‖ The complete specification has "double or divided."

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use in circuits of the kind for which they are designed, substantially as herein described.

[Fourthly] *Thirdly.*—In electricity meters the use, for the purpose of procuring a "powerful and" constant magnetic field, of permanent magnets arranged as described, with very large polar surfaces closely fronting each other "so as to form a narrow slit in which the disc armature revolves", whether the same be magnetised in position or otherwise, and the means described for regulating the same when or if necessary, substantially as herein described and in part illustrated in the accompanying drawings.

[Fifthly] *Fourthly.*—In electricity meters the construction and arrangement of parts forming a divided commutator making contact by means of mercury placed in insulated vessels substantially as hereinbefore described and illustrated in the accompanying drawings, and the use of the divided commutator in and in connection with dynamo machines or electromotors as described.

[Sixthly] *Fifthly.*—The construction and arrangement of parts forming a commutator making contact by means of mercury placed in insulated vessels, the axis of revolution of the commutator being vertical substantially as herein described.

[Seventhly] *Sixthly.*—Making grooves in the pole-pieces of the electro-magnet or permanent magnet of an electricity meter for the purpose of increasing the action of the brake substantially as hereinbefore described and illustrated in the accompanying drawings.

[Eighthly) *Seventhly.*—The method hereinbefore described and illustrated in the accompanying drawings of combining the disc armature or insulated sectors with the continuous disc constituting the brake.

[Ninthly] *Eighthly.*—The arrangement and combination of parts, hereinbefore described and illustrated in the accompanying drawings, for diminishing the friction of the rotating axis of the meter in its bearings.

[Tenthly] *Ninthly.*—An electricity meter, constructed substantially as herein described and illustrated in the accompanying drawings.

The original form of Hookham meter was described and illustrated in *The Electrician*, Vol. XXII., p. 369; a later pattern was described in Vol. XXXII., p. 220; and a short description of the 1897 pattern will be found in Vol. XXXVIII., p. 405.

The Thompson integrating wattmeter, which is the alleged infringement when in use on the mains of the Bradford Corporation, is a motor meter with a Foucault brake. The field coils carry the main current going to the lamps, and the armature, drum-wound on an ironless core, forms part of the shunt or pressure circuit. To overcome the solid friction, two fixed coils, auxiliaries to the field, are also connected permanently in the pressure circuit, and an inactive non-inductive resistance is added to bring up the resistance to the desired amount. Current is led to the armature through silver brushes resting against a silver commutator. An illustration of the meter, and a more complete description of it, will be found in Mr. Ricks' 1897 B.A. Paper, *The Electrician*, Vol. XXXIX., p. 574.

Among the alleged anticipations referred to in the evidence is an early Ayrton and Perry patent (No. 2,642 of 1832), "Contrivances for Registering the Amount of Work given Electrically to any part of an Electric Circuit in a given time." The following is an extract from the latter:—

"If now the only work done by the motor is done in overcoming fluid friction, or in causing magnets to revolve in front of metallic plates such as copper, or as in Arago's disc experiments, in all these cases the forces resisting motion are proportional to the velocity, and it is obvious that the number of revolutions made by the motor in any time is proportional to the electrical energy given to the circuit in that time."

The first claim in this specification runs as follows:—

"In measuring the total amount of energy given to an electrical circuit, the use of an electrometer whose fixed and movable parts have soft iron or else non-magnetic cores, wound respectively with a coil or coils of small resistance, through which the main current of the circuit passes, and a coil or coils of high resistance, through which passes a current proportional to the differences of potentials at the ends of the circuit in question, the motion of the motor being resisted by vanes immersed in a fluid or by any other resistance which is proportional to the velocity substantially as described.

The following is an extract from an early patent of John Monro for "Improvements in Electric Light and Power Apparatus" (No. 1,626, of 1882), a patent referred to during Mr. Hookham's cross-examination:—

"As a means of measurement of the electric current employed in lighting and for motive purposes, I employ an adaptation of a device known as Barlow's wheel. In this a horseshoe magnet encloses a disc of copper mounted on an axle, and when the current passes from the axle by the wheel to a pool of mercury into which the edge of the disc dips, such a disc rotates. This rotation is proportional to the strength of the current, and by fitting a suitable indicator or counter to the axle of the disc I can register the number of turns, and so graduate my indicator as to show amperes. To screen off the effects of extraneous magnetic influence, I enclose my ampere meter in a thick case of soft iron."

The patent alluded to as the "Handford" patent is an Edison patent (British Patent No. 2,675 of 1882), Handford being the English patent agent. It is for "Improvements in Electrical Meters, which Improvements are also partly applicable to Motors to be employed for other purposes," and the specification continues as follows:

"The said invention, relating to improvements in electrical meters, has reference to the use in combination with indicating or registering apparatus of what is herein designated a mono-electro-dynamic motor for operating or controlling the operation of such indicating or registering apparatus, which motor is a non-commutator or uni-polar machine, its inductive portion being a straight or one part conductor, through which the current passes in one direction only. This one part or straight inductive portion is in the translation circuit, or in a shunt therefrom around a definite resistance in the translation circuit; the electrical energy consumed in which circuit is to be measured, whilst the field coils or helices of the machine are in a multiple arc circuit. Means located in the translation circuit are employed for opening the circuit of such field coils or helices, when the last translating device is removed from circuit and for closing the circuit of such field coils or helices when the first translating device is placed in circuit. The motor is provided with devices for imparting to it a definite loading in combination with which may be used means for varying such load to compensate for variations in proportionate friction, this part of the invention being also applicable to motors to be employed for other purposes."

The meter is then described in greater detail with the assistance of drawings:

The "mono-electro-dynamic motor" is composed of an iron base which forms the back of the field electro-magnet of the machine, one pole of which is the upper end of the central core, while the other pole is formed by the ring, or a number of separate pole pieces, supported on cores rising from the iron base and surrounding the central pole piece. Both inner and outer cores are provided with wire bobbins. In the magnetic field in the annular space between the inner core and the surrounding pole-pieces of the outer core is located the revolving part. This is "preferably" a cylinder which may be of copper, and which is supported by a central pivoting spindle resting in a depression in the top of the inner core. The spindle passes through a guiding yoke and through the centre of the closed upper end of the cylinder, and is secured rigidly thereto. It is pointed, and is constructed of platinum or platinum iridium alloy, so as not to amalgamate with the mercury, with which the depression above referred to is partly filled. The revolving pivot or spindle is located in the translation circuit, and the mercury is used to make good and sufficient contact, in order to carry a powerful current without heating.

The lower end of the revolving cylinder is provided with means for maintaining contact with the mercury in a circular trough. This means is "preferably" in the form of fans or paddles, which dip into the mercury, and while maintaining the circuit complete, act to retard the movement of the motor, giving it a definite loading, or a definite amount of work to perform.

After describing other parts of the instrument and accessories to it, and the manner in which it is to be connected up, the specification continues:—

"In order that the rotating shell may so perform its work that the speed of rotation will be directly proportionate to the current, the paddles upon the cylinder must be correctly proportioned and arranged in a proper manner. Since the meter may be made of quite large size, and when so made will have a large initial friction, it is preferred for large size meters to make the cylinder paddles loose and provide means for varying their dip in the mercury in proportion to the speed, in order to make the speed of rotation of the cylinder directly proportionate to the current."

The claims are:—*First:* In an electrical meter the combination with indicating or registering apparatus, of a mono-electro-dynamic motor, operating or controlling the operation of such indicating or registering apparatus; and having its inductive portion in the translation circuit, or in a shunt therefrom, around a definite resistance in the translation circuit, the electrical energy consumed in which circuit is to be measured, a multiple arc circuit including the field coils or helices of such motor, and means located in the translation circuit for respectively opening and closing the circuit of such field coils or helices when the last translating device is removed from circuit and the first one placed in circuit, substantially as hereinbefore described.

Second: A mono-electro-dynamic motor, in combination with means for giving such motor a definite loading, and means for varying such load to compensate for variations in proportionate friction, substantially as, and for the purposes hereinbefore described.

The following is the official translation of the article by M. Marcel Deprez in *La Lumière Électrique* (Jan., 1884, p. 223) on the Siemens energy measurer, alluded to in the case:—

"Mr. Siemens has exhibited at Vienna an instrument designed to measure the energy absorbed by any apparatus whatever using an electric current. It is composed essentially of a small dynamo electric machine of the Siemens type, of which the primary and secondary are quite free from iron. The primary takes the form of a galvanometer bobbin (cadre) wound with thick wire in which the current to be utilised passes. The secondary is, on the contrary, wound with very fine wire, and is connected in shunt with the main circuit; the brushes of the commutator are connected one with the source, the other with the end of the circuit in which are placed the apparatus for utilising the current. Lastly, the axis of the secondary is provided with wings which revolve in any liquid, such as paraffin oil or any other insulating liquid, which fills the whole apparatus. Any counting device whatever registers the number of turns which the secondary makes in a given time, and from this number of turns the inventors consider they can deduce the quantity of energy absorbed by the main current.

"It is easy to show that this is incorrect, and that this apparatus does not at all make known the quantity of energy absorbed by the useful circuit unless the difference of potential between the two extremities of this circuit remains constant, in which case a simple measurer of intensity would suffice. Indeed, let us designate by i the intensity of the current which passes through the secondary when equilibrium is established.

"I the intensity of current passing through the primary when equilibrium is established.

"E the difference of potential between the brushes of the secondary.

"e the electromotive force developed in the secondary when it revolves with an angular velocity equal to unity, and the primary is traversed by a current equal to unity.

"R the resistance of the secondary.

"w the angular velocity of the secondary.

"When the secondary revolves it develops a counter electromotive force proportional to the speed and to the intensity of the electric field of the primary, that is to say, to I this electromotive force is expressed by ewI, and the current i then determined by the equation

$$i = \frac{E - ewI}{R}.$$

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"On the other hand, the primary being traversed by I the mechanical effect exercised by the primary on the secondary is proportional to Ii from well-known laws of electro-dynamics, which can be applied here, because this instrument contains no magnetic masses. This couple, proportional to Ii, would have the effect of increasing the speed until the counter electro-motive force of the secondary balances the difference of potential between the brushes, if the same rotation of the secondary does not develop, owing to the wings, which turn in paraffin oil, a mechanical resistance proportional to the square of the speed. When this resistance balances the couple Ii we have

$$Ii = Kw^2 \text{ (K designating a constant)};$$

but we have, replacing i by its value, $Ii = \frac{EI - ewI^2}{R}$,

whence $$Kw^2 = \frac{EI - ewI^2}{R},$$

whence we infer $$w = \frac{-eI^2 \pm \sqrt{e^2I^4 - 4kREI}}{2kR}.$$

The angle described by the secondary in time dt is wdt, and during a time t $\int wdt$ we have

$$\int \frac{-eI^2 \pm \sqrt{e^2I^4 - 4kREI}}{2kR} dt,$$

while the quantity of energy absorbed usefully in the same time is

$$\int EIdt.$$

"The two integrals cannot be equal, and in consequence the number of turns of the counter expresses something quite different from the quantity of energy absorbed. It is probable that the inventors of this instrument have considered the counter electromotive force developed by this apparatus as negligible, because it contains no magnetic masses, and it turns slowly. Indeed, even admitting this hypothesis, the equations are simplified and we have

$$i = E/R, \quad Ii = kw^2 = EI/R,$$

whence $$w = \frac{I}{\sqrt{kR}} \sqrt{E},$$

and $$wdt = \frac{I}{\sqrt{kR}} \sqrt{E} dt.$$

Whence it follows that in this case the number of turns of the secondary would be proportional not to $\int EIdt$, but rather to $\int \sqrt{E} Idt$, from the integral of which one can never derive $\int EIdt$. This instrument is then useless.

"I am now going to show how it is necessary to modify it to obtain the desired result. In place of providing the axis with wings turning in a medium whose resistance is proportional to the square of the speed, let us attach to it a copper disc revolving between the limbs of a permanent magnet, and dispense with the paraffin oil completely. The rotation of the disc between the poles of the magnet will have the effect of developing in the interior of the disc induced currents following a well-known law, which I formerly applied in my magnetic speed-indicator, exercising on the magnet a magnetic force proportional to the first power of the speed. We have then

$$Ii = k'w = EI/R,$$

whence $$\int wdt \frac{I}{k'R} = \int EIdt,$$

which solves the problem.

"In order to make this solution more rigorous, it would be necessary, in addition, to reverse the arrangement adopted by M. Siemens, that is to say, to put the thick wire on the secondary and the fine wire on the primary, It would then be the latter which would be connected in shunt with the main circuit."

This article is commented on as follows by F. Uppenborn, jun., in the *Centralblatt für Elektrotechnik*:—

"In this relation we have already shown that Siemens' instrument gives incorrect measurements, since it is pre-supposed that the friction is proportional to the first power of the speed, while notwithstanding, as is known, the coefficient of the second power is unduly large. . . . . What we say briefly in words, Mr. Deprez says more precisely in his careful calculation. Meanwhile we would call attention to one consideration, which, if it has not entirely escaped the attention of Mr. Deprez, yet is not mentioned in his interesting Paper. It is, namely, in general to lay stress on the attempt to relieve more delicate measuring instruments from the performance of their own inherent work. But if this cannot be effected, then care must be taken that the measuring and measured forces be great in comparison with the forces coming otherwise into play. If we apply this law to the instrument under consideration, it results that one must then endeavour to diminish the frictional resistance as much as possible and to make as great as possible the force consumption of the Faraday disc."

Knowles v. Isle of Man Tramways and Electric Power Co.

In the Manx High Court, on Monday, the hearing of this action was commenced. It was brought by Mr. W. L. Knowles, late engineer to the defendant company, to recover £1,183, alleged to be due for salary and commission. Mr. Browne, for the company, admitted £33 was due in respect of salary, and said the company had been and was willing to pay the amount at any time. As to the claim for £1,150 commission at 1½ per cent. on the cost of construction of the Ramsay section of tramways, he asked for particulars, and said there was never any agreement to pay that or any other commission. The hearing was adjourned.

Heyl Dia v. Edmunds and Others.

In the Court of Appeal last week before the Master of the Rolls and Lords Justices Rigby and Collins, Mr. Clare mentioned this case, which was an appeal by the plaintiff from a decision of Mr. Justice Kekewich. Counsel said that the plaintiff had come to terms with the defendants, and had paid their costs, and he therefore asked leave to withdraw the appeal. Mr. Russell, for the respondents, said he assumed the appeal was abandoned. The action was one to restrain defendants from divulging a secret process.

Their lordships gave the leave asked for, and the appeal was accordingly withdrawn.

City of London Electric Lighting Co. v. Corporation of London.

The judgment of Mr. Justice Farwell declaring the validity of the electric lighting contracts acquired by the City of London Electric Lighting Co., Ltd., was referred by the Court of Common Council to its streets committee, who yesterday brought up a report recommending that the City solicitor be instructed to lodge an appeal against the judgment. This report was carried by a majority of 86.

PARLIAMENTARY INTELLIGENCE.

COUNTY OF DURHAM ELECTRIC POWER BILL.

The Committee appointed by the House of Commons to consider electric power bills resumed its investigation into this bill on Friday.

At the opening of the proceedings the CHAIRMAN (Sir J. Kitson) stated that the Committee would accept the recommendations in the report of the Joint Committee of 1898 on electrical energy generating stations in the following respects, viz.: Compulsory powers for acquiring sites for generating stations and land for pipes and mains therefrom, and other works, whether within or without the area of supply, might as a principle be granted, but they were prepared to hear petitioners who objected to particular sites selected by promoters. In the case of powers being given for the erection of generating stations outside the area of supply, powers might be given for laying mains in streets leading from the generating station to the boundary of the area of supply, the local authorities having the option of breaking up and reinstating the streets at the undertakers' expense, and the Committee were prepared to hear petitioners who alleged that they were under special disadvantages arising from this provision with respect to the bill before them.

Mr. S. Z. DE FERRANTI, who was under cross-examination on Thursday when the Committee adjourned, was further cross-examined by Mr. J. D. Fitzgerald, Q.C. (for the District Councils of Hebburn and Felling). He said it was the case that the amount of electricity which he estimated that the company would supply was larger than that at present supplied by Sheffield, Newcastle, Blackpool, Leeds, Manchester, Edinburgh, Glasgow and Liverpool taken altogether.

In cross-examination by Mr. Baggallay, Q.C. (for the promoters of the Tyneside Electric Power Bill), WITNESS said he was not aware whether it was or was not proposed by the Durham Co. to place any limit on the dividends they might declare, or to place any restriction on price in the event of the profits going beyond a certain amount. He thought it would lead to the financial failure of both undertakings if districts within the Durham Co.'s profit area of supply were allowed to choose whether they should take their electricity from the Durham Co, or the Tyneside Co., nor did he think that that would be fair competition.

In re-examination, WITNESS stated that the class of business the company proposed to obtain did not at all correspond with the supply of one large city. If cities like Manchester and Liverpool could obtain the load which the company anticipated, they would be able to produce electricity at the same price, and therefore probably to rise to the same output.

Sir F. BRAMWELL, C.E., said the carrying out of the company's scheme would lead to the establishment of manufactures in country districts, and so to the avoidance of undue concentration of business and manufactures in towns. It would, he thought, have the same effect on manufactures as the extension of the mains of water companies had on building in the country. The Tyneside manufactories were distributed over both banks of the river. In one sense—that of the diminution of capital cost—the compactness of the area of supply was important to a company. He thought it would be prejudicial to the interests of the public if the Tyneside Co. were allowed to compete with the Durham Co. in the district bordering on the Tyne, because it would result in the southern part of the Durham Co.'s proposed area of supply being deprived of the means of supply.

Mr. J. TODD, chairman of the Durham Electric Lighting committee, said he had been authorised by his Council to give evidence in support of the bill. Electricity was used in some collieries in which he was interested, and it there cost from 4d. to 6d. per unit. If the company obtained their powers the proprietors would take current from them. In a colliery there would be both a night and a day load. Pumping could be done very largely by electricity, and pumping operations were carried on chiefly at night.

Ald. HINDMARSH said that the Gateshead Corporation had entered into a provisional agreement with the Durham Co. for the supply of electricity for lighting and traction.

Ald. ARMSTRONG (ex-mayor of Jarrow) said he was authorised by the Jarrow Corporation to support the bill. The Corporation attached the

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greatest importance to the scheme because they wanted to provide cheap means of transit by tramway for the working classes, from the congested parts of the town near the river to healthier localities in the south.

Mr. STEPHEN SELLON, C.E., said he was interested in a number of tramway schemes in the County of Durham. By adopting electric traction it was possible for tramways to be worked at rates that would otherwise be out of the question. He was not interested in the County of Durham Co. except as a future customer.

Mr. W. L. MADGEN, one of the promoters, said he was well acquainted with the district covered by the bill, and had had a large share in determining what that district should be. Numerous industries were being carried on in the county, including engineering, quarrying, iron working, brick making, colliery work, &c. There were 20 local authorities in the proposed area of supply, and, with the exception of Felling and Hebburn, which had a joint population of only 34,000, they all assented to the proposals of the bill. It was certainly the case that the scheme of the promoters was to generate electricity, and a separate but allied company was to supply it. The advantage to the consumers lay in the fact that they would get electricity under more economical engineering conditions than would be the case if separate generating stations were put down in, say, Hebburn, or Felling, or Jarrow. Hebburn had a provisional order, but there were no means of knowing whether the local authority would carry it out. The promoting company was allied with the British Electric Traction Co., which had the means of obtaining any capital it desired. Its own subscribed capital was £1,300,000. He would prefer not to have a sliding scale inserted in the bill as to the price at which electric energy should be supplied to consumers. He would rather have the question dealt with by means of general legislation later on when more was known of the economics of the matter. Personally, however, he would not object to the insertion of a clause rendering the company subject to general legislation on this point.

The CHAIRMAN (addressing Mr. Moon, for the promotors) said: The Committee wish to know more about your substantiality—your power of carrying out the scheme. Supposing this great county were given over to you, they wish to be satisfied that you have the power and influence to raise the necessary capital. I would suggest to you that you should bring evidence directly before us on that point.

Mr. SYDNEY MORSE, solicitor to the promoters, said that certain financial companies had definitely undertaken to take up the whole of the capital of the scheme which was not taken up by the public. The capital was first to be offered to the public, and supposing the public did not take it all up the whole of the balance would be found by two existing companies—the British Electric Traction Co. (Ltd.) and the Brush Electrical Engineering Co. (Ltd.).

Mr. J. D. FITZGERALD, Q.C., for the Councils of Hebburn and Felling, said the question was whether these two thriving Tyneside towns were to be included in the scheme against their will. From their position they were suited for an electrical undertaking, and this was why the promoters were so anxious to include them in their area. The District Councils wished to be left free to deal with their own districts. The districts had a joint population of 40,000. Hebburn had already obtained a provisional order, and Felling was about to apply for one. The promoters were promoting another company, which was to distribute electrical energy to the consumers. The distribution company, which was about to get provisional orders for Jarrow and Gateshead, was going to sell to the consumer on the maximum demand system. When the distribution company got its provisional order there would be an end of all the boasted benefits which the present promoters were to confer on manufacturers, for electric energy would be sold to the immediate consumers at the highest price. This was the real upshot of this great scheme, which professed to have the object of reviving the trade of Tyneside, and enabling this country to compete with the United States and other trade rivals. The consumer would have to pay two sets of profits.

Mr. P. C. Major, chairman of the Felling Council, and Mr. J. Smale, chairman of the Hebburn District Council, gave evidence in opposition to the bill.

Mr. H. W. HANDCOCK, C.E., spoke of the suitability of the districts of Hebburn and Felling for an electricity supply works, and he thought that electricity could be economically generated there. He admitted that electricity could be more economically generated in one large than in a number of small generating stations, apart from the question of transmission. Copper was, however, now very dear, and the principle of saving coal at the expense of copper could not be carried too far. His estimate for an electricity scheme for Hebburn was £21,588 which would give a station capacity of 500 H.P. at the start, and plant could be extended as the demand increased. His estimate for a similar station for Felling was £15,500 with supply to consumers at 5d. per unit for the first 100 hours and 2d. per unit after. Current for motive power would be supplied at 3d. down to 0·9d. He estimated a load factor of 40 per cent. for public lighting and 18 per cent. for private lighting and motive power. The charge for street lamps would be £2. 12s. per 16 c.p. lamp per annum.

Mr. Handcock was the last witness against the Durham Co.'s bill and the Committee proceeded to deal with that of the Tyneside Co.

TYNESIDE ELECTRIC POWER BILL.

On Tuesday, Mr. BAGGALLAY addressed the Committee on behalf of the promoters of the Tyneside Electric Power Bill, not only stating his objections to the Durham Co.'s bill, but opening the case of the Tyneside Co., which the Committee agreed to hear before deciding on the preamble of the Durham bill. He remarked that the area of supply selected by the Tyneside Co. lay equally along both sides of the Tyne, and would take in the whole manufacturing and industrial parts of Tyneside, including Newcastle, Gateshead, Tynemouth, South Shields, Jarrow, Wallsend, Hebburn, Felling, and Walken. The Tyneside Co.'s primary object was to supply electric power for trade and manufacturing purposes, while the supply for lighting and traction was quite a secondary object. The difference between the two bills, therefore, was that the Durham measure was chiefly for lighting and traction, and the Tyneside bill was for trade purposes; with regard to the petitions, the objections of the local authorities related chiefly to the breaking up of streets, to competition with themselves, and to the question of whether they or a company should be able to make a profit out of the supply of electricity. He need not dwell on the question of the breaking up of streets nor on that of competition with the local authorities, as the company did not want to compete in the matter of distribution. If the local authorities wanted to make a profit out of the manufacture of electricity for trade purposes they wished really to step out of their legitimate sphere. There was a strong petition in favour of the Tyneside bill from a large number of manufacturers and traders, and among those who petitioned against it was the Newcastle-on-Tyne Electric Supply Co. (Ltd.).

Mr. ASHTON (a member of the Committee): The local authority is, under your bill, to have a veto on the retail supply of energy where it involves any breaking up of the streets. Do you propose that the local authority shall have a veto on supply in bulk as well as on retail supply?

Mr. BAGGALLAY: No, not if it is a bulk supply given to an authorised Parliamentary company. Counsel added that the Tyneside Co.'s proposed area of supply was 65 square miles south of the Tyne and 60 square miles north. The capital of the company was to be £1,000,000.

Sir A. NOBLE, C.E., vice-chairman of Sir William Armstrong, Whitworth and Co. (Ltd.), said that the promoters of the Tyneside Bill were all substantial local gentlemen of high position, and interested in industries of the Tyneside district. Armstrong, Whitworth and Co. employed in the Newcastle district about 20,000 or 21,000 hands. They used electric light themselves largely, and he had no doubt that, under certain circumstances, they would be very considerable customers of the Tyneside Co., and that if they could purchase electric energy they would use electric power to a much larger extent than if they generated it themselves. The passing and putting into force of the Tyneside bill would, he thought, prove very beneficial both to his company and to the neighbourhood. He was not aware that the Newcastle Electric Supply Co. already supplied electricity very largely for power purposes.

The CHAIRMAN: In view of the fact that there are two companies in the field, do you not think that the districts to the north of the Tyne would afford sufficient scope for an electric power supply company?—I should hardly think so. I should think that it could work much more economically if it had both the northern and southern sides of the Tyne.

Sir A. SCOBLE: Do you not think it would be fair to put it on a company as a condition that they should serve the lean as well as the fat parts of the district?—I do not think it would be unfair to stipulate that the company should supply the districts within a certain distance. I do not think it desirable that two companies supplying in bulk should compete in any particular area.

Mr. A. A. C. SWINTON stated that he was a promoter of the bill. He was connected with both the Scarborough and Cambridge Electric Supply Companies, which were both successful undertakings, and he had been responsible for laying down large electrical plants. He knew, as a matter of fact, that the Tyneside scheme was in the field long before that of the Durham Co., the former being cut and dried before the latter had been decided on. Some of the promoters of the Tyneside bill were interested in works on both sides of the Tyne. There were in the district manufactures of a nature that made it particularly desirable that there should be a good electric supply. That was particularly the case with the chemical industry, which required enormous amounts of electric energy. Such energy must be produced either by water or by coal. Very little could be done by water in this country, and Tyneside was, of course, an excellent place for obtaining a cheap supply of coal. The company proposed that it should be bound to supply energy in bulk at rates named in the bill to all authorities who applied for it. The distribution would be left to the local authorities. The charges were based on the Brighton system, but were not exactly the same as those in force at Brighton. For the first 200 hours of maximum supply the charge was to be 5d. per unit where there was a general supply, and 4d. per unit where the company supplied to a local authority in bulk for distribution; for a further quantity not exceeding 400 hours the price was to be 3d. per unit in the one case and 2d. per unit in the other; and for a further quantity exceeding 400 hours 1½d. and 1d. respectively. The promoters also proposed that there should be a sliding scale: the price was to come down as soon as the company had paid 10 per cent. In his opinion the proper system to adopt if the country was to be covered with these electric supply schemes was that the generating stations should be put down in the centre of a manufacturing area, and not on the edge of it, and that the different fields of supply should be allowed to grow until they met in what had been called a "lean" area. The promoters of the Tyneside scheme had no fear of the competition of the Durham scheme. They looked forward eventually to supplying hundreds and thousands of horse-power. He thought that in course of years the local authorities might wake up to the necessity of doing something of this kind if it were not done by a company, but he believed that they would be quite ten years behind private enterprise. He had no doubt whatever that if Parliament authorised the scheme it would be carried out with great benefit to the district.

Cross-examined by Mr. PAGE, Q.C., on behalf of the Gateshead Corporation and Whickham District Council: Under the bill the local authorities would be able to prevent the promoters of the bill from breaking up streets for any purpose whatever, except that of passing the mains through the district.

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Cross-examined by Mr. RICKARDS, Q.C., for the Newcastle Electric Supply Co.: There were 19 local authorities in the proposed area of supply of the Tyneside Co., and the company hoped to come to terms with 17 of them. There would be no compulsion on the company to distribute electric energy retail in any district in which they had not obtained the consent of the local authorities. They were not, however, particularly anxious to distribute electricity retail. They would rather see distribution companies established and supply those companies in bulk. It was proposed to establish one of the company's generating stations at Wallsend, which would probably prove the most suitable site for the supply of the whole Tyneside district. The proposed site had been scheduled by the Newcastle Electric Supply Co. for the compulsory purchase, but he thought it would be too large for the company, and that it was of more importance to Tyneside Co. The promoters would probably adopt either the two-phase or three-phase system. The pressure would probably be 10,000 volts, but the question had not been definitely decided on. He would not be in the least surprised to hear that the Newcastle Supply Co. was charging less than the maximum charges given in the schedule to the bill, and he had no doubt that the charges actually made by the Tyneside Co. would be less than the schedule. A circular had been sent to every local authority in the district offering to supply at the following rates: Where the local authority distributed—for the first 100 hours of supply, 4d. per unit; for the second 100, 1½d.; and for the third 100, 1d. Where the company distributed—for the first 100 hours, 5d.; for the second 100, 2d.; and for subsequent hours, 1½d. They had also offered to supply consumers for motive power for manufacturing purposes for the first 100 hours, 3d.; and for subsequent hours, 0·9d.

By Mr. Squarey (for Tynemouth Corporation): It was the case that the Corporation of Tynemouth had an electric lighting order, but they had had the order for nine years and had done nothing. They were only now putting up a generating station.

Mr. HANS HAMILTON, on behalf of South Shields Corporation, asked whether it would not be unfair for the promoters to insinuate, by means of the private wayleaves into the districts where the local authorities had spent large sums of the ratepayers' money in establishing electric light undertakings. WITNESS replied that it was absolutely necessary for the purposes of trade that the large power companies should have access to the principal works.

Replying to Colonel Long (a member of the Committee), WITNESS said he did not think he was bound by the pledge given by Mr. Ritchie on the second reading of the four electric power bills that the companies would not go into a district without the consent of the local authority. He thought that that pledge applied more particularly to the Lancashire Bill. He was willing to take the chance of having the Bill thrown out on the third reading because he would not adopt that pledge.

Mr. WORTH, calcium-carbide manufacturer, said that the Company of which he was managing director contemplated establishing works on Tyneside, and had arranged with the promoters of the Bill for a continuous electrical supply of 5,000 H.P., at a price of a little over half-a-farthing per unit.

The Hon. C. A. PARSONS, one of the promotors of the Bill, said a great advantage would be derived from the use of very large steam turbine units, which would considerably reduce the first cost of the plant and also the coal consumption. It was most important that the North and South sides of the Tyne should be included in one supply district as they were practically on one footing as regards trade. The Bill made no provision for overhead wires, the intention being to put all the mains underground.

Yesterday (Thursday) Mr. Parsons was examined and cross-examined to considerable length as to the proposed charges to be made by the promoters. The chairman suggested that small consumers would be placed at a disadvantage by the fixing of excessively low rates to very large consumers—rates which were not really remunerative in themselves—WITNESS said that no protection of small consumers was provided in the bill with the exception of the sliding scale. He agreed, however, that it would be wise to protect the small consumer against undue preference.

The CHAIRMAN: I do not ask you to define how such protection should be afforded, but it is a principle of Parliament to protect the average consumer.

Mr. J. M. DAVIDSON, Managing Director at Newcastle of the United Alkali Co., said that the Company had works in Gateshead, Hebburn and Jarrow, employing on Tyneside about 2,500 workmen. The processes were at present carried out by steam-power, but if the company had the advantage of cheap electrical power it would be a very great boon to them. It was necessary to do everything they could to meet the competition of foreign countries, and he thought that there were many directions in which a cheap supply of electricity might be profitably employed. He earnestly hoped that the Tyneside Co. would be given the privilege of supplying electricity on the south side of the Tyne. He knew that the directors of the Tyneside Co. were men who understood their business, and were likely to establish their works on such a principle that the cost would be kept at the lowest possible point. They were people who were resident in Newcastle, who had an enormous stake in Neweastle, and who would be perfectly good for any bargain to which they attached their signature.

Mr. N. COOKSON, managing partner of Cookson and Co., one of the largest lead manufacturers in the country, with works at Tynemouth, chairman of the Wallsend and Hebburn Coal Co., and one of the promotors of the Tyneside Co.'s bill, said that the measure was supported by the largest manufacturers in the district, and if it were passed its financial success was, he thought, assured.

Sir BENJAMIN BROWN, chairman of R. and W. Hawthorn, Leslie and Co., engineers and shipbuilders, of Newcastle and Hebburn, having also given evidence in support of the bill,

The Committee adjourned till to-day (Friday).

CHARING CROSS AND STRAND ELECTRICITY SUPPLY BILL.

The Committee of the House of Commons, presided over by Mr. A. H. Brown, further considered this bill on Friday last. Mr. Worsley Taylor, Q.C., on behalf of the London County Council, asked the Committee to throw out the bill on the ground that the promoters had selected the most important thoroughfares in which to lay their mains, and that there was not the slightest necessity or justification for this selection. Various local authorities also objected to the scheme, chiefly on the ground of the interference with traffic which it would cause, and a number of witnesses were called on this point. The Committee ultimately found the preamble proved.

LONDON UNITED TRAMWAYS BILL.

On Friday the House of Commons Committee, presided over by Sir U. Kay Shuttleworth, considered this bill for powers to construct about 18 miles of electric tramways in the county of Middlesex. The only opponents were the Middlesex County Council and certain frontagers along the proposed routes.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said it was a very important scheme in the interests of the western suburbs of London. The London United Tramways had already an extensive system of lines in West London, running from Hammersmith Broadway to Kew Bridge, with powers to carry a tramway to Hounslow. They had also a line along the Uxbridge-road to Acton and Ealing. These lines were at present worked by horses, but within a short time would be converted to the overhead trolley system. The company had powers to construct several connecting lines, and the Kew Bridge to Richmond line was also their property, but did not at present form part of the general system. On the completion of the company's generating station in July next the whole of the lines would be operated electrically. The proposals of the bill were to extend the line from Acton through Ealing to Hanwell, and from Heston and Isleworth through Twickenham and Teddington to Hampton Wick. The opposition of the Middlesex County Council was based upon a suggestion that at some time or other they would, in conjunction with the London County Council, carry out a scheme of tramways for themselves. But the promoting company were in possession, and the County Council were not the purchasing authority.

Mr. CLIFTON ROBINSON, general manager of the company, said the electric cars would accommodate 80 passengers in place of 36 to 44 in the horse cars. The adoption of electric traction at Stockton had led to an increase of passengers carried in one year from a million to eight millions, and a like increase had resulted in other cases. The proposals of the bill would increase the company's mileage from 21 to 39. They at present carried 10,000,000 passengers a year, and anticipated an increase to 40,000,000 or even 50,000,000 if the system was completed as now proposed.

At this point the Committee decided that the County Council must confine its opposition as regarded the preamble of the bill to the question of interference with the roads and bridges under their control, they having no *locus standi* on the question of the desirability of the construction of the lines.

Lord ROBERT CECIL (for the Council) then intimated that, under the circumstances, they did not think it would serve any useful purpose to prolong the opposition, and would therefore reserve their right to appear in the House of Lords against the bill.

The Committee, having heard witnesses and counsel for the frontagers at its sitting on Tuesday, decided to pass the preamble of the bill, subject to certain conditions—viz., first, all curves must be improved; secondly, as far as possible 9ft. 6in. must intervene between the footpaths and the lines; thirdly, where two footpaths did not exist the Committee must be satisfied as to the provision of a second in case of building taking place; fourthly, the Committee must be satisfied that a double line was not required where a single line was proposed.

HUDDERSFIELD CORPORATION TRAMWAYS.

In the House of Commons on Tuesday, on the order for the consideration of this bill as amended, Sir J. WOODHOUSE moved that it should be recommitted to the former committee, and that that body should be instructed to consider and report as to the expediency of reinserting in the bill the power to construct tramways to places outside the borough. The Committee had deleted that power from the bill on the ground that it was intended to appoint a joint committee to consider the subject of municipal trading, but this was not a question of municipal trading. Huddersfield originally undertook the working of its own tramways because they wold otherwise have been idle, a company having tried and failed, and no other lessee being forthcoming. In 1898 one of the suburban districts obtained a provisional order to construct tramways, but leased them to Huddersfield, which was the centre for the district, and other suburbs asked to be connected with the borough lines as well. The question was solely one of convenience and good government. The Huddersfield Corporation proposed to go into those districts at their special request, and the only opposition came from the Lancashire and Yorkshire Railway Co., on the ground of competition. He submitted to the House that it was not within the purview of the Government or of the House to refuse to municipalities that which had been granted year after year for years.

Lord E. FITZMAURICE said it was never intended that the Committee on Municipal Trading should put a veto on trading in the supply of gas, water, and tramways, but that it should deal with alleged excesses of municipal trading in other directions.

The PRESIDENT OF THE BOARD OF TRADE (Mr. Ritchie) said the Committee was debarred by the Standing Orders of the House from

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sanctioning tramways outside the borough, but their position was that if the House thought they ought to reconsider their decision apart from the Standing Order they were willing to reconsider it. He favoured the extension of tramways outside towns because to it they must look largely for a solution of the housing difficulty.

The motion was agreed to.

SOUTH EASTERN METROPOLITAN TRAMWAYS.

The Select Committee of the House of Commons, presided over by Col. Cotton-Jodrell, on Tuesday commenced consideration of a bill giving power to the South Eastern Metropolitan Tramways Co. to substitute electric for horse traction on their tramway running from Greenwich to Catford on either the surface contact or conduit system.

Mr. LITTLER, Q.C., for the promoters, said the enormous increase in the number of passengers necessitated the present application, as electric traction would be cheaper, afford an accelerated service, and allow an increase in the number of cars run. In nine years the London County Council would have the power of purchasing this line, but the company had come to the conclusion that even for that short period it would be worth while to provide electric traction. The capital necessary for that purpose would be in all £42,000—£33,000 in shares and £9,000 by loan. The South Metropolitan Gas Co. opposed the bill on the ground of danger to their mains from electrolysis, and the London County Council oppo ed the adoption of any but the conduit system, as did also the Lewisham Board of Works.

Sir W. H. PREECE said the road along which it was proposed to run was an ideal road for an electric line, as its width was 60ft. The reconstruction of the line would cost £14,000, the electrical equipment £12,000, the mains £2,000, and the cars £8,000, and £4,000 was allowed for contingencies. The company rather preferred the surface-contact system, which had many advantages, was absolutely safe and very workable. There was no practical example of the system in this country or elsewhere with insulated returns, but this company were very anxious to give it a fair trial. The board of Trade regulations would protect the Gas Co.'s mains from all danger of electrolysis. He admitted that the surface contact system had been replaced at Washington by the conduit system. Prof. Kennedy, however, had rather favourably mentioned the surface contact system, and they were convinced that it had advantages that warranted a fair trial being given to it. His opinion was that this company would not lay down this system without a twelve months period of probation. If the system were tried and failed there would remain the opening in the centre of the road, and the only expense would be the putting in of the conduits. The surface contact system was working satisfactorily at Monte Carlo, and it was also in use at Paris. There was no danger of electrolysis from tramways laid down under Board of Trade regulations. The cause of electrolysis was the use of the rails as returns. In the case of the South London line that had been mentioned; it was an old line and a standing disgrace to London, but the railway company were now making alterations.

Mr. JACOB ATHERTON gave evidence as to the overcrowded state of the tramcars at the present time, and the large number of passengers carried. The surface contact system would cost about £2,000 per mile less than the conduit system. The Board of Trade would have to be satisfied even though the present bill passed. The system had been tried in Washington (U.S.A.), and had for special reasons been exchanged for the conduit system. There were now in Paris being constructed lines on the surface contact system. When he found sound financial people ready to lay down the system and take all risks for six or twelve months, he thought it was worth while trying it. He had two offers before him, one from a German firm and one from an American company.

Sir JOHN WILLOX, M.P., Chairman of the Blackheath and Greenwich Electric Light Co., said his company had recently erected a large, new station, and had a quantity of surplus power available. They, therefore, proposed to supply the South-East Metropolitan Tramways Co. with the power necessary for the working of their line.

The Committee, on Wednesday, after hearing counsel, decided to pass the preamble of the bill.

Yesterday (Thursday) the committee proceeded with the consideration of the clauses of the bill.

On behalf of the Lewisham Local Board the committee were asked to insert words in the bill restricting the Tramway Co. to the use of the conduit system of electric traction; and by the London County Council to insert a clause rendering it obligatory for the company to obtain the assent of the London County Council to the system adopted, or in the event of such assent not being obtained, that the Council should have a right to acquire the line at the end of the company's term without paying anything in respect of the electric plant laid down.

Mr. CASTLE, Q.C., for the South Metropolitan Gas Co., asked the Committee for a protective clause in respect of the danger from electrolysis to their pipes and mains, and the right to make any alterations required for themselves. There was, he said, everywhere a desire to substitute electricity for horse traction on tramways, and the effect of the use of electricity would be to set free electric currents all over the place, the effect of which it was impossible to foresee. In the area of the South Metropolitan Gas Co. there had already occurred cases of electrolysis, and fusion had taken place between their pipes and the electric wires. They therefore felt bound to ask for the protection of Parliament. It had been argued that the Gas Co. were intruders on the public highway, and must take any risk necessitated by the electric tramway or the user of the public. But that argument was entirely wrong. The first right to the sub-soil of the roads was in the adjoining freeholders, and all that was granted away was the public user, and anything that interfered with the gas or water mains or the drains interfered with the amenities of the houses. Therefore the gas company were in their proper place, and anyone interfering with them was interfering with the adjoining proprietor's property. The Board of Trade might make regulations, but they were not efficient for the purpose. Sir W. H. Preece had put his hand on what was required in the case of these electric lines; it was not only regulation, but supervision from time to time. Accidents would occur here and there, electricity would escape, pass through moist soil, turn the water into hydrogen and oxygen, which would attack the iron and turn it into plumbago. The damage might amount to thousands of pounds in the case of a large undertaking like the South Metropolitan Gas Co. Sir W. H. Preece had said there would be no danger from electrolysis in the present case, but, if that were so, a protective clause would do no harm, but only make the Tramway Co. careful in laying down their system. The Gas Co. also desired that in any interference with their pipes and mains the works should be carried out by themselves at the Tramway Co.'s expense.

Mr. CHAS. CARPENTER, Chief Engineer to the South Metropolitan Gas Co., said the power given to the Tramways Companies under the Act of 1870, to make alterations in gas pipes and mains had never been exercised, because horse traction did not necessitate such interference. But in respect to electric traction the making of the conduits would require a depth of from two to three feet, and in some cases necessitate the shifting of the gas mains. The main that would in the present case be affected was a 2ft. 6in. high pressure main.

Mr. W. R. COOPER gave evidence as to the effect of electrolysis on iron pipes and said attempts had been made to protect the pipes by coating them, but such means had not proved to be of much value, and could not be applied to pipes already laid.

Mr. JAS. SWINBURNE said electricity damaged gas and water pipes by corrosion. The prevention of the leakage of electricity with the rail return system was a matter of degree. If the Board of Trade regulations were carried out, they would keep it down to a small extent. Escaping electricity would travel along a pipe until it met with a non-conductor, and then in leaving a pipe created corrosion, and salts of iron would be formed. With rail returns leakage could not be stopped altogether, moisture and salts were always present in the earth. In America were there were no rules such as those of the Board of Trade, electrolytic action was about four times as rapid as in England where a low pressure current was used. Insulated returns would be a perfect protection as leakage would be unlikely. The surface contact system was an experimental one, and he could not speak as to its electrolytic effect. He saw no reason why gas companies should not be compensated for damage done to their pipes. A proposal had been made in the United States to substitute earthenware pipes, but that was impracticable. To put insulated returns in tramways was difficult, and if Parliament insisted on them, it would cripple the tramway industry more than it would protect the pipes. The tramways should be allowed to use rail returns, but if they damaged other people's property they should pay for it.

After hearing counsel, the Committee decided not to restrict the tramway company to the conduit system, rejected the proposals of the London County Council, and also negatived the claim for compensation in case of damage by electrolysis to the pipes of the South Metropolitan Gas Co., but agreed that the Gas Co. should themselves have power to make any alterations of pipes or mains required, and inserted a proviso as to arbitration.

MANCHESTER AND LIVERPOOL EXPRESS RAILWAY BILL.

Owing to extreme pressure on our space we are compelled to hold over our report of the proceedings before a House of Commons Committee on this Bill, which was commenced on Tuesday and was continued on Wednesday and Thursday. The Committee adjourned until this day (Friday).

PARIS EXHIBITION NOTES.

(FROM OUR CORRESPONDENT.)

PARIS, *Tuesday, May* 8.

Perhaps the feature which calls for first comment in connection with the Paris Exhibition, 1900, is its quite phenomenal unreadiness, except in those sections devoted to the fine arts and to the amusement of the masses. Here some degree of completeness may be noted. Those whom duty calls to describe these events are accustomed to find displays of this character in the packing-case stage on opening days, but here, on the 8th of May, nearly four weeks after the official opening by President Loubet, a large part of the Exhibition can hardly be said to have even reached the packing-case stage. And it is subject for comment how far this state of affairs has been caused by the opening ceremony having been fixed for so early a date. In the course of a stroll through the spaces devoted to fixed and moving machinery yesterday, by dint of carefully picking one's way through the heaps of opened and unopened cases, railway trucks and engines, balks of timber, masonry and ironwork, and carefully avoiding the huge pits at every point awaiting the advent of heavy castings not yet apparently even on the spot, it was possible to sound those responsible for the erection of these machines on the causes for this backwardness, and several did not hesitate to blame the State officials for their precipitency in opening the Exhibition as early as April 14. To make things appear more forward

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than was the case, much was done that had to be subsequently undone, the workmen were led to leave their work to join in the "festivities" which naturally followed the official opening, and so very much valuable time was lost which can never be regained. The exhibition is open, the public crowds in, and the work is interfered with in a dozen ways that would have been avoided if the opening had been deferred to, say, May 1. This is undoubtedly a main cause of the disappointment loudly expressed on every hand. It is this cause also which is at the bottom of the inextricable confusion which everywhere prevails. To provide pathways and points of vantage for the opening-day visitors, things were placed on one side, which, only too surely, it was impossible to find when they were required for use. I have somewhat laboured this point, as it is unquestionably an extremely serious state of affairs for all concerned, and renders a visit to the Exhibition at this time an absolute waste of time and money. The greatest sufferers will undoubtedly be those firms whose enterprise and farsightedness led them to push matters at the outset vigorously, and who now find their efforts abortive, as the only persons who come to see their exhibits, newly erected, running in most cases for the first time in public, and with all the "bloom" upon them, are a crowd of country holiday makers, with mouths agape, whose unstinted admiration is magnificent, but is not business, and it is from the business point of view that those who have sent masses of expensive machinery, apparatus or instruments must of necessity regard these international shows. And this is not to mention the damage caused to moving parts of machines from the clouds of dust and particles of timber and plaster flying in all directions from the work in progress all around. It is positively disheartening to witness the condition, from this cause alone, of some of the more forward exhibits.

Altogether, the state of affairs at this moment at Paris should prove a valuable object lesson to those who have the organisation of similar shows in the future, to delay rather than expedite the opening ceremonies. There is usually a lamentable want of method in shows of this nature, but at Paris this lack of method, and the sacrifice of the "educational" to the "entertainment" aspect of this vast display has led to fearful waste of energy, and must represent the loss of a colossal sum in hard cash.

A further complaint at Paris is the difficulty of obtaining skilled labour—masons, carpenters, bricklayers, painters, &c. A great effort should surely be made by the State officials of the countries where these international exhibitions are held to secure that an adequate supply of skilled artisans are at the disposal of exhibitors, many of whom come with their exhibits hundreds of miles, and are on arrival at an obvious disadvantage compared with their native competitors. This disadvantage, always present from the nature of things, is doubly felt when the supply is so noticably inadequate as is the case at Paris.

Up to Sunday, May 6, the Exhibition was favoured with a spell of fine dry weather, and this has, of course, facilitated operations. In fact, it is difficult to conceive what the condition of affairs would have been if the weather had been otherwise. On Sunday evening, May 6, about 5 p m., a heavy thunderstorm passed over Paris, and while it helped to lay the immense clouds of dust which the introductory windstorms had created from the mass of suitable material at hand, it caused much inconvenience to those employed in the erection of machinery, statuary, and buildings. The half-emptied packing cases in the open were soon deluged, the paths were pools of mortar, the railway track became a swamp, with the result that on the resumption of operations on Monday morning a good deal of extra labour was involved in clearing things; which proves how essential to the ultimate completion of this exhibition is yet another months or six weeks of fine dry weather. Without it the Paris exhibition of 1900 will not be ready till August.

Nickel Electroplating.—According to the *Electrical World and Engineer* of New York, in a Paper read before the March meeting of the Chicago Electrical Association, Mr. C. F. Burgess gave a solution of the difficulty of obtaining a thick layer of adherent nickel in electroplating. A peculiar molecular strain is set up within the nickel during deposition, which reaches a value when a certain thickness is reached, such that the layer detaches itself from the iron or other metal surface, or is easily removed by subsequent polishing. In the electrochemical laboratory at the University of Wisconsin experiments have been made in depositing nickel from the ordinary plating solution and under ordinary conditions, with the exception that an alternating current is passed through the vat in addition to the usual direct current. It was found that this had a marked influence on the character of the deposit, it being possible thus to obtain a coating as thick as desired.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Alleged Incendiarism.—At the Central Criminal Court last week Christian Maddock, engineer, was indicted for attempting to set fire to a pattern store belonging to the India Rubber, Gutta Percha and Telegraph Works Co., Silvertown, with intent to injure. Mr. Guy Stephenson, who defended at the request of Mr. Justice Lawrance, moved to quash the indictment. The facts set out in the indictment were that the prisoner placed on the inflammable wooden floor of the pattern store wooden pattern blocks covered with cotton waste, that he saturated them and the surrounding floor with methylated spirits, and placed a freshly-trimmed but unlighted candle in the midst. Counsel argued that the acts done by the prisoner might have been a preparation to commit the offence, but they did not amount to an attempt. The last act depending upon the prisoner must be done in order to constitute an attempt. Mr. R. D. Muir for the prosecution argued that all that was necessary to constitute an attempt was that the act done should be sufficiently proximate to the commission of the crime to manifest clearly what the intention was. In this case the prisoner's intention was clearly manifest by his acts. Mr. Justice Lawrance was of opinion that, as something remained to be done by the prisoner, and as there was no interruption, what the prisoner did did not amount in law to an attempt. He accordingly quashed the indictment.

Arbroath.—Mr. Mathew Buchan has been appointed consulting electrical engineer.

Barnsley.—The charge for electric current for motors has been fixed at 1½d. per unit. A new main is to be laid along the Pontefract-road at an estimated cost of about £1,000.

Barrow-in-Furness.—The accounts of the electricity department were submitted to the Council on Monday. The chairman of the Electric Lighting committee (Mr. Smith) said the electricity station had been working for 12 months. The capital expended was £32,540. 16s. 10d., and the revenue £2,630. There was a gross profit of £758, of which £735 was absorbed in interest, leaving £23 for sinking fund. The average charge for current for private lighting was 4·97d., and the cost of generation, &c., per unit 3·4d. On the recommendation of the Highways committee it was decided to enter into an agreement with the British Electric Traction Co. with reference to the conversion and working of the Barrow tramways.

Battersea (London).—The Vestry has decided, on the recommendation of their consulting engineer (Prof. A. B. W. Kennedy) to lay distributing mains on both sides of St. John's road. Petitions have been lodged against the London County Council's two tramway bills with a view to secure further amendments in the measures.

Bradford. The Electricity committee are inviting tenders for electric motors of 4½, 7 and 10 H.P. for one year. The electrical engineer (Mr. R. A. Chattock) has also been authorised to obtain motors exceeding 10 H.P., hitherto the limit, and supply same in cases were application is made for them.

Canterbury.—A report on the first year's working of the electricity undertaking has been presented to the Lighting committee by the town clerk (Mr. H. Fielding). The consumers connected on March 31 were 195, against 106 in 1899. The number of public lamps is 12 arcs and 213 incandescents. The revenue account shows a gross surplus of £1,913. 2s. 7d., which, after allowing for legal reserve, was sufficient to pay a dividend of 4½ per cent. on the capital expended (£34,000), and to place to reserve £468. 2s. 7d. Interest on loan amounted to £673. 12s. 8d., and sinking fund to £833. 9s. 11d., leaving a net profit of £406.

Chesterfield.—An inquiry will shortly be held into the application of the Council to borrow money for erecting electricity works. The charge for current has been fixed at 6d. per unit for public and private lighting, and 3½d. for power. Applications have been received for the equivalent of 4,713 8 c.p. lamps. There are also applications for 11 motors, aggregating 50 H.P., and as it is proposed to erect 50 arc lamps for street lighting, the original scheme will have to be enlarged.

Croydon.—An inquiry was held last week into the application of the Corporation to borrow £20,570 for electric lighting. The town clerk (Mr. E. Mawdsley), and the electrical engineer (Mr. T. H. Minshall), supported the application. Mr. Minshall said that the present loan was for extensions of mains and plant, £6,800 being for station plant, and the balance for cables and mains. The loan was applied for owing to the great increase in the demand for current. Up to 31st March, the supply was equal to 45,122 8-c.p. lamps for private, and 3,500 for public lighting. When the Corporation took over the undertaking there were 18,000 lamps for private and 2,000 for public lighting. The existing plant would only be sufficient to meet the demand next winter, assuming a normal increase, without any reserve. The new plant would supply about 15,000 8-c.p. lamps alight at one time, or about 20,000 connected. In all probability the new plant would not be available until the winter after next.

Future consumers of the electricity department are to be charged on the maximum demand system.

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Dublin.—The electric tramway service between Inchicore and Westland-row has now been extended to Victoria Bridge over the Grand Canal Dock at Ringsend. The only route still worked by horse cars is that portion of the Sandymount line from Haddington-road to the Sandymount terminus on the Strand road. This horse service is likely to be a permanency owing to the railway bridge at the commencement of London Bridge-road being so low that trolley wires cannot be passed under it at such a height as will allow the electric cars to run beneath.

The receipts of the Electricity department for the past quarter were £3,167. 3s. 9d., an increase of £577. 7s. 2d.

Dunmanway (Cork).—The Rural Council have considered tenders for the electric lighting of the town. A local tenderer (Mr. John Atkins) offered to supply and erect the necessary generating plant for £1,000, to light the town until 11 p.m. by incandescent lamps, and to maintain same for £30 per annum provided he obtained permission to supply current to private consumers. Messrs. Robert Dawson and Co., of Stalybridge, through their representative (Mr. Hunter), also offered to submit a scheme, but no figures were given. Opposition to the proposed area of charge was raised. The Council passed a resolution in favour of electric lighting, but the matter is to remain in abeyance until the sanction of the Local Government Board has been obtained.

East Grinstead.—The General Purposes committee are to report upon the advisability of obtaining electric lighting powers.

Electric Auto Cars.—Sir Howard and Lady Vincent have engaged an Oppermann electrical victoria for the season.

Electric Tramways in the City of London.—At yesterday's meeting of the Court of Common Council a communication was read from the London County Council, stating that the Highways committee of that body had under consideration a proposal to introduce a bill seeking powers to construct tramways in London, in which it was proposed to construct a new line of tramway from Farringdon-road and Ludgate-circus, and asking the City Corporation to support the measure. Mr. Deputy Johnson said it should be made perfectly clear whether the tramways were to be worked electrically. Ultimately the matter was referred to the Streets committee, with instructions to fully report to an early meeting of the Court.

Failure of Electricity Supply.—At the Greenwich Police Court last week Mr. Kennedy gave his decision on the complaint against the London Electric Supply Corporation for failure to supply electric current to the premises of Mr. Shaddick, of the "Dover Castle," Deptford. Particulars of this case were given in our issue of the 27th ult. Mr. Kennedy held that the defendants' plea of *force majeure* did not apply. He was doubtful whether the company allowed sufficient time to overhaul the boilers, especially when they knew of the hardness of the water and that the boilers would not last many weeks. He did not, however, rest his judgment so much upon that ground as upon their taking Mr. Shaddick as a new customer when they knew that, through the failure of the Colchester firm to supply new boilers and their inability to overhaul the old, it was, to say the least, doubtful whether they could adequately supply Mr. Shaddick with current. The penalty was singularly inadequate, and therefore he must inflict the full penalty of 40s. in each of the seven cases with 20 guineas costs in the first case and 2s. costs in each of the others, making £35. 12s. in all.

Frome.—Messrs. Medhurst and Kitchin have been appointed consulting engineers to the Council.

Great Yarmouth.—The receipts of the electricity department for the past quarter were £1,767, and, after paying interest, sinking fund, and all charges, there was a clear profit of £65. The statement for the past year showed a profit balance of £437, against a loss of £57 on the previous year. The gross profit from 1895 to 1900 was £7,218, but the net loss was £1,522. The Wellington Pier and the Pavilion are being wired at a cost of £70.

Greenock.—Mr. E. S. Fedden, who was recently appointed electrical engineer at Sheffield, terminates his engagement here on Saturday, and will take up his duties at Sheffield next week.

Hammersmith (London).—The engineer and manager of the electricity department (Mr. G. G. Bell) submitted a report on the result of the past year's working to the Vestry on Wednesday. The consumers increased during the year from 275 (representing the equivalent of 19,390 8 c.p. lamps) to 464 (representing 26,365 lamps). The average number of lamps per consumer had decreased from 70 to 56. This was mostly due to the number of small flats in the parish which was wired, £3,375 were received for lighting and maintaining 150 public arc lamps, 63 additional arcs had been added since last report, 620,078 units have been supplied for private lighting, producing £10,274. 5s. 7d., which worked out at an average price of about 4d. per unit. The average lighting hours of the lamps had been increased from 840 to 900 per annum, but owing to the reduction of practically ½d. per unit, the annual revenue per lamp had gone down from 10s. 10d. to 9s. The total cost of generation, distribution, &c., was £7,764. 14s. 11d., or 2·05 per unit, a decrease of nearly ½d. per unit on last year, being 56·5 per cent. of the revenue, leaving a gross profit of £5,974. 0s. 10d., or 43·5 per cent. towards paying interest and sinking fund charges. The whole of the buildings, generating machinery, and distributing mains have been maintained in efficient working condition out of revenue. The result of the year's working showed a net profit of £1,615. 4s. 8d., after the deduction of interest and repayment of capital. The capacity of the generating station is equal to supplying a further 10,000 8 c.p. lamps, after allowing an ample margin to reserve.

Hampstead (London).—The Guardians are applying for a loan of £2,003 for electric lighting and other purposes. The Vestry have taken up a loan of £90,740 on account of £97,178 applied for for electric lighting, to be repaid within 42 years, and have decided that the cost of all plant and machinery covered by the loan which it may be necessary to renew or replace during the currency of such loan, shall be defrayed out of a special sinking fund or out of maintenance account.

Hull.—An inquiry was held on Tuesday into the application of the Corporation to borrow £42,000 for electric lighting extensions. The town clerk said that the total of electric lighting loans was £128,490. The present loan was required to meet the increasing demand for current. The undertaking was financially a success. Last year they made a profit of £1,924. 3s. 4d., which was carried to reserve which now amounts to £10,092. There was no opposition.

Imports of Electrical Goods into the United Kingdom.—The accounts relating to the trade and navigation of the United Kingdom show that the value of electrical goods and apparatus imported during April was £411,335 against £73,085 in the preceding month and £360,966 in April, 1899. The total for the four months ended April 30 was £1,801,538, against £1,546,025 in the corresponding period last year.

Islington (London).—An expenditure of £4,125 has been sanctioned for 25 transformers. The outlay will, however, only be incurred when the London County Council has sanctioned the borrowing of the money.

Kiel (Germany).—The Municipal authorities have decided to erect electricity works at an estimated cost of £35,000.

Leeds.—At present the Corporation are supplying current to 1,500 customers, representing an equivalent of about 110,000 8 c.p. lamps, an increase of 50 per cent. over the figures when the undertaking was taken over from the Yorkshire House-to-House Electricity Co., 18 months ago.

Leyton.—The Council have decided to lay down additional feeders at an estimated cost of £7,288, and the electrical engineer (Mr. F. Harman Lewis), has been instructed to carry out the work.

Light Railways.—In their annual report to the Board of Trade for the year ended Dec. 31, 1899, the Light Railway Commissioners state that during the year 37 orders were submitted for confirmation, and of these 18 were confirmed and one was rejected, as it was considered the scheme should come before Parliament, The remaining 18 are still under consideration. Of the 18 orders under the consideration of the Board at the date of the last report, 17 were confirmed, and one was withdrawn. Up to Dec. 31 last the Commissioners had submitted 88 orders in respect of 91 applications to the Board of Trade for confirmation. Of the 94 applications for the year 1898-1899 nine were withdrawn prior to, and three were rejected without, holding an inquiry. Of the remaining 82 applications 67 inquiries had been held up to Dec. 1, with the result that 47 were approved, two adjourned, one withdrawn, and 17 rejected. The Commissioners express apprehension as to their ability to deal with the great and increasing number of applications within the specified time. In 1897 48 local enquiries were held, in 1898 54, and in 1899 73, but the Commissioners were in considerable arrears with the applications.

Llanelly.—The British Insulated Wire Co. recently arrived at an understanding with the Council for the erection of electricity works and for the conversion and extension of the local tramway. Some difficulty has been experienced in arranging terms with the tramway company, and the Council now propose to exercise their rights of purchase, and as soon as the undertaking passes into their hands it will be handed over to the B.I.W. Co.

London County Council.—At Tuesday's meeting a loan of £10,000 for plant and machinery for the electric lighting scheme of the Poplar District Board of Works was granted, and a loan of £20,000 (on account of £40,000 sanctioned on March 27) was granted to the Shoreditch Vestry for electric lighting work.

The decision of the Light Railway commissioners refusing the application of the County Council for an order to construct light railways in London was discussed, and it was stated that the Highways committee will shortly report upon the course it will recommend the Council to take in regard to this important decision.

Longton.—It has been decided to apply for a loan of £28,500 for erecting electricity works.

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Maesteg (Glam.)—The question of obtaining electric lighting powers is to be discussed at the next council meeting.

Municipal Loan.—The Ilford District Council are inviting tenders for a loan of £66,700 for electric lighting. Tenders to Chairman by the 16th inst.

New Maldon (Surrey).—A special committee has been formed to consider the electric lighting scheme proposed by Mr. F. J. Warden Stevens.

Plymouth.—An inquiry was held by Mr. A. P. Trotter, on Tuesday, into the application of the Corporation to borrow £20,000 for additional generating plant for electric tramway purposes. The town clerk (Mr. J. H. Ellis) stated that electric traction on the Ebrington-street section had been so satisfactory that the Corporation desired to extend it to the northern section of the tramways. The Local Government Board had already sanctioned a loan for the overhead equipment and cars for the Compton section, and the present loan was required for the provision of generating plant, boilers and pipes, accumulators and switch gear, underground mains, &c. At the Corporation's station at Prince Rock there was space for all the plant to be put in. He asked that the loan should be for 30 years. The borough electrical engineer (Mr. Rider) said the Corporation had already borrowed £18,000 for overhead equipment and bonding of the lines. The track already existed, but certain sections of it would have to be renewed with heavier rails to carry the electric cars. That, however, was provided for in the previous loan. Mr. Trotter remarked that the Board had adopted definite rules with regard to the repayment periods of loans. They allowed 30 years for buildings and land, 20 years for electrical equipment and 15 years for cars. Mr. Rider then submitted technical details of the proposed new plant, and stated that the length of the line was over 3 miles of single track. There was no opposition.

Private Bill Legislation.—The Charing Cross, Euston and Hampstead Railway, and the Wellingborough and District Tramroad Bills have been read a second time in the House of Lords. The City and South London Railway Bill has been read a third time.

Redditch.—An inquiry has been held into the application of the Council to borrow £8,000 for electric lighting. The clerk (Mr. G. W. Hobson explained that the present loan was required to meet excess expenditure and carry out extensions. There was no opposition.

Reigate.—The charges for current for private lighting have been fixed at 7d. for the first hour's maximum demand, and 4d. afterwards. The annual charge for public arc lamps is to be £18 per lamp.

Salford.—A special meeting of the Council was held on Monday to consider the report of the special committee recently appointed to investigate certain matters relating to the borough electrical engineer (Mr. C. L. Turner), and certain alleged irregularities in connection with plant contracts. The Committee was composed of the Mayor (Ald. S. Rudman), the Deputy-Mayor (Ald. W. Robinson), and Aldermen Hulland and Phillipps, and Messrs. E. Desquesnes, J. Higson, W. Stephens, and A. Worsley. The report stated that the Committee had held four meetings, at which in the presence of of Mr. Turner, the evidence of Mr. Haworth, chairman of the Electric Light committee; Mr. Bates, member of Council; Mr. Clirehugh, consulting engineer; Mr. Holt and others was taken. Mr. Turner had had the opportunity of asking these gentlemen questions, had subsequently made his own statement to the committee, and had produced such witnesses and documents as he thought fit. In August, 1898, Mr. Turner, as borough electrical engineer, was instructed by the Electric Light committee to prepare and submit plans for the new works and plant required. He did so, and in Dec. 1898, the committee advertised for tenders based upon these plans, &c. The Council, however, rejected the plans and specifications, and the tenders were not opened, but by direction of the Council, Messrs. Lacey, Clirehugh and Sillar were instructed to prepare a new set of plans, which were submitted and adopted in December. In the meantime, Mr. Turner appeared to have conceived that he had the right to appropriate to his own use and benefit a portion of some plans which had been thus rejected. These plans referred to a form of arrangement of pipework originally prepared by him under the direction of the committee, and, as he admitted, prepared at the cost of the Corporation and in pursance of his duty as borough electrical engineer. Without making known that intention to, or seeking the consent or advice of, the chairman of the Electric Light committee, he had a preliminary interview with a firm of patent agents at a date stated to be September, 1899. In the same month Mr. Turner stated that he had an interview in Manchester with a member of a firm of pipe makers, at which it was arranged that the firm in question should take up Mr. Turner's patent upon a royalty of 7½ per cent. payable to Mr. Turner, and in October an agreement was drawn up embodying that arrangement. In November instructions were given by Mr. Turner to the patent agents to secure provisional protection in his name, the official notification being dated Nov. 30 that the grant was registered as being applied for under date Nov. 22. The committee had, at Mr. Turner's request, compared the plans relating to his patent with those prepared by Mr. Clirehugh, and found that there was considerable similarity on a cursory examination, but Mr. Turner had pointed out that his plans disclosed an arrangement of valves and piping aimed at securing that any one of a series of boilers or its connecting steam pipe could be shut off without interfering with the supply of steam from the other boilers. Mr. Turner invited the committee to obtain expert evidence to establish the distinction, but the committee did not deem it necessary to enter further into the question of the validity of the patent, as the borough engineer had declared that Mr. Clirehugh's plans were different and did not effect the purpose for which he had a patent. If so, it resulted that the contractors would not have been chargeable with any royalty in respect of Mr. Turner's patent. The tenders were advertised in Feb. last, and the pipe-making firm already referred to applied and obtained specifications and information from Mr. Clirehugh's firm, and then addressed a letter, not to Messrs. Lacey, Clirehugh and Sillar, the proper persons, but to Mr. Turner, asking for the names of firms tendering for condensers and steam pipes, so that they might, as sub-contractors, submit prices for consideration. Mr. Turner in February, having obtained the desired information from Messrs. Lacey, Clirehugh, and Sillar—without, as they affirm, disclosing its object—supplied the names to the pipe-making firm, who subsequently issued a letter stating that they understood the person to whom it was addressed proposed to quote for the Salford steam-pipe and condensing plant, and pointing out that the pipe installation was in accordance with Mr. Turner's patent system, of which they were the sole licensees. The agent of the pipe-making firm had explained that he thought Mr. Turner's patent was adopted in Messrs. Lacey, Clirehugh and Sillar's plans. Questioned as to these matters, Mr. Turner stated that on receipt by him of the request for the names he saw Mr. Clirehugh, and said he had received the letter asking him to send all the names of intending contractors, and asked if he (Mr. Clirehugh) had any objection to that, and he replied that he saw no objection. Mr. Clirehugh's evidence was that no such statement was made, and that a simple verbal request was made to him by Mr. Turner for the names, without explanation, and he supplied them as a matter of course, having regard to Mr. Turner's official position. In concluding their report the committee expressed the opinion that Mr. Turner was not justified, without the knowledge and permission of his committee, in seeking a patent for work done by him on behalf and at the expense of the Corporation, who were his employers, and that there had been an unfortunate coincidence in the time of his securing a patent for pipework with the time when plans were being produced for contractors with the Corporation in his own department to tender for pipework; that Mr. Turner was not justified in supplying the list of names; that it was difficult to believe that he was not cognisant of what was being done by the pipe-making firm; and, finally, "that Mr. Turner has endeavoured to mislead your committee and members of the Electric Light committee (namely, its chairman and Councillors Haworth and Bates) on important matters of fact involved in the inquiry, with the result that he has lost your committee's confidence." A motion that the report of the committee be received and entered upon the minutes of the Council having been seconded and adopted, the Mayor moved—

"That, in the opinion of this Council, Mr. C. L. Turner has forfeited its confidence, and that he be required to resign his position as electrical engineer, and that three months' salary be paid to him in lieu of notice."

Ald. Mandley moved as an amendment that the electrical engineer be forthwith dismissed. Upon a division the amendment was lost by 28 votes to 12, and the resolution was then agreed to. Ald. Phillips said a letter had been written by a Manchester solicitor threatening the chairman of the Electric Light committee (Mr. A. Haworth) with legal proceedings. He, therefore, moved—

"That in case any legal proceedings are brought against Mr. Haworth in connection with the matter, the Council undertake to defend him."

Mr. Haworth said the action he had been compelled to take in this affair had been most painful. He had every confidence in the electrical engineer up to a certain point. The resolution was passed, and the Council adjourned.

Southport.—The Council on Tuesday decided to apply for sanction to borrow £40,000 for relaying the tram lines recently purchased from the Birkdale and Southport Tramway Co., and to provide the necessary electrical equipment.

Spalding.—As the Council are the owners of the gas works they have decided to oppose an application by a company for a provisional electric lighting order.

Tunbridge Wells.—The Lighting committee have engaged Sir W. H. Preece, at a fee of 50 guineas, to prepare a report as to the best means of preventing nuisance by smoke and vibration at the electricity works.

Underground Telephone Wayleaves.—The Marylebone (London) Vestry have given the National Telephone Co. permission to lay their wires underground.

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NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date) a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made quite complete. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is the most complete and correct book of its kind ever published in any language.

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Submarine Cable-Laying and Repairing.—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Glasgow Corporation require tenders for indiarubber-covered and lead-covered branch cables and carbons for one year. Specifications, &c., may be obtained from the engineer (Mr. W. A. Chamen), 75, Waterlow-street, Glasgow, and further particulars are given in an advertisement. Tenders to the town clerk (Sir J. D. Marwick) by 19th inst.

Glasgow Corporation also require tenders for creosoted poles, oak arms, insulators, ironwork, and ironwork used in telephone construction. Tenders by Wednesday, 16th inst.

Leeds Lighting committee invite tenders for two or three 630 kw. two-phase generators and one or two sets of surface condensing plant. An advertisement contains further particulars, and specifications, &c., may be obtained from the manager (Mr. H. Dickinson), 1, Whitehall-road, Leeds. Tenders to town clerk (Mr. W. J. Jeeves) not later than 10 a.m. of 28th inst.

Bradford Corporation invite tenders for the supply and delivery (for 12 months) of enclosed electric motors of 4½ H.P., 7 H.P., and 10 H.P. Specification, &c., may be obtained from the city electrical engineer (Mr. R. A. Chattock). Further particulars are given in an advertisement, and tenders must be sent to the town clerk (Mr. Frederick Stevens), Town Hall, Bradford on or before 24th inst.

Bradford Corporation also require tenders for the construction and delivery of two steam engines and two 1,000 kw. dynamos. Specifications may be obtained from the city electrical engineer (Mr. R. A. Chattock), and tenders must be delivered to the town clerk (Mr. Frederick Stevens), Town Hall, Bradford, on or before 24th inst. An advertisement gives further particulars.

Newcastle-upon-Tyne Tramways committee invite tenders for switchboards, underground feeders, and pumping apparatus. An advertisement contains additional particulars, and tenders for switchboards and feeders must be sent to the town clerk (Mr. Hill Motum) by 25th inst., and for the pumping apparatus by June 1. Specification and forms of tender can be obtained after 16th inst. from the consulting engineer, Mr. Chas. Hopkinson (Messrs. Hopkinson and Talbot), 26, Victoria-street, London, S.W.

Walthamstow District Council invite tenders for the supply and erection of arc lamp posts and accessories and glow lamps on posts and on existing gas standards in connection with their proposed system of electric lighting. Plans may be inspected and specifications obtained after 17th inst., at the offices of the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., and tenders must be delivered to the clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m. 29th inst. An advertisement gives additional particulars.

Walthamstow District Council invite tenders for fire alarms, wire, &c. An advertisement contains additional particulars, and forms of tender may be obtained from the surveyor (Mr. Edwin Morley). Tenders to the clerk (Mr. E. J. Gowen) before 5 p.m. of 25th inst.

Southampton Corporation invite tenders for the supply and erection of a water-tube boiler with steam and other pipes and sundry ironwork. Specification may be obtained (after 14th inst.) of the town clerk (Mr. R. R. Linthorne), and may be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, St. George-street, Westminster. Tenders to Mr. Linthorne by 28th inst. See also advertisement.

Bridgwater Town Council invite tenders for the supply and erection of electricity generating plant as advertised in another column. Specifications, &c., may be obtained from the consulting

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engineer (Mr. W. H. Trentham), 39, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. W. T. Baker), Town Hall, Bridgwater, before 3 p.m. on June 7th.

Crewe Town Council seek tenders for the supply and laying of about 25,000 yards of three-core cable for street lighting extensions, and the supply of upwards of 500 lamp holders and reflectors for adopting the existing lamp-posts for electric light. Specifications may be obtained from the engineers (Messrs. Hopkinson and Talbot), 26, Victoria-street, S.W., and tenders must be sent to Mr. Frederick Cooke, town clerk, Crewe, by May 26. See advertisement.

Glasgow Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. An advertisement gives further particulars, and the specification may be obtained from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow. Tenders with the town clerk (Sir J. D. Marwick) before 10 a.m. of June 12.

Dundee Town Council invite tenders for supply of copper bonds. Specifications, &c., may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders must be lodged with the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 22nd inst. An advertisement contains additional particulars.

Edinburgh Corporation invite tenders for elevators and coal and ash conveyors for the McDonald-road electricity station. An advertisement gives further particulars, and specifications may be obtained from the resident engineer (Mr. F. A. Newington), Dewar-place. Specifications may be seen at, but not obtained from, the office of the consulting engineer (Prof. A. B. W. Kennedy), 17, Victoria-street, London, S.W. Tenders must be delivered to the town clerk (Mr. Thomas Hunter, W.S.) by 21st inst.

Worksop District Council require tenders for electricity generating plant. Tenders to clerk by 23rd inst.

The Guardians of *West Ham* Union invite tenders for the erection and maintenance for 12 months of electric lighting installation. Tenders to clerk, Union-road, Leytonstone, E., by May 16.

Heywood Corporation require tenders for electricity generating plant. Specifications, &c, from town clerk (Mr. J. H. Baldwick) and tenders by noon on May 14.

Corporation of *London* Streets committee invite tenders for the supply on hire of electrically-driven dust carts. Tenders to town clerk (Sir John B. Monckton), Guildhall, E.C., by June 1.

Paddington (London) Vestry invite tenders for carrying out certain proposed alterations to the existing electric lighting at the public baths. Tenders to vestry clerk (Mr. Frank Dethridge), Vestry Hall, Harrow-road, London, W., by May 14.

Burnley Corporation invite tenders for laying about 2,000yds. of cable. Tenders by May 14.

King's Lynn Corporation invite tenders for the supply of steam dynamos, boiler, switchboard and cables. Tenders by May 17.

Central Electric Supply Co. (Ltd.) invite tenders for electrical plant. Tenders to Mr. F. J. Walker, 19, Carnaby-st, London, W., by May 22.

Rhyl District Council invite tenders for the supply and erection of electricity generating plant. Tenders to Clerk by 2 p.m. of May 14.

Brighton Corporation invite tenders for incandescent lamps for 12 months from July 1 next. Tenders by June 11.

Tenders are invited for wiring the *Leeds* Central Fire Station. Tenders to town clerk by 28th inst.

The *Bengal Nagpur Railway Co.* (132, Gresham House, Old Broad-st., E.C.) require tenders for electric lighting plant. Tenders by May 10.

TENDERS RECEIVED AND ACCEPTED.

For the supply of electricity meters to the Brighton Corporation electricity works for one year from June 1, 1900, the following tenders were submitted (each) :—

Reason Manfacturing Co. (*accepted*)	£2	10	0	British Th.-Houston Co.	£4	5	0
General Electric Co.	5	5	0	Johnson & Phillips	4	0	0
S. Z. de Ferranti (Ltd.)	4	12	0	Chamberlain & Hookham	3	10	0
				British Electric Meter Co.	2	16	9

Messrs. Campbell and Isherwood's tender has been accepted by the Liverpool Select Vestry for wiring the Nurses' Homes at the Workhouse, Brownlow Hill.

The Sheffield Corporation have accepted the tender of Messrs. John Brown and Co. for the supply and erection of three marine-type boilers at the electric lighting station for £8,550. Bennis mechanical stokers are to be fitted to the boilers at £100 each.

The Birkenhead Corporation have accepted the following tenders : Tetlow Brothers, three Lancashire boilers and fuel economiser and mechanical stokers ; Siemens Brothers and Co., three steam dynamos ; Klein Engineering Co., independent condensing plant, re-cooling tower and two boiler feed pumps ; Electrical Power Storage Co., accumulators and booster ; Marshall, Fleming and Jack, a 12-ton overhead travelling crane.

APPOINTMENTS VACANT AND FILLED.

Accrington Corporation require the services of an electrical clerk of works to supervise, under the direction of their consulting engineer (Mr. J. N. Shoolbred), the laying of cables in the streets and the erection of electrical plant at the generating station, at a salary of £3 per week. Further particulars are given in an advertisement, and applications must be sent to Mr. A. H. Aitken, town clerk, Town Hall, Accrington, by noon of 18th inst.

The Hastings Corporation require an assistant electrical engineer. An advertisement contains further particulars, and applications must be sent to the borough electrical engineer (Mr. Leonard Andrews), Earl-street Works, Hastings.

The Johnson-Lundell Electric Traction Co. require an engineer and general manager and a secretary. Further particulars are set out in an advertisement, and applications should be addressed to the chairman (Mr. Leonard W. Holmes), 17, Soho-square, London, W.C.

Salford Electric Light committee require an electrical engineer, salary £400 per annum. Further particulars are set out in an advertisement, and applications (addressed to chairman of committee) must be forwarded to the town clerk (Mr. L. C. Evans) by noon of 21st inst.

The Aberystwith and Chiswick Electric Supply Corporation invite applications for the post of resident engineer at their Chiswick station, now building. Commencing salary £225 per annum. Applications to secretary. See advt.

An assistant lecturer and demonstrator in electrical engineering is required for the University College of North Wales, Bangor. Applications to the secretary and registrar (Mr. J. Lloyd, M.A.), not later than June 9. See advertisement.

The resident engineer of the Scarborough Electric Supply Co. has a vacancy for a pupil. See advt.

An advertisement invites applications for the post of managing engineer of a cable works on the Continent.

A switchboard attendant is required at the Hull Tramways' power station. Applications to City electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull. See advt.

Salford Corporation want a clerk of works for the electricity station at Pendleton. Applications to Mr. J. Holt, 6, St. Mary's Gate, Manchester, by 19th inst.

An installation inspector is wanted for the Manchester electrical department. Applications to chairman by 15th inst.

Mr. John Christie, of Glasgow, has been appointed resident electrical engineer and manager at the Brighton Corporation electricity works, under Mr. Arthur Wright, at a salary of £400 per annum, rising by annual increments of £25 to £500. There were 44 applicants for the position and these were reduced to four, viz. :— Mr. Christie (who asked for a salary of £450), Mr. R. H. Campion (of Blackburn, who asked £300), Mr. P. W. d'Alton (late of the London Electric Supply Corporation, who wanted £600), and Mr. A. A. Day (of Manchester, who required £400). After consultation with Mr. Wright it was decided to appoint Mr. Christie, the engagement being for five years, but determinable by the Corporation at one month's notice.

Since Mr. Turner's retirement from his position at Salford on Monday last, Mr. F. A. Wilkinson has been appointed borough electrical engineer (*pro tem.*). Mr. Wilkinson was previously the chief assistant engineer.

The Cardiff Lighting Committee have appointed Mr. W. H. Illingworth, of Halifax, mains superintendent at a salary of £150 per annum.

Mr. A. G. Hancock, late assistant electrical engineer at the Chatham, Rochester and District Electric Lighting Co.'s station has been appointed, out of 19 candidates, assistant engineer at Bray.

BANKRUPTCIES, LIQUIDATIONS, &c.

It has been resolved to wind up Howell's Anti-Inductive Telephone Syndicate (Ltd.) voluntarily, and Mr. D. F. Basden, 33, St. Swithin's-lane, E.C., has been appointed liquidator.

Claims against H. L. Howard (trading as Thompson, Howard and Co.), electrical and mechanical engineer, Wyvestow, Dragon-parade, Harrogate, and at York and Hull, must be in by 22nd inst. Mr. A. T. Wilkinson, O.R., 28, Stonegate, York, is trustee.

John Grant Macandrew, trading as the Waverley Electric Co, 117, George-street, Edinburgh, and Portobello, has executed a trust deed. The principal trade creditors include :—

Edison and Swan Co.	£140	7	7	Siemens Bros. and Co.	£19	4	4
Drake and Gorham	65	14	1	C. Joyner and Co.	15	15	1
Telegraph Manuf'ct'g Co.	51	3	2	General Electric Co.	15	9	0
D. F. Wishart and Co.	36	13	8	Mathew Buchan	12	10	0
John Hunt and Co.	25	15	0	J. W. Singer and Sons	12	9	2

The liabilities amount to £688. 0s. 2d., and the assets to £323. 10s. 5d. At a meeting of creditors on the 4th inst. it was proposed that debtor's father and other friends should pay on debtor's behalf a composition of 10s. Mr. Macandrew, sen., was allowed time to consider the suggestion.

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Laing, Wharton and Down (Ltd.)—(In Liquidation).—In connection with the realisation of the assets of this company we understand that it will probably be some considerable time before the liquidator is able to make any proposition to the unsecured creditors. In the meantime it may be stated that these creditors are unlikely to receive payment of their debts in full.

Mannesmann Tube Co. (Ltd.)—(In Liquidation).—We learn that there are hopes of a small dividend being paid shortly to the unsecured creditors of this company. No distribution of assets can, however, take place until the debenture-holders' account has been settled, and the claims of the secured creditors, which are now being dealt with, are adjudicated upon.

Williamson and Joseph (Ltd.)—(In Liquidation).—In reply to our inquiries regarding the liquidation of Williamson and Joseph (Ltd.) we are informed that there is practically no prospect of any dividend being paid to the unsecured creditors in this matter. None of the assets of the company have so far come into the liquidator's hands, the receiver for the debenture holders being still in possession. This gentleman has up to the present, we understand, been unable to obtain an offer for the business sufficient to cover the amount of the debentures and interest.

Plant for Sale.—Messrs. Cornelius and Boulter, the Promenade, Cheltenham, announce in an advertisement the sale by auction on 22nd inst. at noon, of the contents (including electric lighting plant and machinery) of the Assembly Rooms, Cheltenham. Catalogues, &c., from the auctioneers.

The Tynemouth Corporation have a 30 H.P. Marshall steam engine and a belt-driven dynamo (175 amperes 65 volts) for sale. An advertisement gives additional information, and offers must be sent to the borough surveyor (Mr. John F. Smillie), Town Hall, North Shields, by noon of Tuesday the 22nd inst.

The Tunbridge Wells Corporation invite offers for their electricity works switchboard. Particulars may be obtained from the borough electrical engineer (Mr. Horace Boot). See Advt.

A 37-kw. Siemens dynamo is advertised for sale in another column. Applications to clerk of works, Eaton Hall, Chester.

"Monobloc" Accumulators.—Messrs. Drake and Gorham, sole agents in this country for the Monobloc Accumulator Syndicate, Ltd., forward a catalogue of these accumulators. The Monobloc is known on the Continent as the "New Julien," and references are given, in the list before us, to tramway systems abroad where this type of cell is in use. Tests and trials to which the cells have been subjected on the Continent give the capacity as 9 watt-hours and 5·22 ampere hours per lb. of electrode, and the efficiency is shown to be very high. Special plant has, we are informed, been installed at Bakewell, Derbyshire, for the manufacture of the cells on an extensive scale. The appearance of the Monobloc accumulator is familiar to our readers through the medium of our advertisement pages, and briefly it may be stated that the block of the positive material is composed of punched sheets of lead, built up from the bottom of the cell so as to form one homogeneous mass, which is crossed-tied at all points to give considerable mechanical strength. The holes punched in these horizontal sheets also form a casing and receptacle for the negative electrodes, which are in the form of vertical pencils. The tramway services at Ghent and Dunkirk have been conducted entirely with accumulator cars for more than a year, and the commercial results are said to compare favourably with the published figures for the trolley under similar conditions. At Ghent there are 36 cars in regular work and 11 reserve cars. The method of suspension of the cells under the car is such that the woodwork is not liable to damage by the acid.

"Constant" Arc Lamps.—Mr. G. Braulik, of 217 and 218, Upper Thames-street, London, E.C., forwards a new price list of continuous current "F" pattern arc lamps, manufactured by Messrs. Koerting and Mathieson. Mr. Braulik calls attention to the increased sales of these lamps, and states that some of the largest supply companies and corporations in the country are using them. There will shortly be ready a new price list of enclosed arcs for alternating and continuous current, also of double carbon and inverted arc lamps.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 2 to May 8, with the ports of destination:—

Africa—Cape Town, £43; Durban, £269. *Argentina*—Buenos Ayres, £88; Rosario, £52. *Australasia*—Adelaide, £76; Port Darwin, £8) (telegraph material); Sydney, £283; Wellington, £209. *Belgium*—Ostend, £36. *British Guiana*—Demerara, £41. *France*—Rouen, £105. *Germany*—Borkum, £21 200 (telegraph cable); Hamburg, £427 (including £400 telegraph material). *Gibraltar*—£130. *Holland*—Amsterdam, £85. *Hong Kong*, £52. *India*—Bombay, £685; Calcutta, £688 (including £317 telegraph material); Madras, £770. *Japan*—Kobe, £659; Nagasaki, £127; Yokohama, £3,235. *Mauritius*—£63 (telegraph material). *United States*—New York, £355. *Zanzibar*—£40. Total £30,798, against £8,484 in the corresponding week last year (May 3 to May 9).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 4, 1900.

6,276. J. G. BEEVERS. Manchester. Improvements in shade or globe holders for electric lights.
6,296. W. BORCHERS. London. Improvements in electric furnaces.*
6,301. W. BEST. London. Improvements in or connected with means for electrically igniting miners' safety lamps
6,308. R. A. FESSENDEN. London. Improvements in incandescent lamps.*
6,312. H. A. COHN and E. GEISENBERGER. London. Improvements in and apparatus for the production of soda and chlorine by the electrolysis of chloride of sodium, the invention being also applicable for the production of potassium sodium, aluminium or other metals of the same class.
6,317. W. P. THOMPSON. London. Improved automatic interrupter for overhead conducting wires and the like. (E. Vittani, Italy.)

April 5, 1900.

6,348. H. D. WEBB. London. A new and improved insulation for electrical wires.
6,385. J. F. COOLEY. London. Improved methods of and apparatus for electrically separating the relatively volatile liquid component from the component of relatively fixed substances of composite fluids.*
6,405. W. H. SCOTT. London. Improvements in switches for use with electric motors.

April 6, 1900.

6,475. E. HARNETT. London. A self-contained electric incandescent lamp and method of charging same.
6,478. W. F. JONES. London. Improvements in electro-magnetic mechanism.*
6,479. P. RIBBE. London. Improved accumulator plate.*
6,488. SIEMENS BROS. AND CO. (LTD.). London. An improvement in apparatus for simultaneously actuating from one point the controlling switches of the several electrical motor cars of a tram. (Siemens and Halske, Actiengesellschaft, Germany.)*
6,496. J. SKOPEC and M. OREL. London. An improved automatic circuit breaker for use in connection with electric railways.

April 7, 1900.

6,499. R. A. LEHFELDT. London. An electric meter depending on the electrolysis of mercury.
6,526. A. MÜNKER. Berlin. Improvements in electric fire alarms.*
6,528. J. C. RICHARDSON and M. WHITWILL. London. Improvements in or relating to electrolytic apparatus.
6,530. J. C. RICHARDSON and M. WHITWILL. London. Improved capillary diaphragms for electrolytic apparatus.
6,533. F. M. BROWNE and R. ROWE. London. Photomatic-telegraphy by electricity for transmitting pictorial particulars so as to reproduce from distant places facsimiles of direct portraitures automatically and speedily.
6,540. M. STEIN and G. FREUND. London. Improvements in or relating to electric railways with underground conductors.*
6,548. H. B. WHITMORE. London. Improvements in brush holders for dynamo machines or electric motors.
6,564. R. GAERTNER. London. Improvements in reflectors for electric incandescence lamps.*

April 9, 1900.

6,615. W. R. EDWARDS. London. Improvements in terminals and binding screws for electric batteries and connections.
6,621. J. SAX AND CO. (LTD.). London. Improvements relating to electrical switches. (G. Busch, Germany.)
6,637. J. A. FLEMING and MARCONI'S WIRELESS TELEGRAPH CO. (LTD.). London. Improvements in relays.
6,642. C. F. MORRIS and W. HENLEY. London. Telephonic device for imitating the sound of guns.

April 10, 1900.

6,650. C. PETITJEAN. Coventry. Improvement in telephone switches.
6,652. A. D. HUNTER. London. Improvements in telephone transmitters.
6,671. E. FRANKE. London. Machine for filling accumulator plates with active materials.*
6,674. H. GOETZE. Dresden. Phonograph cylinders.
6,675. E. BAER. Dresden. Electrical key or stencel-board contact-apparatus for telegraphic communication.
6,681. E. DERVIN. London. Improvements in electric coherers.*
6,686. J. DEWAR and B. SHERMAN. London. Improved apparatus for forming a silence chamber for telephonic purposes and the like.
6,693. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric transformers. (W. S. Moody, United States.)*
6,701. O. C. STRECKER. London. Improvements in the process of electrolytically preparing metals or alloys for lithographic purposes.
6,703. T. BERGMANN. London. Improvements in electromagnetic light machines for regulating the sparking moment.*

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

1,434. BROWN. Electric telegraph apparatus.
4,360. VEDOVELLI and PRIESTLY. Apparatus for use in electric traction on the conduit system.
4,931. WISE (Crehore and Squier). Means for generating and impressing semi-cycles of electromotive force on electric circuits for telegraphic and other furnaces.
6,064. WISE. (Crehore and Squier.) Electric relays.
6,205. LOIR. Electric motor vehicles.
7,479. JUSTICE. (Priess Electric Storage Syndicate, Ltd.) Secondary batteries.
7,892. JUNGNER. Electrical batteries.
8,097. CHATTERLEY. Apparatus for regulating the arc in electric arc lamps.
8,240. PARTRIDGE and LONDON ELECTRIC SUPPLY CORPORATION (LTD.). Safety devices for use in connection with electrical distributing systems.
8,468. BOHLE, BOHLE and PHILLIPS. Arc lamps.
9,434. STOCKWELL. Electric arc lamps.
9,872. GRELET and VIVES. Phonographs.
10,238. DUBOIS and MUTUAL ELECTRIC TRUST (LTD.). Coin-operated mechanism specially applicable for electric and other meters.
10,839. SCHINDLER. Automatic electric cut-out devices for electric cooking apparatus.
11,325. BOCHET. Electric traction.
11,881. CRONEAU. Electrical apparatus for effecting rotation at a distance.
13,650. KENWAY. Bonds for electric tramways and railways.
25,403. MATHEWS. Electric low-water alarm for steam generators.
25,768. ROWNTREE. Electric lifts or elevators.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.).

The fifty-third ordinary general meeting of the shareholders was held on Wednesday, at Winchester House, London, E.C., under the presidency of Mr. W. S. ANDREWS.

The SECRETARY (Mr. E. Steer Hodson) read the notice convening the meeting,

The CHAIRMAN said: What I have to say to-day does not amount to very much. So far, however, as it goes, I think you will agree that it is particularly satisfactory, because it shows the continued existence of the annual augmentation in our receipts which all shareholders, equally with all directors, like to be able to perceive in the figures. The income for the half-year ended Dec. 31, 1899, including dividends from the Western and Brazilian Telegraph Co. and other telegraph companies, amounted to £139,596. For the previous half-year the total reached was £119,360, so that you see an increase is shown upon the figures of the last half-year of £20,236. This improvement results from an increase in message receipts, which are, as a fact, rather larger, the amount thus netted being £22,381. That is on the right side, but, as you know, this company receives from other companies certain dividends, and sometimes the periods at which those dividends are paid are not identical in the different years, so that there may be a little variation. This does not affect the total eventually, of course, because they average one another, but, as a fact, there was in this year a decrease of £2,145 from the circumstance I have stated. Then, the increase in the traffic receipts shows, on being analysed, that we got most of the increase from the east coast of South America; but there has been an increase in the receipts from the west coast of South America and from the west coast of Africa, with a slight decrease in the traffic with South Africa. The principal item is the large increase in the receipts from the east coast of South America. Turning to the expenditure side of the accounts, we find that the total expenditure for the half-year was £25,596, while that for the previous half-year was £21,999. There is therefore an increase in the expenditure in the past half-year of £3,597. There was an increase in the London expenses of only £209, but in other expenses the increase was £3,524, less a decrease in working expenses at the stations of £136, leaving the net increase at £3,597. As showing that we do not increase our expenses needlessly, I may say that practically the increase which I have mentioned in the expenditure this time is nearly all made up by the cost of repairs of cables, which item exceeded by £3,100 the amount spent under the same heading in the preceding six months. As you know, that is an item which is not within our control. The breaking of your cables results from natural causes, and all that we can do when it happens is to repair the cables as quickly as we possibly can, so that the break may not interfere with your trade. There may be more expenses on this account as the cables grow older, but that is an unknown quantity, and it does not do to dwell upon it. After payment of £3,200 for debenture interest and sinking fund, and providing for the payment of income-tax, there is a credit balance on the half-year's business of £109,284. To this has to be added £5,062 the balance brought forward from June, making together £114,346, from which £177, further expenses in connection with the closer working union of the companies, and two interim dividends for the September and December quarters, amounting to £62,379, have been paid, and this leaves a balance of £51,791. Then we have transferred £45,000 to the reserve fund, and after that operation a balance is left of £6,791 to be carried forward. That seems to me to be a pretty satisfactory state of affairs. Then it is an agreeable thing to know that since our last meeting the remaining interests of shareholders in the Western and Brazilian Telegraph Co. have been acquired, so that we may now look on it that we are not only under one roof, but that we are one institution; and henceforward you will hear not of the Western and Brazilian Telegraph Co., because it will very soon disappear from this sublunary sphere altogether, and your attention will be confined to the Western Telegraph Co.—the new name of the company. As far as we can gather (it never does, of course, to prophesy) we hear very good accounts of what is likely to be the condition of the United States of Brazil for some longish period to come. The country seems, as far as we can gather, to have taken a turn. It has passed through the darkest period, and seems to be emerging into the light. What will be the intensity of the light, of course, we cannot prognosticate, but all circumstances seem to run pretty much together—rise in exchange, increase in general business, increase in our business, and so on—as pointing to a satisfactory future. We therefore seem to have passed the most gloomy period, but I do not think after all that our gloom, even under those circumstances, has been extreme. In making these arrangements for the companies coming together certain questions had to be considered, and one of them was the question of duplicating the existing cable in the interests of the Government; and you may remember that we told you that that agreed very much with our own desires. We have suffered a good deal from breakages of one of the cables, and it has cost us much for repairs, and interfered more or less with the traffic. We are now proposing to lay—in fact, we have been laying part of it—a new cable of an exceedingly excellent type, which is to give us a high rate of speed right away from Para to the Plate. We are very pleased to see that the laying of this new cable appears to coincide with what we are led to believe will be the almost immediate future of Brazilian trade and commerce, and therefore we have taken a step in time, which will probably result in a very satisfactory state of receipts, and so on. We have also had to increase the accommodation at certain stations in connection with our line, which we believe will also give us a certain increase, though not a material increase, of business. Well, these things are not to be done for nothing—they will cost money; but to the extent by which you deplete your reserve fund—by which extent you will deplete yourselves of interest now coming in—you will have something that will turn out better—namely, this new additional direct line, and the great encouragement and growth we expect in the traffic that will ensue from the laying of it; and we look on that substitution of good working plant for the reserve as a more advantageous investment. The steamship "Buccaneer" has had to be chartered because we have been obliged to send home the "Norseman" for repairs. She will be overhauled thoroughly, and we may find means of effecting certain economies in her working; at all events, we shall try to do so. The next matter I have to draw your attention to is the question of the superannuation fund and the pension fund. It works very well, but at the same time we have felt that there is an inconvenience in it in that the clerks are supposed always to be continued in the service until the age of 60. Now, 60 for a telegraph clerk is rather an advanced period of life, and we want therefore to make an alteration in the pension fund to the effect that we make the pension payable at the age of 55 instead of 60. You must not of course gather from that that we propose to remove these gentlemen from our staff at the age of 55. We should not do that unless we find the services of any particular individual or the state of his health after long service in the tropics such that it would make it advantageous for the company to pay the pension instead of continuing the man in the performance of his active duties. We do not think that this will be very costly to the company. It is true that a loss has been talked of, and the resolution is obliged to take that form, but if there should be any loss, it is to be made up. As a fact, no loss in the superannuation fund is anticipated, although it is necessary to take the resolution in that way; and as respect any deficiency in the pension fund, the sum required is estimated by the actuaries at less than a total of £3,000, spread over 20 years. That is not a very desperate thing. Supposing the whole of the staff of the Western and Brazilian Co. to join in these measures—and, of course, whatever measures there are for the benefit of the staff must be extended to all, supposing them all to join the fund, and the adhesion of all the new officials—that would amount in all to about £1,200 a year. I do not think there is anything else that I need draw your attention to, and therefore I will conclude by moving—

"That the report of the directors and the accounts to Dec. 31, 1899, now submitted, be approved and adopted."

Sir A. J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed a resolution authorising the directors to make such contribution as were necessary to make the staff superannuation and pension funds operative at 55 instead of 60 years of age, and to amend the indentures of these funds accordingly.

Mr. D. H. GOODSALL seconded the motion, which was carried unanimously.

Mr. ENNIS afterwards proposed a vote of thanks to the chairman, directors, and officers, whose services he warmly recognised.

Major COTTON seconded the motion, and referred especially to the admirable manner in which the amalgamation had been carried out between the Western and Brazilian and the Brazilian Submarine Companies—a measure which, he said, would prove greatly to the interests of the shareholders.

The resolution was carried unanimously, and was briefly acknowledged by the chairman, and the proceedings terminated.

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Cuba Submarine Telegraph Co. (Ltd.).

The fifty-seventh ordinary general meeting of this company was held on Wednesday, at the offices, 53, Old Broad-street, London, E.C., Mr. CHARLES W. PARISH presiding.

The SECRETARY (Mr. James Scott) read the notice calling the meeting.

The CHAIRMAN said: The revenue account is by no means so encouraging as we have been accustomed to. You may remember that it was in 1895 that the revolution in Cuba took a serious form; up to that time we were in full enjoyment of advantageous rates, and although these were reduced in 1898, on account of the competition from the New York-Hayti cable and the Bermuda-Jamaica cable, owned by the Direct West India Co., the loss was more than compensated for by the increased business brought us by the revolution and the Spanish-American war—directly I may say, by the heavy Government work, and indirectly from the land lines being destroyed by the Cuban rebels, which naturally caused a considerable increase of local business to be sent over our cables. As you are aware, I have at our late meetings urged you to be prepared for reduced receipts, and we have not hesitated to strengthen our reserve fund as much as possible during the exceptionally good years that we have enjoyed, that we might be the better prepared to face the lean years to follow when peace was restored. The actual traffic receipts for the half-year ending Dec. 31st amount to £12,008, as compared with £25,740 during the corresponding half-year of 1898, a falling off of more than 50 per cent., which as stated in the report is due principally to the lower rates at which we are working, and to the competition of the land lines which have now been restored. I may also point out that during the last half of 1898 we were still dealing with some extra business caused from the war. The second item of the revenue account is the sum of £5,316 which we have received on outstanding accounts, and is part of the amount I explained to you at our last meeting was received at Madrid from the Spanish Government, against the balance of certain accounts for Government messages sent during the war, and which had not been settled by the Spanish officials before leaving the island, and were treated as outstandings in our accounts. The third item of our revenue comes from interest on investments and deposits, and amounts to £2,181, which is a larger sum than usual, for we have had the benefit of a high rate of interest on a large cash balance. Taking all sources of income together, we have received £19,512, against £27,483 in the corresponding period of 1898. Our expenses in 1899 amounted to £6,192, against £7,585 in 1898, a reduction of £1,393, which is chiefly accounted for by £207 under salaries and wages, £330 maintenance of lines, £133 printing and stationery, and £515 depreciation on stores and cable in stock. We have carried £4,937 to reserve fund, which brings up this account to £130,000, and after paying our preference dividend we are able to propose a dividend at the rate of 6 per cent. per annum, which after all is not an unsatisfactory result. This brings me to the sixth paragraph of our report, which refers to the state of our cables. The break in the Cape Cruz-Manzanillo cable was repaired without difficulty, but I regret to tell you that the section between Cienfuegos and Cape Cruz, which was laid in 1831, proved so extremely weak that it was impossible to lift and repair it. This was the cable which was laid on the deferred payment system; it was not originally made for our company but it has done us good service. We have now one cable working direct from Cienfuegos to Santiago, and this line is practically duplicated by the coast cables. You will have learnt from the report that Mr. Keith and Mr. Scott have lately visited America in the interests of our company, and I am very glad they did so, for I believe that considerable benefit will result from their journey. It may be a convenience if I refer to the present position we are in towards the United States Government. There are three points we are anxious to have settled. In the first place, we would like the American Government to recognise our concessions, which they have not yet done; secondly, we desire payment of our subsidy of £2,000 per annum, due under our 1895 concession for the coast cables; and thirdly, there is the claim of £8,174 for the cost of repairing the damage done to our property during the Spanish American war. You are aware that we turned to the Foreign Office who have been most helpful, and negotiations are now being carried on by Her Majesty's Ambassador in Washington with the United States Government. As a result of these negotiations we have lately been informed by Lord Salisbury that the question of our concessionary rights and the arrears of the subsidy have been referred to the United States Secretary of War, under whose department the matter is receiving attention; and as regards the claim for £8,174 for damage done, President McKinley has asked the Senate and House of Representatives to reimburse to our company the expenses we have incurred. You may have noticed in the newspapers a reference to the message that the President sent, but we have not yet heard if this message has come up for discussion; at any rate, I hope you will gather from what I have said that your interests are being well looked after. We received the subsidy from the Spanish Government up to the end of 1898, but so far we have received no payment since, which is a great hardship, for we would never have laid the coast cables without the promised subsidy. Mr. Keith and Mr. Scott had the opportunity when in New York of discussing with the International Co. our mutual interests, which was very advantageous. Our rates are very low, but we hope as the state of the island improves we may have the benefit of some increase in business, though, on the other hand, trade is bad in the West Indies, and there seems no expansion of traffic from that source. As far as our receipts have gone for this year they appear much the same as those for the six months we are now dealing with. I now move the adoption of the report and accounts.

Mr. GEORGE KEITH: I beg to second that.

Mr. PRICE: What position will the company in future be in as against the overland competition? Will your concession, if recognised by the United States Government, give you a monopoly of the communication between the various points where you touch, or will you have to face severe overland competition?

The CHAIRMAN: I think we must always be prepared to meet competition. The land lines are now practically being worked under the charge of American officials and naturally they will send a great many messages over those lines. We have certain rights under our concessions, and though, perhaps, they should give us more traffic than they do, it is an exceedingly complicated matter, but I may tell you that we are watching it as closely as possible.

Mr. PRICE: But will not the system of overland lines virtually kill the business of the company?

The CHAIRMAN: There have always been overland wires, only from one cause or another they have not been very successfully worked.

Mr. PRICE: I know Cuba—that part of it—a little, and I am aware that in the past there has not been very much competition overland, but with the Americans working them I fear things will be different.

The CHAIRMAN: That is what we refer to in the report.

The resolution was then unanimously carried.

A resolution approving the payments on dividend account set out in the report was unanimously approved, and a cordial vote of thanks to the chairman and directors terminated the proceedings.

West Coast of America Telegraph Co. (Ltd.).

The third ordinary general meeting was held on Tuesday, at the offices, Winchester House, London, E.C., under the presidency of Mr. J. DENISON-PENDER.

The SECRETARY (Mr. Fred. L. Robinson) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, you will see by the report and accounts that the receipts for the year ended Dec. 31 last were £28,347, as compared with £25,080 in 1898, thus showing an increase of £3,267. This satisfactory result has been chiefly derived, of course, from an increase of traffic, which has come from some revival of trade on the coast, and the exchange, which has gone up from 12½d., about the average of 1898, to 16d., which has been the average of 1899, or nearly so. Having regard to the increase in receipts, you will naturally turn to the expenditure to see if there has been an increase there, and I am sorry to say that there has been, although I think I can show you that it has been impossible to keep the expenditure down further. The expenses in 1899 were £21,065, as against £18,840 in 1898. Thus the increase in the expenditure has been £2,224. The cause of this increase has been chiefly the repairs of cable, and of course where you have repairs you have the cost of the new cable you put in, which is a very material item. Also with respect to the ship, we, as you know, get a rebate on every week that she is lying in harbour doing nothing. During the 12 months under consideration the ship had been out more than usual, and therefore the cost of insurance has been considerably greater, to say nothing of the increased cost of coal, of which everyone is aware. The sections under repair have been for the 12 months from Serena to Valparaiso, which was repaired in March and again in August. The cause of the interruption there was found to be the bad ground upon which the cable was laid, it being rocky. The line has been moved further seawards, and I think we have better ground there now, and are therefore not so likely to have interruptions. Another repair has been in the Caldera-Serena cable, which was repaired in the beginning of March, and at the end of March again. That latter repair was caused by a landslip, which tautened out the cable and put a fault into it. Another repair has been to the shore end at Antofagasta, where the shore end has been renewed. I think I have mentioned at previous meetings that with respect to expenditure, especially in a company such as this, it entirely depends on the cable repairs; and if we are fortunate enough one year to have the expenditure low, we must not count very much on that, because the next year may bring, as the last year brought, a considerable increase in the item. With respect to the balance that we have of £7,282 you will see that that has been dealt with by the payment of the interest on the debentures and the income bonds. These bonds, you will remember, were issued at the time of the reconstruction of this company. They were taken by our good friends, the Brazilian Co., and some were also taken by the Construction Co., but the interest on them is not cumulative. For two years we paid nothing on them, but this year I am glad to say that we have been able to pay the 4 per cent. out of profits. That is certainly a move in the right direction. The only important event that has taken place in connection with this company this year has been the closing of one of our offices. We have taken the cable out at Caldera, and have closed that office. It has lately never paid its expenses, and therefore it was for the benefit of the company that the expenditure should be reduced there. Meanwhile the public will not suffer in the least, because there is a Government land line, and the traffic will be handed to the Government. The messages which are to be transmitted to Europe or other parts of the world will come on to our line at one of the other stations. I do not think I have anything more to say to you on this occasion. If the political situation in South America remains quiet, we have every reason to hope that even the present figures, which are distinctly satisfactory compared with those of the previous year, may be more satisfactory in the future. I may mention that last year we had a certain accession of traffic owing to the fact that the cable of our neighbours, the Central and South American Co., was broken down. This year that cable has not been broken down, but nevertheless our traffics so far

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show an increase on those of last year. I now move the adoption of the report and accounts.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which was carried unanimously.

A vote of thanks to the chairman terminated the proceedings.

Submarine Cables Trust.

The twenty-ninth ordinary annual meeting of the certificate holders of this Trust was held on Tuesday at the offices, Winchester House, London, E.C., under the presidency of the Most Hon. the Marquis of TWEEDDALE.

The SECRETARY (Mr. Sidney Collett) having read the notice calling the meeting,

The CHAIRMAN said: I have now to ask your approval of the report and accounts, which I presume you will take as read. The income for the past year amounted to £24,789, or an increase over that of 1898 of £3,333. The principal cause of this apparent increase in the income of the Trust is that we have received, and brought into the credit of our revenue account, a full year's dividend and bonus on the shares of the Eastern Extension Telegraph Co., amounting to £9,294, whereas last year only three full quarters, and the balance of the December quarter, 1897, were carried to the credit of revenue, making a total of £5,994, or a difference of £3,300. In previous years it was customary to bring into our revenue account the December quarter's dividend and bonus for the year in respect of our holding in the Eastern Extension Co., which was sometimes paid a few days after the date of making up our accounts; but we are now able to leave this dividend out of the revenue account until it has actually been received by us. There are one or two other differences which make it difficult to properly compare the amount of the dividends received during the current year with the previous year, owing to the dates of the receipt of dividends being somewhat variable, more particularly in the case of the American investments; but these differences are all fully explained by notes under the schedule of stocks and shares held by the Trust and income received therefrom, which will be found on page 2 of last year's accounts and page 6 of the present year's accounts. It will be seen on reference to the revenue account that after deducting the expenses of the Trust, there is an available balance of £23,601, which has been sufficient to pay two coupons of £3 each, due on October 15, 1899, and April 15, 1900, and leave a balance of £3,315. In accordance with the terms of the Trust deed, the surplus funds of the Trust are to be used in the redemption of certificates, either by purchase in the open market, provided that the price paid for each certificate be less than £120, or secondly, by tender from the certificate holders for the redemption of certificates held by them, provided that no tender shall be accepted at a higher price than £120; and, failing those two methods, by drawings at £120. Inasmuch as the price of the certificates was quoted above £120 ex div., the trustees decided to draw 27 certificates, which was done on Friday, April 27, this year. In paragraph 5 of the report will be found full particulars of the changes which have been made during the year in the investments of the Trust. They are very few, and practically consist of the sale of some Anglo-American stock in order to enable us to take advantage of an offer made by the Commercial Cable Co. of our proportion of a new issue of their shares at par. This being a very profitable transaction for the Trust, we had no hesitation in agreeing to take them. I now move the adoption of the report and accounts.

Mr. J. DENISON-PENDER seconded the resolution, which was carried unanimously.

The CHAIRMAN: I have now to propose—

"*That the unanimous resolution of the Trustees to invest the produce of the sale of £1,200 Anglo-American Telegraph Co.'s preferred stock in the purchase of 66 shares of $100 each of the Commercial Cable Co., and £15 ordinary stock of the Eastern Telegraph Co. (Ltd.), be and the same is hereby confirmed.*"

Sir A. J. LEPPOC CAPPEL seconded the motion, which was carried unanimously.

Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Gane, Jackson, Jefferies and Wells were afterwards elected auditors of the Trust for the current year.

The CHAIRMAN, in acknowledging a vote of thanks, observed that he thought the Trust was now getting into a very satisfactory condition.

The proceedings then terminated.

London Platino-Brazilian Telegraph Co. (Ltd.).

The twenty-second ordinary general meeting of this company was held on Tuesday, Mr. W. S. ANDREWS presiding.

The SECRETARY (Mr. E. Steer Hodson) having read the notice calling the meeting,

The CHAIRMAN stated that the income for 1899 was £29,643, or £6,645 less than that for 1898. There was, however, really an increase in the cable receipts, amounting to about £660, but there was a decrease in land line traffic receipts of £7,328. This arose from an accidental circumstance—the payment in 1898 by the Government of £5,000 odd for night service performed during the disturbances. The expenses for 1899 were £6,832, a net decrease of £1,480 compared with 1898, owing to savings which had been effected by the closer working union of the company with the Western Telegraph Co. The profit in 1899 was £22,531, a decrease of £5,052 on 1898. Including £2,859 brought forward from 1898, the amount available at Dec. 31 last, after paying the usual debenture interest, was £19,390. An interim dividend of 4s. 6d. a share was paid in respect of the June half of 1899, and the directors now proposed a further dividend of 2s. 6d. a share, making the same distribution as for 1898. This would leave £6,249, from which they had made a transfer to reserve of £5,000, leaving £1,249 to be carried forward. He concluded by moving the adoption of the report and the payment of the dividend recommended, making 3½ per cent. for the year.

Mr. J. DENISON-PENDER seconded the motion, which was carried unanimously.

Messrs. Deloitte, Dever, Griffiths, and Co. were re-elected auditors, and a vote of thanks to the chairman closed the meeting.

Hampstead Electric Supply Co. (Ltd.).

The annual meeting of this company was held on Monday, Mr. E. T. READ, F.R.G.S., presiding.

The CHAIRMAN, in moving the adoption of the report, first dealt with the accounts for the 13 months ended Dec. 31st last. He pointed out that, in addition to the £165,000 paid for the assets of the Hampstead Battery Co., there had been expended upwards of £16,000 for further plant and other property. This might appear rather a large sum, but it gave him, personally, much satisfaction, as it indicated that their business was a progressive, and not a stagnant one. The expenditure by the company on motor cars, experiments, &c., had been £729, of which one-fifth had been written off. One of the future outlets for their day current they expected to be the supply of power for motor cars, and that would be a profitable source of revenue. Up to the present, however, the accumulators used for motor cars were very heavy, and did not satisfy the requirements in the case of light vehicles. The London Electric Cab Co. had had to suspend running their cabs temporarily, as they found that the accumulators, though so heavy, would not store the requisite amount of electric energy to enable the vehicles to be run with satisfaction. That difficulty was now being overcome. The electric motor traffic industry was in its infancy, and he had not the slightest doubt that within a short time accumulators would be devised which would do all that was wanted. He was happy to say that, so far as the electric light portion of the company's business was concerned, the capital expenditure was now practically stopped for a certain period. Speaking roughly, there had been added to their customers' roll some 200 houses during the period under review, and besides that, at the end of 1899, they connected the large stores in the Finchley-road, belonging to John Barnes and Co. (Ltd.). Current was supplied to those stores only at Easter, after the close of the period covered by the accounts. The number of lamps connected at those stores were equivalent to 44,000 c.p.; and, in addition, the lifts in the building were being operated electrically. The company had in hand contracts for connecting 500 houses further, and many other estates were being developed in the district which would, no doubt, bring to the company more orders for current. In not a single instance had the company's light failed, except in one small case where the wires were for an hour or two interrupted by the action of railway employés. That was a thing which he thought few electric light companies could say. The profit on the electric light department for the 13 months was £5,000 odd, and it would have been larger but for the great rise in the price of coal. The directors had been testing certain mechanical contrivances by which, if coal was maintained at its present high price, it would be possible to burn an inferior class of coal without giving off a tremendous lot of smoke in the neighbourhood. So far as they had gone, the experiments had resulted admirably. The profits from Taylor and Lown's department had been disappointing, but this was due to trade reasons which it would not be advisable to enter into. Messrs. W. P. J. Fawcus, E. J. Cave, and D. H. Evans had resigned from the board because they were not able to give the necessary time to the affairs of the company. He was convinced that they had a sound and progressive business capable of making a profit of anything between £10,000 and £15,000 per annum. It was an exceptional thing for an electric light company to pay a dividend until it had been established several years. This company had already distributed something by way of dividend although they had had to pass the dividend for the half-year ended Dec. 31st last. The business was increasing so fast that the company had not enough money to properly deal with it, but the directors were taking steps to provide for the necessity.

The motion having been seconded, Mr. PARKER expressed himself as disappointed with the report, and remarked that the prospectus promised the shareholders a profit of £18,000 per annum. It seemed to him that the company was going from bad to worse. The chairman had held out the prospect of further capital being raised, with the further deferring of the hopes of the shareholders with regard to a dividend.

The CHAIRMAN said that he could not agree with Mr. Parker. He considered the report a satisfactory one.

Mr. PRESTON asked if, in view of the large diminution in the profits foreshadowed in the prospectus, the board contemplated taking any steps to obtain the repayment by the vendors of a portion of the purchase money.

The CHAIRMAN replied in the negative, and added that he considered it would be time and money thrown away to attempt anything of the sort.

Mr. PRESTON moved, as an amendment, the appointment of a committee of shareholders to investigate the affairs of the company.

Mr. FUCHSBALG seconded the amendment, which, on a show of hands, was declared negatived.

The original motion was then carried, with about half-a-dozen dissentients.

New General Traction Co. (Ltd.).

The directors' report states that the gross profits for the past year were £76,299. 17s. 5d., after deducting £6,116. 10s. 6d. for general expenses, salaries, &c., chargeable against revenue. With £6,212. 4s. 10d. from last year, the total was £82,512. 2s. 3d. The further £100,000 6 per cent. preference capital was placed in June last. After deducting the dividend of 6 per cent. on the outstanding preference capital for the past year (£13,487. 13s. 4d.), a balance of £68,742. 19s. 6d. remains, which the directors propose shall be dealt with by transferring £10,769. 5s. 8d. to reserve, £942. 18s 8d. to meet difference of present market value of consols purchased and lodged as caution money, and the purchase price

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(£20,000) to general reserve, and to carry forward the balance of £37,030. 15s. 2d.

The directors consider the result of the year's work satisfactory. During the year considerable progress has been made in the company's operations. The system of electric tramways at Coventry was completed and opened for traffic in January last, and is now in regular operation. The work at Norwich is nearly finished, and it is expected that the system of some 20 miles will be opened and working during the next few weeks. Great progress has also been made with the work of this company's lines in the vicinity of Philadelphia. The system there amounts to about 20 miles, 13 miles of which will shortly be opened. During the year a considerable amount of new business has been submitted to the company, but the only new business concluded has been an extension of the lines at Philadelphia, and an arrangement come to with the town of Airdrie. An Act for the construction of a short line of tramway in the latter district is now before Parliament. Resolutions to carry out certain alterations in the articles of association will be submitted to the meeting for approval.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27½d. per oz. (May 10). Consols (2¾ per cent.) 100—100¼ for money, 100$\frac{7}{16}$—100$\frac{7}{16}$ for account; 2½ per cent. 97½—98 (May 10). Stock Exchange Settling Day: Consols, May 4; Stocks and Shares Continuation Days, May 14 and 29; Ticket Days, May 15 and 30; Pay Days, May 16 and 31; Mining Share Carry-over Days, May 11 and 28.

EDWARDS AIR PUMP SYNDICATE (LTD.)—At the annual meeting on Wednesday the chairman (Mr. C. W. Milne) said that the income from royalties was £3,219, compared with £1,768 in the previous 15 months. The progress made was entirely satisfactory. The syndicate had popularized the pump among electrical engineers and engineers for large ironworks, &c, and the revenue from that source had considerably increased. He was sorry that up to the present they had not disposed of any of their foreign patents. He believed that the more likely source of revenue from America and European countries would be by giving a licence for the use of the foreign patents to first-class engineering firms in those countries. The report was adopted and Mr. Edwards then explained that his reason for resigning his seat at the board was that he felt he could hardly do the syndicate justice. There were seven foreign patents on which no royalty had been received during last year. He admitted that the directors had been handicapped by not having funds to work these patents.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	May 5	4,298	+ 203	18	73,262	+ 3,855
Blackpool Corporation...	„ 3	279	+ 32	5	1,905	+ 470
Blackpool and Fleetwood	„ 5	333	− 85	18	4,252	− 108
Bradford Corporation...	„ 6	413	+ 79	5	2,269	+ 512
Brisbane Trams	Mar. 21	1,943	+ 579	25	50,870	+15,512
*Bristol Trams & Carriage	May 4	2,881	+ 66	18	48,920	+ 1,916
*Buenos Ayres & Belgrano	Apl. 8	2,582	+ 498	14	31,912	+ 4,750
City & South London Ry.	May 6	1,283	+ 288	18	22,245	+ 2,928
Dover Corporation	„ 5	189	+ 38	5	974	+ 89
Dublin United	„ 4	3,477	+ 490	18	57,708	+12,163
Dublin Southern Dist....	„ 4	804	+ 31	18	14,069	
*Glasgow Corporation ...	„ 5	9,194	+ 234	...	...	...
*Liverpool Corporation...	Apl. 28	7,270	+ 963	16	116,961	+15,552
Liverpool Overhead Rly.	May 6	1,433	+ 7	18	25,335	+ 1,047
*Sheffield Tramways	„ 6	2,148	+ 846	18	34,379	+11,598
*South Staffs. Trams....	„ 4	704	+ 76	18	11,598	+ 502

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 2.		Price Wednesday, May 9.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending May 9. Highest	Lowest
			TELEGRAPHS.								
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 17 4	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£823,720	Stock	15/0	Anglo-American	62	65	62	65	5 12 8	Feb., May, Aug., Nov.	...	...
£3,063,240	Stock	30/0	Do. Preferred	114¼	115¼	114	115	5 4 9	„ „	115⅛	114⅛
£3,063,240	Stock	27/0	Do. Deferred	14½	14⅝	13⅞	14⅛	9 9 6	...	14⅜	13⅞
$13,313,300	$100	$1½	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	102	104	3 17 0	„ „	103	...
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	10	9½
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞	105⅞	101⅞	105⅞	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11⅜	12⅛	11⅜	12	5 16 8	Jan., Apr., July, Oct.	12⅛	11⅜
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	103	103	100	103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150	155	150	155	4 10 4	Jan., Apr., July, Oct.	158	150
£1,626,858	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	„ „	9⅛	98
£1,433,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) ...xd	114	119	113	118	3 7 10	May and November ...	113	...
250,000	10	6/6	Eastern Extension ..... xd & bonus	15⅝	16⅛	15⅞	16⅛	4 6 2	Jan., Apr., July, Oct.	16⅛	15⅞
£330,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	120	114	118	3 8 5	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.) ...	100	103	100	103	4 17 1	January and July.....	...	...
£25,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100	103	100	103	3 18 5	February and August	100⅛	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)xd	103⅞	103⅞	100⅞	103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust ..... xd	11⅛	11⅜	11⅛	11⅜	4 9 4	Jan., Apr., July, Oct.	11⅜	1⅛
180,042	10	3/0	Do. 6 per Cent. Preference..... xd	15⅛	15⅝	15	1⅛	3 17 5	„ „	1⅝	15
150,000	10	15/0	Great Northern of Copenhagen.....ex coupon 43	32	34	32	34	3 13 6	January and July.....	31	...
£30,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	100	104	100	103	4 8 0	...	...	...
17,000	25	12/6	Indo-European.....	54	59	54	58	4 6 2	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105	103	103	108	5 11 7	March and September	..	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102	105	102	105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	7⅛	...
3,381	£100 Cert.	6%	Submarine Cables Trust	12¼	13⅜	12¼	13⅜	4 13 0	„ „	12¼	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97	100	97	100	5 0 4	March and September	99	...
20,008	2½	...	West Coast of America	⅛	1	⅛	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 14 7	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅜	1⅛	⅜	1⅛	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	9¾	9½	9¾	6 3 1	„ „	9⅝	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	100	104	3 16 11	June and December ...	...	...
297,980	10	3/0	Western Telegraph (late Brazilian Submarine)	14½	15	14½	15	4 13 4	Mar., June, Oct., Dec.	14⅝	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	103	108	103	108	4 13 10	June and December ...	107⅜	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2⅜	3⅛	2⅛	3⅛	4 5 9	August	2⅜	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜	⅝	⅜	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
490,000	5	3/0	National	4⅞	5⅛	4⅞	5⅛	5 17 1	February and August	5	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	13	15	13	15	4 0 0	„ „	14⅛	13⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	13	15	12	14	4 5 9	„ „	13⅛	12
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛	5⅜	5⅛	5⅜	4 13 0	„ „	6⅛	5⅛
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97	100	97	100	3 10 0	June and December .	97	...
171,504	1	0/8	Oriental..... ....xd	¾	1	¾	1	5 0 0	April and October....	1	...
58,000	5	2/6	United River Plate	4⅜	5⅛	4⅜	5⅛	7 2 10	July	...	...
16,658	5	1/4	Do. 5% Cumulative Preference	4⅜	5⅛	4⅜	5⅛	4 15 3	June and December .	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, May 2.	Price Wednesday, May 9.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 9. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅛ 12⅛	11¼ 12¼	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	10½	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8⅛ 9⅛	8⅛ 9⅛	3 13 8	March and September	8⅞	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7 7⅛	7 7⅛	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9 10	8¾ 9½	4 14 9	February and August	9⅝	9 1/16
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅛ 5⅜	5¼ 5⅜	3 18 3	" "	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6⅞ 7⅛	6¾ 7⅛	4 0 0	March	6⅞	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	108 111	4 2 2	June and December...	109	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	9½ 10½	10 11	4 0 0	February and August	10⅜	10½
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12 1/16	12⅛
£490,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December ...	125	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½ 10½	9½ 10½	3 16 2	...	10	9 1/16
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	110 113	109 112	4 0 9	...	111½	109½
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13⅜	12⅜ 13⅜	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7⅛	7 7⅛	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅞ 2	1⅞ 2	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½ 4⅝	4½ 4⅝	6 6 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½ 14½	13½ 14½	3 9 0	April and October	14	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December ...	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	96 98	3 11 10	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½ 7	6½ 7	3 11 5	"	...	...
300,000	1	8%	Rand Electric	½ ¾	½ ¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	...	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	170 190	170 190	4 4 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15 7/16	1 ⅛
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4 4½	4 4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½ 15½	14½ 15½	4 8 10	March and September	16	15 1/16
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	15/16 1 1/16	15/16 1 1/16	6 8 4	...	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅝ 1	⅝ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16 ⅛	1/16 ⅛	...	...	...	...
£250,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	...	...
100,000	5	...	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,060	2	1/2⅜	Brush Electrical Engineering	1⅞ 2	1⅞ 2	4 0 0	September	1 1/16	1 1/16
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cum.	2 2⅛	2 2⅛	5 6 8	"	2 1/16	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103 113	103 113	3 19 8	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 5 9	June and December ...	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½ 15½	14½ 15½	4 16 9	" "	15½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 116	112 116	3 18 5	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅞ 1⅞	1⅞ 1⅞	5 16 5	...	1⅞	...
£150,000	Stock	7/)	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
60,000	1	0/7 1/16	Chadburn's Ship Telegraph Ordinary	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
60,000	1	0/7 1/16	Do. 6 per Cent. Cumulative Preference	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3¾ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 19 3	" "	...	...
60,000	1	0/7 1/16	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	2	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4⅛	3½ 4⅛	6 13 4	" "	4⅜	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December ...	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛ 5	4⅛ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101 104	101 104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2⅜ 2⅝	2⅜ 2⅝	4 16 0	January and July	2⅝	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2¾ 3⅛	2¾ 3⅛	4 6 2	July	...	‡
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 105	103 106	3 16 2	January and July	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½ 14½	13½ 14½	3 15 10	February and August	14½	13¾
30,000	5	1/6	Do. 4½ per Cent. Preference	5¼ 5⅜	5¼ 5⅜	3 18 3	" "	5⅜	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	" "	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	" "	21 9/16	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 103	103 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	35 37	35 37	4 12 4	March and July	37⅛	36½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	10 11	10 11	3 3 7	...	10½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	11½ 12½	11½ 12½	4 16 0	April and October	12½	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference ...xd	7 7⅛	7 7⅛	4 0 7	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 105	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102 104	102 104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½ 23½	22⅜ 23⅛	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£3 paid)	8¼ 8⅝	8¼ 8⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 8 5	...	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref. ... xd	9¾ 10¼	9½ 10¼	4 17 7	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16 17	15⅝ 16⅜	3 12 9	...	16	15⅞
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16 17	15⅝ 16⅜	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12⅝ 13⅛	12 13	4 12 4	...	12⅝	12½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	125¼	125⅛
40,000	5	2/8 3/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref. ...xd	5 5⅛	5 5⅛	5 14 4	...	5⅛	5
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	4 1/16
320,000	Stock	5%	Do. 5 per Cent. Debentures	104 107	104 107	4 14 10	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk Prov. Certs. (£57½% to be p.l.)	37 40	37 40	...	...	...	...
208,940	10	3/0	Central London Ordinary	10 10½	10 10⅛	2 17 2	June and December ...	10 1/16	10
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	67 70	61 64	2 18 7	January and July	63	...
37,500	10	1/5 7/16	Do. (Nos. 22,501 to 60,000) ...xd	6 7	5½ 6½	2 5 4	...	6	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	135	...
£200,000	Stock	5%	Do. (1896)	...	133 137	3 13 8	...	135	133⅛
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22⅜ 23⅜	22⅜ 23⅜	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14⅜ 15⅛	14⅜ 15⅛	3 17 5	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 116	3 17 11	January and July	...	...
75,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	1/16 ⅛	¼ 5/16	19 4 0	...	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16 ⅛	1/16 ⅛	12 0 0	...	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9½ 10½	9½ 10½	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8 3/16 8 5/16	8⅜ 9	4 3 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼ 13½	13¼ 13½	3 14 1	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	2 15 6	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅜ 4⅛	3⅜ 4	...	...	3 1/16	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5¼ 5½	5 5⅛	5 9 1	May	5⅜	5⅛
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 18	16 18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜ 10¾	10⅜ 10¾	4 13 0	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9⅜ 10⅜	9⅜ 10⅜	4 15 3	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100 103	100 103	2 18 8	June and December ...	101	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,148. [No. 4. Vol. XLV.] FRIDAY, MAY 18, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 2M/r., or 70pf.

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NOTES.

ELECTRICAL schemes still continue to occupy a large share of the attention of the committees of both Houses of Parliament. During the past week seven electrical bills have been brought before committees of the House of Lords, while committees of the House of Commons have had before them a similar number, not to mention official bills for the confirmation of provisional orders. Of these 14 bills no fewer than 10 relate to electric traction on railways or tramways, three to electric lighting schemes, and one—the Tyneside bill—to an extensive power scheme, already described in our columns. Doubtless our readers will learn with surprise that during another entire week the Tyneside bill has danced its long *pas de deux* with the Durham bill before Sir JAMES KITSON'S all-too-patient committee. Local municipal opposition, Ossa piled on Pelion, accounts for the greater part of this extravagant consumption of precious time; but it is clear that the partisans of local municipalisation are hugely overdoing their resistance. Unfortunately, however, all this iteration and reiteration *ad nauseam* of the arguments of the opponents tend to push the conclusion of the work of the Select Committee dangerously near to the summer vacation, and may seriously retard, even though failing to overthrow, these power schemes.

IN the room adjoining that in which Sir J. KITSON'S Select Committee is sitting, the bill providing for the electric express railway between Liverpool and Manchester has been occupying throughout the week the attention of another Select Committee, presided over by Sir J. KENNAWAY. Owing to the novel character of this proposed railway, technical matters have had to be sifted very thoroughly in the evidence and cross-examinations. Among these the questions as to limiting speed and the provision of adequate brake power were, perhaps, those of greatest interest to our readers. Expert evidence was given as to the facility with which a speed of 110 miles an hour could be attained and maintained by electric traction on the mono-rail system, Sir WILLIAM PREECE, Dr. EDWARD HOPKINSON, Mr. S. B. COTTRELL, and Mr. H. F. PARSHALL testifying to this. A more serious problem, however, was presented by the braking requirements at such a high speed, though we are sure that it is one for which there is happily a quite satisfactory solution. At 110 miles an hour a train weighing 45 tons would possess kinetic energy amounting to 41 million foot pounds. To dissipate this energy at the brakes would develop so much heat that a dangerously high temperature might be developed, were not special provision to be made to get rid of the heat quickly.

THE ultimate possible speed on a railway, however, is not so much a matter of engineering as of finance. It is the pace that kills—the capitalist, not the passenger. There is a limit, in fact, to the price people would be willing to pay for travelling fast, or the price which a benevolent Government would allow express railway companies to charge them. On the other hand, a railway costs more both in capital outlay and in annual expenditure, in proportion to the speed. Few people nowadays resemble the Scotchman who was delighted with a 24 hours' journey from Edinburgh to London, by way of compensation for the enormous draft upon his purse; but the number of people must be still fewer who would pay double fare for double speed, as a general practice. Accordingly, express railways like that now proposed must have their speed limited to such a figure that the permissible fare will attract a sufficiently remunerative traffic. As time goes on, pressure of business will doubtless raise this limit even to far above 110 miles an hour.

IN a strongly-worded article, our contemporary *L'Industrie Electrique* warns intending visitors to the Paris Exhibition that all the installations and exhibits in the electrical section will not be completed before June 15; and this article having been written before the fire in the Château d'Eau and the destruction of an important part of the switching appliances, it appears not improbable that the date of actual completion will be even later. At the opening of the Exhibition the state-

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ment on all sides that the electrical generating plant would not be in operation for a fortnight was treated with scepticism, for it appeared incredible than an exhibition of this character should be opened before proper provision had been made for lighting it. These forebodings, however, fell far short of the mark, and the date given was first shifted from the beginning to the middle of May; and even now what electric lighting and power supply is available is being delivered to a large extent through temporary connections, so that the forecast of our contemporary is by no means improbable. Fault is also found with the architectural arrangement of the Palais de l'Electricité, for some of the important exhibits have had to be placed in low-roofed parts of the building which some writers have sarcastically termed *oubliettes*. Our contemporary, however, seeks to console exhibitors in these parts by suggesting that during the hot weather visitors will be attracted thither by the coolness and shade!

WHILE we in this country have been discussing the storage battery problems to which Mr. WADE recently directed our attention, Dr. PETERS has contributed an article to the *Centralblatt für Accumulatoren und Elementenkunde* giving the results of some experiments he has been making with the object of ascertaining, if possible, the cause of the softening of the positive plates which occurs in the cells of the pasted type after they have been in use for a long time. We hope that the abstract of his article, which appears in another column, may lead to that exchange of views and experience which Dr. PETERS desires. German electricians have gone into the question of the storage of electrical energy by chemical means with their accustomed thoroughness, and with the advantage of a more sound training in chemistry than is usually possessed by electrical engineers in this country; and if we do not wish to be outstripped in the race we must follow their example and make a systematic examination of the products formed in the storage cell.

OUR esteemed contemporary the *Journal of Gas Lighting* has been greatly excited, in its last two issues, over what it deems an unfair comparison between gas and electric meters, recently made by a German electrical journal. Our contemporary evidently believes the comparison to have originated with ourselves, overlooking the fact that it appeared in a brief abstract we published of an article in the *Elektrotechnische Zeitschrift* for April 5. The article gave some interesting statistics collected by the Physikalisch-Technische Reichsanstalt, which we summarised, as to the use of electricity meters in Germany. In the course of the article statements were made, of which the following is a translation:—

> It is to be noticed, in addition, that in gas meters also great accuracy cannot be attained. Owing to the influence of the pressure of the gas, temperature, and the chemical composition of the gas, which primarily determine the heat energy conveyed by the gas, the gas meter is burdened with so many sources of error as a work-measurer that, as compared with it, the electricity meter in its present form must be designated as quite an accurate apparatus, even at small loads.

OUR gas contemporary challenged *us* to prove this assertion, which we gave in a somewhat condensed form. It declared that it did "not mean to let [its] contemporary off from this task." And then, because we were too occupied last week with far graver matters to take up this ridiculous challenge at once, it has issued the following amazing proclamation:—

> The challenge we addressed last week to *The Electrician* to make good its astounding claim for superior accuracy of electricity meters to gas meters has not been taken up in the current issue of our contemporary. We have scanned its columns carefully without finding any notice of our imputation upon our contemporary's veracity or competence as a witness to the comparative accuracy of consumers' electricity and gas meters. A charge of this kind is only to be ignored at the price of a very obvious conclusion.

Comment is superfluous.

The Royal Society.—Among the Papers down for reading yesterday was "The Circulation of the Surface Waters of the North Atlantic Ocean," by H. N. Dickson.

Telegraphists in the Army.—It has been decided to enlist 60 more Post Office telegraphists for the Royal Engineers, the services of more operators being urgently needed in the field.

Personal.—The King of the Belgians has conferred the decoration of Knight Commander of the Order of Leopold upon Mr. Windsor Richards, past president of the Institution of Mechanical Engineers and of the Iron and Steel Institute.

The 1,000 Miles Motor Car Ride.—The greater number of the motor cars which left London recently on a 1,000 miles tour arrived back in town on Saturday night. A correspondent asks if this may be called a *tour de force*. The cars are now on exhibition at the Crystal Palace.

Nominations for F.R.S.—Among the candidates for the Fellowship of the Royal Society, announced at the meeting of the Society on Thursday last, are the following:—G. J. Burch, J. G. MacGregor, D.Sc., T. Muir, W. J. Sell, James Walker, D.Sc., and C. T. R. Wilson, M.A.

Wireless Telegraphy in the Russian Navy.—The St. Petersburg correspondent of the *Daily Mail* states that, in consequence of the success attending the experiments with M. Popoff's system of wireless telegraphy, the Russian Naval Minister has decided to introduce it into the navy. The whole of the Black Sea fleet will, our contemporary says, be fitted with the necessary apparatus this summer.

"Electrical Measurements."—A special course of 10 lectures, with laboratory work, on "Electrical Measurements for Electrical Engineers and Electricians" will be given at the Borough Polytechnic Institute, Borough-road, London, S.E., by Mr. John Henderson, D.Sc. (assisted by Mr. H. S. Saunders), on Monday evenings, from 8 to 10 p.m., commencing May 21. The course is intended only for students having some elementary knowledge of electricity. The syllabus is set out in an advertisement on another page, which also contains some further particulars.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Paramaribo—Cayenne	Feb. 16, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Manila—Iloilo	April 9, 1900 ...	—
St. Dominguez—Curaçao	May 6, 1900 ...	May 13, 1900

A Double Tariff Aron Meter.—A modification of Dr. Aron's meter, converting it into a double tariff meter, is described in the *Electrotechnische Rundschau* of May 15. The principal parts of the meter itself are precisely those of Dr. Aron's latest pattern of ordinary meter, but there are two sets of dials instead of one, and next to each is a clock-face with a pointer similar to that of an alarm clock, which is set to the time at which that set of dials is to come into action. By a simple addition to the clockwork gear of the meter, one or other of counting trains is geared to the driving wheels of the meter according to the time.

A Large Double-Current Generator.—There will be shortly installed in one of the stations of the Chicago Edison Co., says the *Electrical World* of New York, a new generating unit,

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possessing many interesting features in point of size. It is stated to be the largest double-current generator yet constructed. It has a rated capacity of 2,500 kw., and will supply from the same winding continuous current at 240 volts or three-phase currents for transformation to 4,500 volts. The machine will have 40 poles, and will run at 75 revs. per min., and will be worked in parallel on the alternating as well as on the continuous-current circuit. It is expected that this machine will admit of being safely worked with a 40 per cent. overload for one hour.

Obituary.—The death is announced of Mr. Edward Pritchard, which took place suddenly at his residence in Birmingham on the 7th inst. Mr. Pritchard was well known as a mining, waterworks and tramway engineer. In the last capacity he was responsible, among other schemes, for the cable tramways installed in Birmingham, and was the original adviser to the Birmingham Tramways Co. for the change-over on one section of their lines to the accumulator system of electric traction. He was also consulting engineer for the Carlisle tramways, now in course of construction. But a few days ago, he gave evidence before the House of Commons Committee in support of the bills of the London United Tramways Co., and of the South Lancashire Tramways Co. He was in his 63rd year at the time of his death.

A Russian Water-Power Scheme.—According to the *Engineer* an important water-power scheme in connection with the Dnieper is reported to have been formulated by an English company. At the point where the Dnieper takes a south-westerly direction in order to discharge itself into the Black Sea, near Kherson, it passes a succession of rapids. The company proposes to render the waterway navigable by constructing locks. The necessary capital, amounting to $4\frac{3}{4}$ millions, will be found by the company, while the Government is to guarantee 3 per cent. interest on this sum. The company seeks permission to utilise the power of the rapids for the generation of electricity over a period of 80 years; the Government, however, is to have the option of purchasing the undertaking at the end of 80 years.

Machinery for Canada.—The editor of the *British Columbia Review*, writing to the *Engineer*, points out that the Canadian Government has increased the preferential rebate from 25 per cent. to $33\frac{1}{3}$ per cent. in favour of British manufacturers, thus offering unique opportunities to British machinery of all kinds. This $33\frac{1}{3}$ per cent. rebate, it is claimed, is sufficient to enable the British manufacturer to compete successfully with the Americans. The demand for boilers of all kinds, mining machinery and accessories, dynamos, hoisting engines, turbines, &c., extends throughout Canada. In conclusion, it is suggested that so important is the $33\frac{1}{3}$ per cent. rebate, in view of the immense mining and industrial developments of Canada, that those who enter the field now will have an immeasurable advantage over those who follow later.

Fire at the Paris Exhibition.—The fates appear to be against the completion of the Paris Exhibition, and more particularly of the electrical section. On Tuesday morning a fire occurred in the cellars of the Château d'Eau, which contains the electrical machinery, not only for illuminating the waterfall and fountain, but also, it appears, for lighting the Palais de l'Electricité. Like other parts of the Exhibition, this installation was behindhand, and it appears that just previously to the outbreak the workmen were completing the connections to the switchboards in the cellars beneath the basins of the fountains. While the men were away at lunch a strong smell of burning was noticed, and it was discovered that some of the woodwork in the cellar was in flames. The fire was extinguished within 10 minutes, but not before all the connections to the switchboards were destroyed.

The Blondlot Electricity Meter.—The following description of this meter is taken from an abstract in the *Journal* of the Institution of Civil Engineers. One bobbin oscillates below a second bobbin in such a manner that the quantity of electricity which passes in the circuit during one oscillation remains constant, irrespective of the intensity of the current. These oscillations are registered and counted, and their number indicates the total quantity of electricity which has passed through the meter, the actual amount being obtained by multiplying this number by a constant q, the value of which is known. The apparatus is very sensitive, is instantly started, and conforms to the most abrupt variations of current. The apparatus employing neither a magnet nor an iron core, can be used for alternating as well as continuous currents. A full description, with diagrams, of the meter is given in the *Mémoires de la Société des Ingénieurs Civils de France*, 1899.

International Association for the Advancement of Science, Art and Education.—A meeting of the above association was held on Friday afternoon last, in the hall of the Society of Arts, when Prof. Patrick Geddes delivered an address on the aims of the association and its forthcoming assembly at the Paris Exhibition. Prof. Geddes explained that the Association had its origin in the strong conviction felt that the time had arrived for the constitution of that international association which had often been discussed and had never quite taken form. In response to a circular inviting co-operation, upwards of 500 members of the British Association had expressed their heartiest approval of the scheme, and agreed to form part of the committee. The members of the French Association and of the Paris Exhibition and the Paris University had likewise welcomed the proposal. Lectures would be delivered and congresses would be held, and the chairman (Prof. Archibald Geikie) expressed the hope that the success of the Paris meeting would be such that they would be able to connect the various scientific organisations throughout the world in a far more friendly way than had ever before been possible.

Embarras de Richesse.—In Monday's *Glasgow Herald* two advertisements proffering telephone service to the citizens are published. The first of these, which is headed "Corporation Telephones," appears rather premature. It offers, however, an unlimited service at five guineas per annum, or a toll service at £3. 10s. per annum, plus 1d. per outward call, on one-year agreements. The second advertisement is by the National Telephone Co., and is headed "Some Reasons against Joining an Opposition Telephone Exchange in Glasgow." It points out that subscribers to "an opposition telephone exchange" would have no intercommunication with the 8,000 Glasgow subscribers of the National Telephone Co., and explains that the former would have to pay terminal fees to the National Co. with respect to conversations with subscribers outside the Glasgow telephone area. The National Co. offers an unlimited service at £10 per annum for the first instrument, and £8. 10s. for the second, or a toll service at £3. 10s., and 1d., the latter being the same rate as the Corporation offer. The advertisement continues: "These rates . . . . . are infinitely cheaper than the £5 or £6 proposed to be charged for talking to the comparatively small number who can be connected to any merely local opposition system." It is added that the National Telephone Co. are re-arranging their Glasgow system, and that in a few months all their Glasgow subscribers will have a double-wire service.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, May 18th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Ordinary Meeting at the Westminster Palace Hotel, Victoria-street, S.W. Paper to be read: "A Short Review of the Motor-Car Industry," by B. H. Joy and C. H. Rush.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "The Structure of Metals," by Prof. J. A. Ewing, F.R.S.

THURSDAY, May 24th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting at the Society of Arts, John-street, Adelphi, for Members, Associate Members and Associates only, to receive the Annual Report of the Council, and Statement of Accounts and Balance-Sheet for the year ended December 31, 1899.

FRIDAY, May 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) Experiments illustrating the Aberration called Coma," by Prof. S. P. Thompson, F.R.S.; (2) "Notes on the Measurement of some Standard Resistances," by R. T. Glazebrook, F.R.S.; (3) "On the Strength of Ductile Materials under Combined Stresses," by J. J. Guest.

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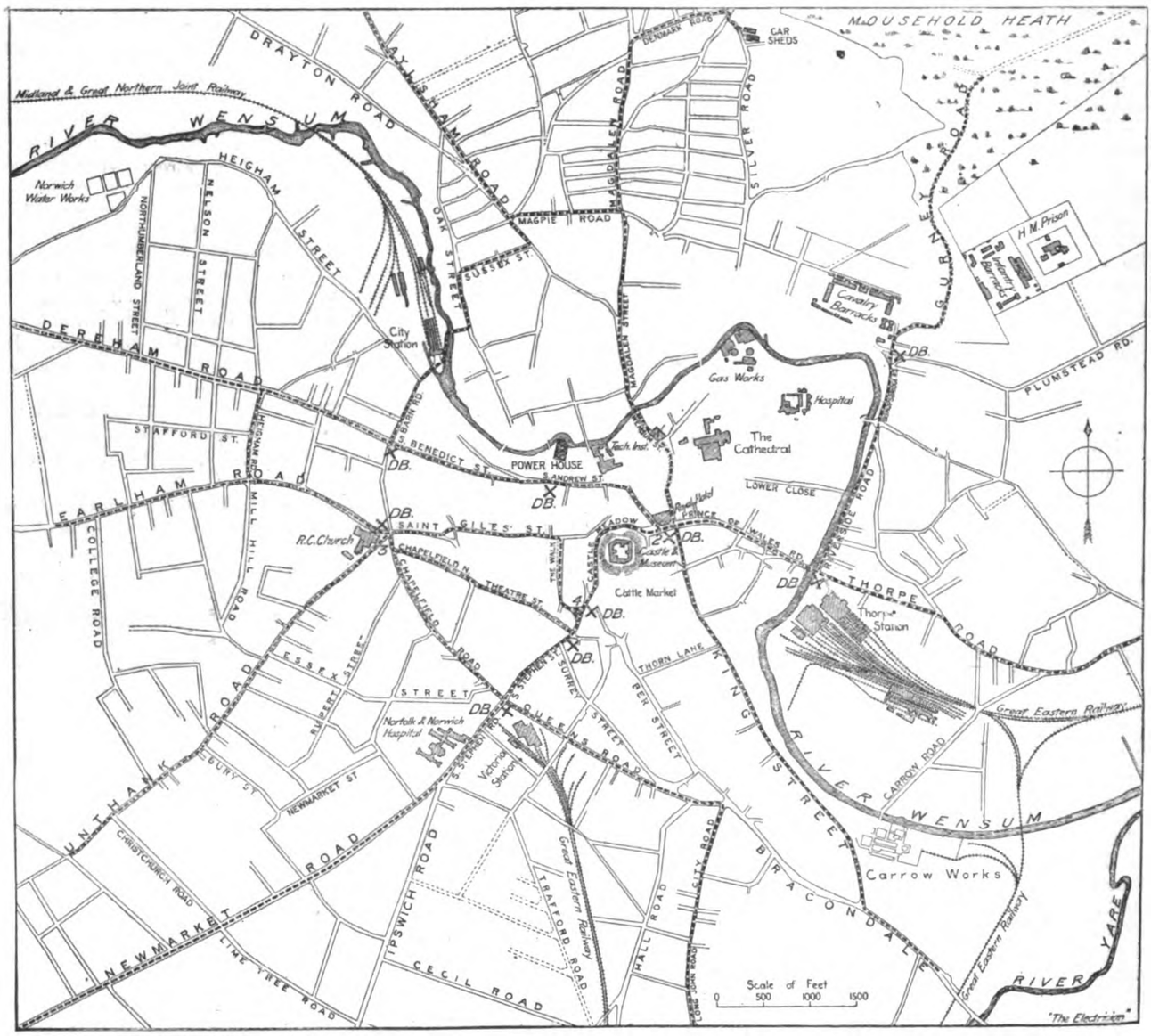
NORWICH ELECTRIC TRAMWAYS.

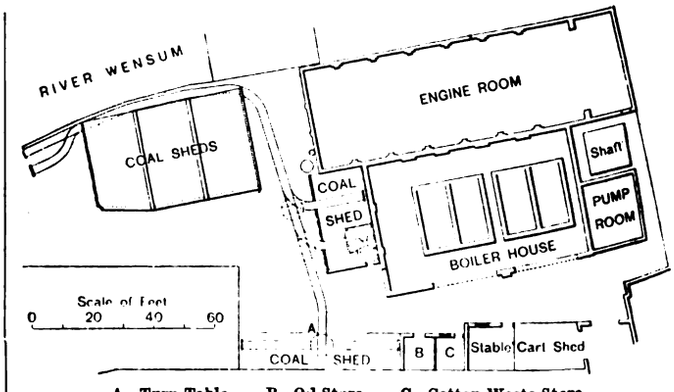
Up to the present time the ancient city of Norwich has not possessed a tramway of any description. The impending opening there of some 20 miles of electrically equipped tramways, therefore, marks an important event in the history of the city. The event is also of no small importance in the history of electric traction in this country, for it has hitherto been the custom in British cities to commence the experiment of electric traction with but a few miles of trolley line. At Norwich, however, no less than 20 miles of track have been equipped for this, the first stage of the tramway system, the present tramways being so laid out as to form a substantial backbone for further extensions over the municipal area.



——— Tramway Routes. X *DB*—Distributing

MAP OF NORWICH ELECTRIC TRAMWAYS.

Before describing this new tramway system we may state briefly the history of its development. In January, 1897, the Borough Council had under consideration two opposing schemes for the construction of tramways and light railways, one by the New General Traction Co., and the other by the British Electric Traction Co. In April of that year a committee of the Council recommended the adoption of the first named scheme, and this recommendation was approved by the Council in the beginning of May. A bill was promoted by the New General Traction Co. for the incorporation of the Norwich Electric Tramways Co., with a capital of £240,000 in shares and borrowing powers up to £80,000. The bill provided for the construction of 5 miles 24 chains of double track and 11 miles 17 chains of single track. It came before a House of Commons Committee on May 31, 1897, and was not oppose



A—Turn Table B—Oil Store. C—Cotton Waste Store.

GROUND PLAN OF POWER STATION.

The "compulsory purchase" clause provided for a period of 50 years before the clause could be enforced by the municipality. The work of constructing these tramways was commenced at

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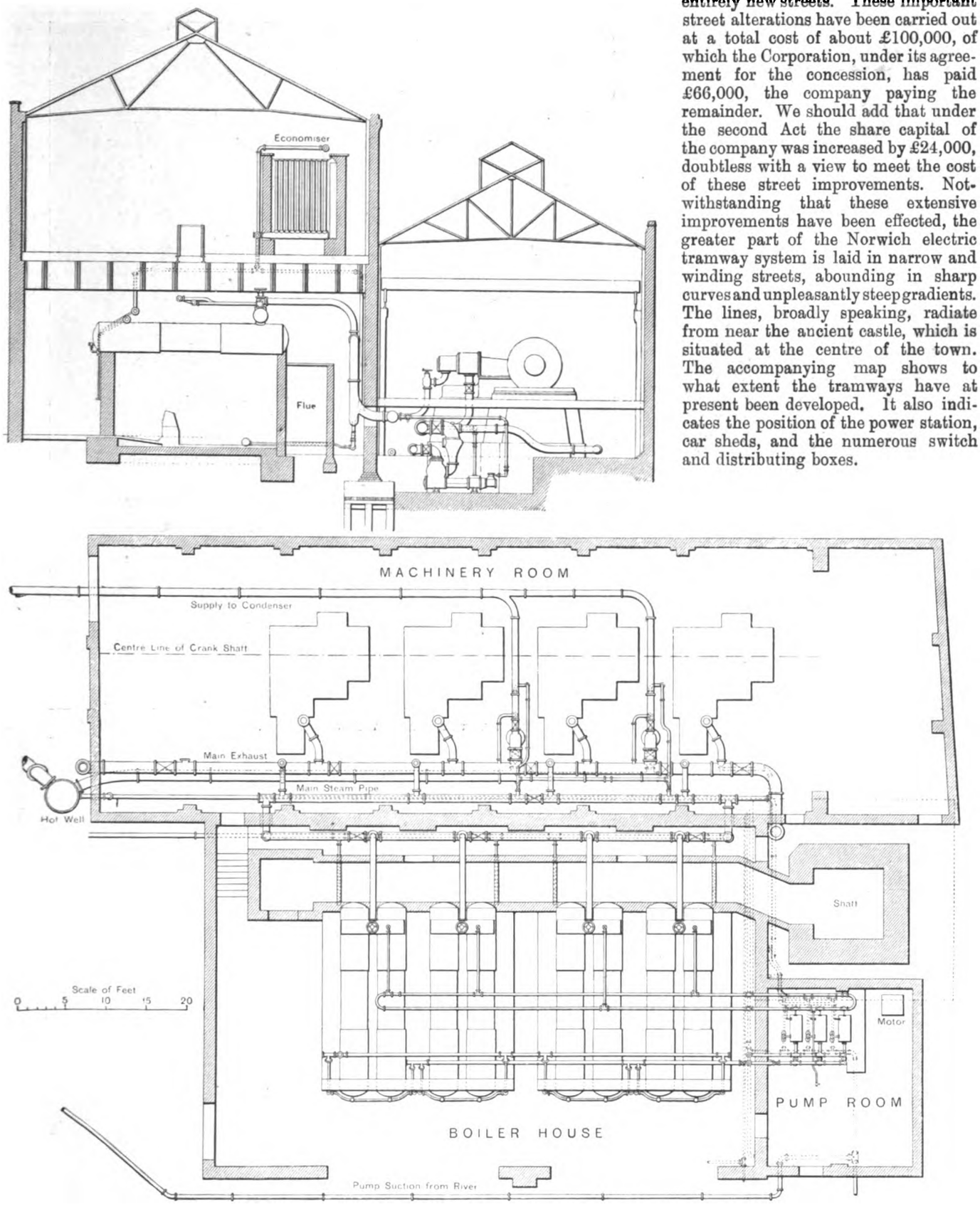
the end of 1897, the contract for the entire equipment being let to Messrs. Pauling and Co. (Ltd.), of Westminster. It was found, however, that this Act did not make sufficient provision for the development of a suitable tramway system, chiefly owing to the narrow and winding character of the streets of the ancient city. A new bill was therefore brought before Parliament in 1898, for powers to construct additional tramways having a length of 14 chains of double track and 68 chains of single track, and to make extensive street alterations, including the widening of seven and the construction of two entirely new streets. These important street alterations have been carried out at a total cost of about £100,000, of which the Corporation, under its agreement for the concession, has paid £66,000, the company paying the remainder. We should add that under the second Act the share capital of the company was increased by £24,000, doubtless with a view to meet the cost of these street improvements. Notwithstanding that these extensive improvements have been effected, the greater part of the Norwich electric tramway system is laid in narrow and winding streets, abounding in sharp curves and unpleasantly steep gradients. The lines, broadly speaking, radiate from near the ancient castle, which is situated at the centre of the town. The accompanying map shows to what extent the tramways have at present been developed. It also indicates the position of the power station, car sheds, and the numerous switch and distributing boxes.



NORWICH ELECTRIC TRAMWAYS: PLAN AND ELEVATION OF MACHINERY AND BOILER ROOMS AT POWER STATION.

Some idea of the difficult nature of the ground over which these tramways have been laid will be gathered from the following particulars. The minimum radius is situated at the junction of Red Lion-street and Rampant Horse-street, and is

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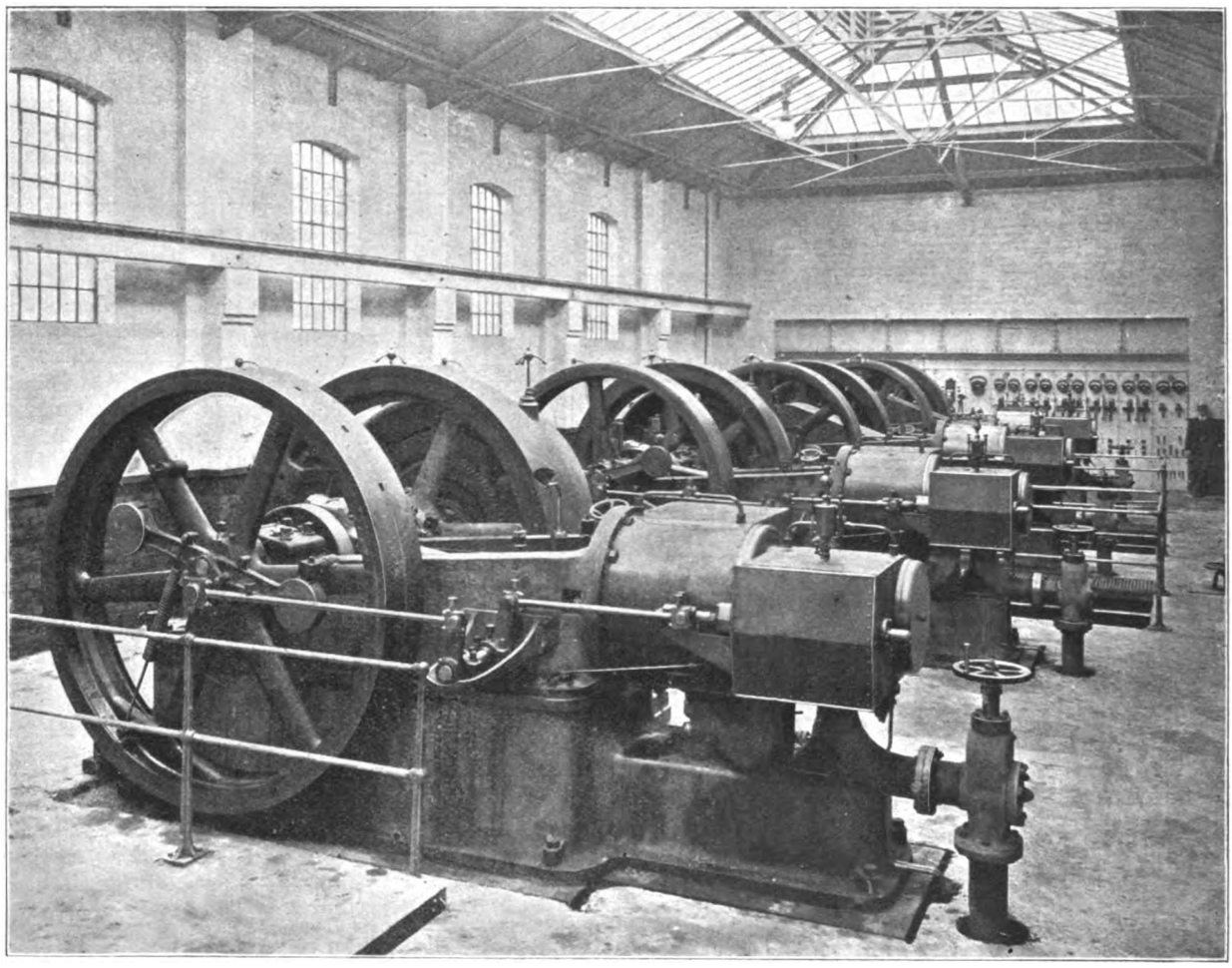
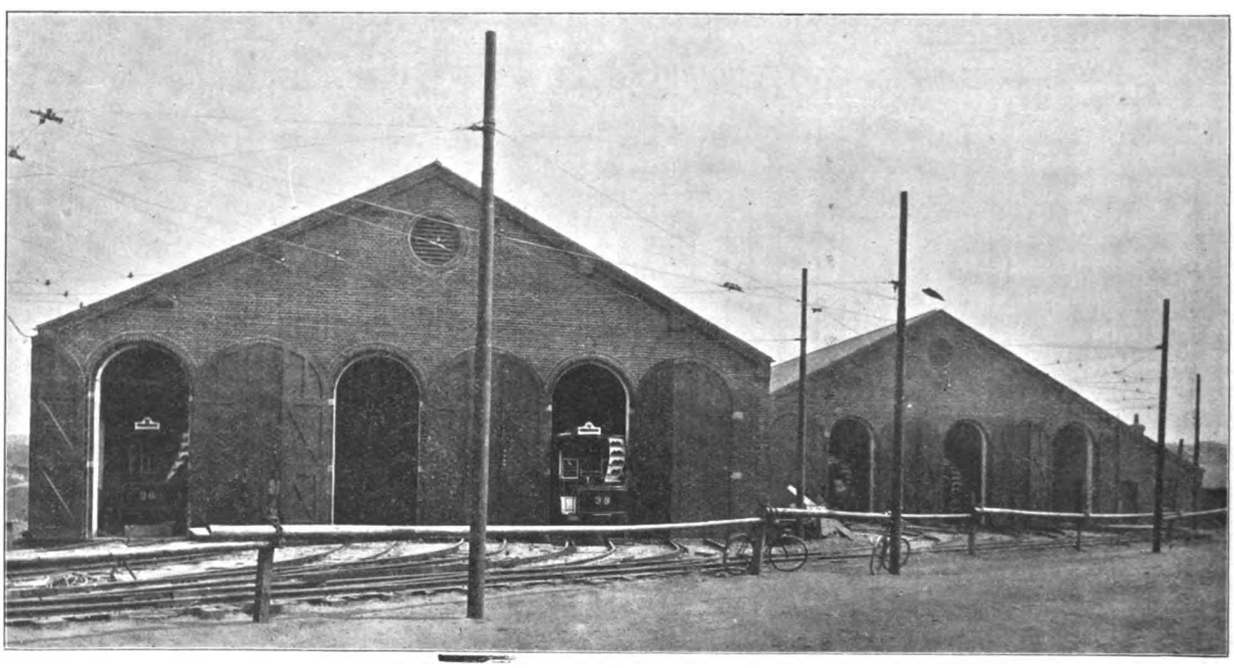
35ft. in length. The sharpest gradient curve is situated at the turning of Queen's-road into St. Stephens-street, and takes place on a gradient of 1 in 18. It is composed of curves of 70ft., 42ft. and 50ft. radius. The sharpest gradient is at the Whitehall Hill, and is 1 in 12. Numerous curves and gradients nearly as difficult as these examples abound, and in several places the roads have had to be terraced owing to the depression which would otherwise have occurred on the outer side of the curve.



Machinery Room at Norwich Electric Tramway Power Station.



Norwich Electric Tramway Car Sheds.

The general character of the construction work and electrical equipment carried out in connection with these tramways is indicated in the accompanying set of illustrations from

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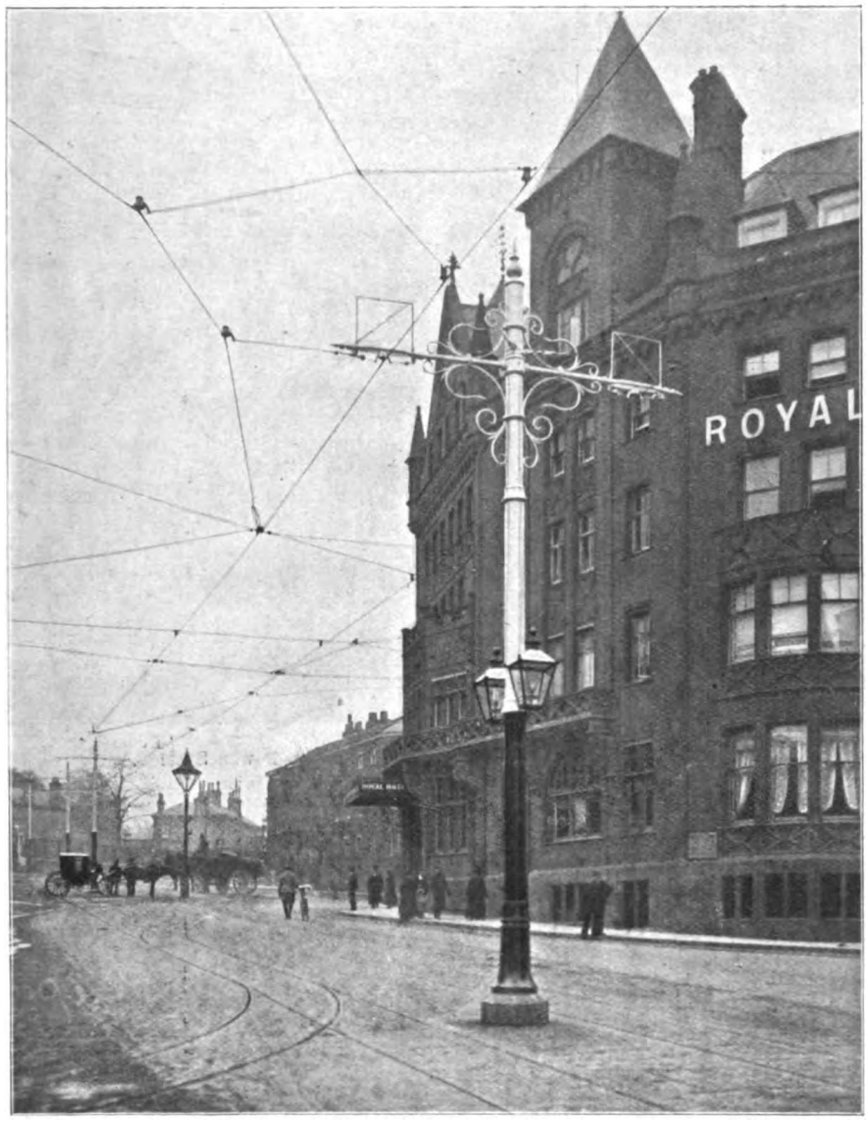
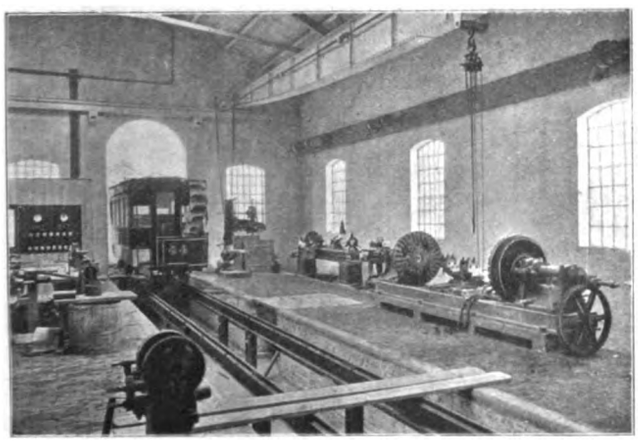
recently-taken photographs. These show the interior of the spacious machinery room at the power station, which is very suitably located near the centre of the tramway system, and on a site adjoining the River Wensum, by which coal and condensing water are readily obtained. This station is of 1,280 H.P. capacity, and is equipped with Browett - Lindley engines direct coupled to Westinghouse generators, steam being supplied from Babcock-Wilcox boilers. Views are also shown of the front and back of the switchboard, and of a typical portion of the track work and overhead equipment; also of the car sheds and workshops and of the type of motor car adopted.

These tramways are constructed on a 3ft. 6in. gauge, of cast welded 45ft. steel rails, weighing 65½lb. per yard on the straight, and up to 90lb. for guard rails on the sharp curves. The numerous and often difficult points, &c., have been successfully carried out by means of Messrs. Askham Bros. and Wilson's patent automatic fixed points, which have been extensively used on the tramways of this country and abroad. For some parts of the Norwich track the same manufacturers have supplied their movable and open points of crucible cast steel. We shall describe this "special work" later in the article. The equipment includes 40 motor cars and 10 trailers, it being intended to run 36 motor cars, with a varying number of trailers according to requirements. There will be a 10-minutes service of cars on all routes between 6 a.m. and 11.15 p.m. The cars are double decked, and each has a capacity of 52 passengers, 26 outside and the same number inside.

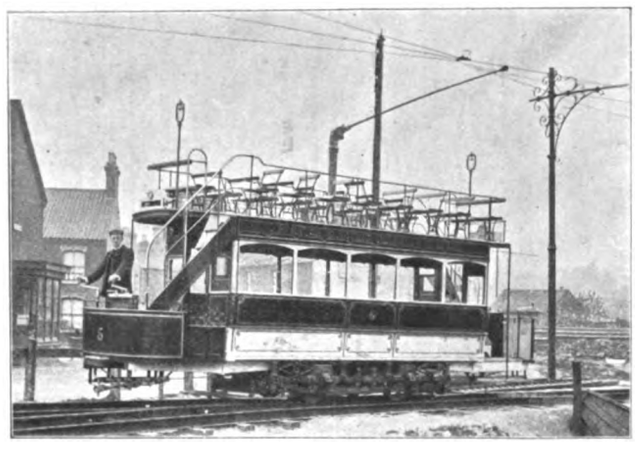


NORWICH TRAMWAYS: VIEW SHOWING CENTRE POLE AND OVERHEAD EQUIPMENT OF SPECIAL WORK SHOWN AT "2" ON THE MAP.

The electrical equipment of the track of these tramways has been carried out on the overhead trolley system. The details of its construction, however, are remarkably varied owing to the peculiar nature of the route. A separate forward and return trolley wire has, of course, been employed throughout the system, even on those portions of it which are of single track. Over some parts of the route these are carried on ornamental centre poles with double brackets, as shown in one of our illustrations. In other places side poles with single brackets of varying length are employed. Again, in other places side poles on both sides of the streets with span wires are used; while in very narrow streets span wires with wall rosettes have been erected. In one or two places where rosettes were



REPAIRING SHOP AT NORWICH TRAMWAY CAR SHEDS.



NORWICH ELECTRIC TRAMWAY MOTOR CAR.

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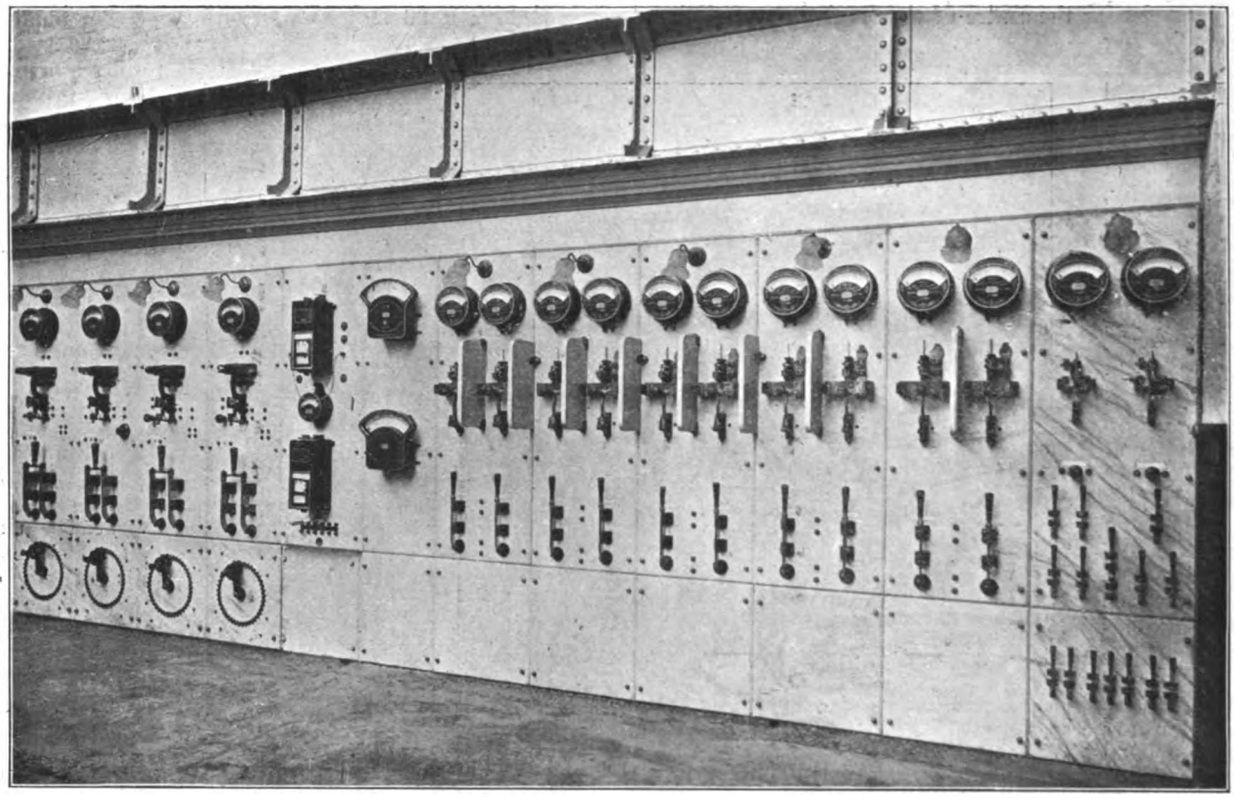
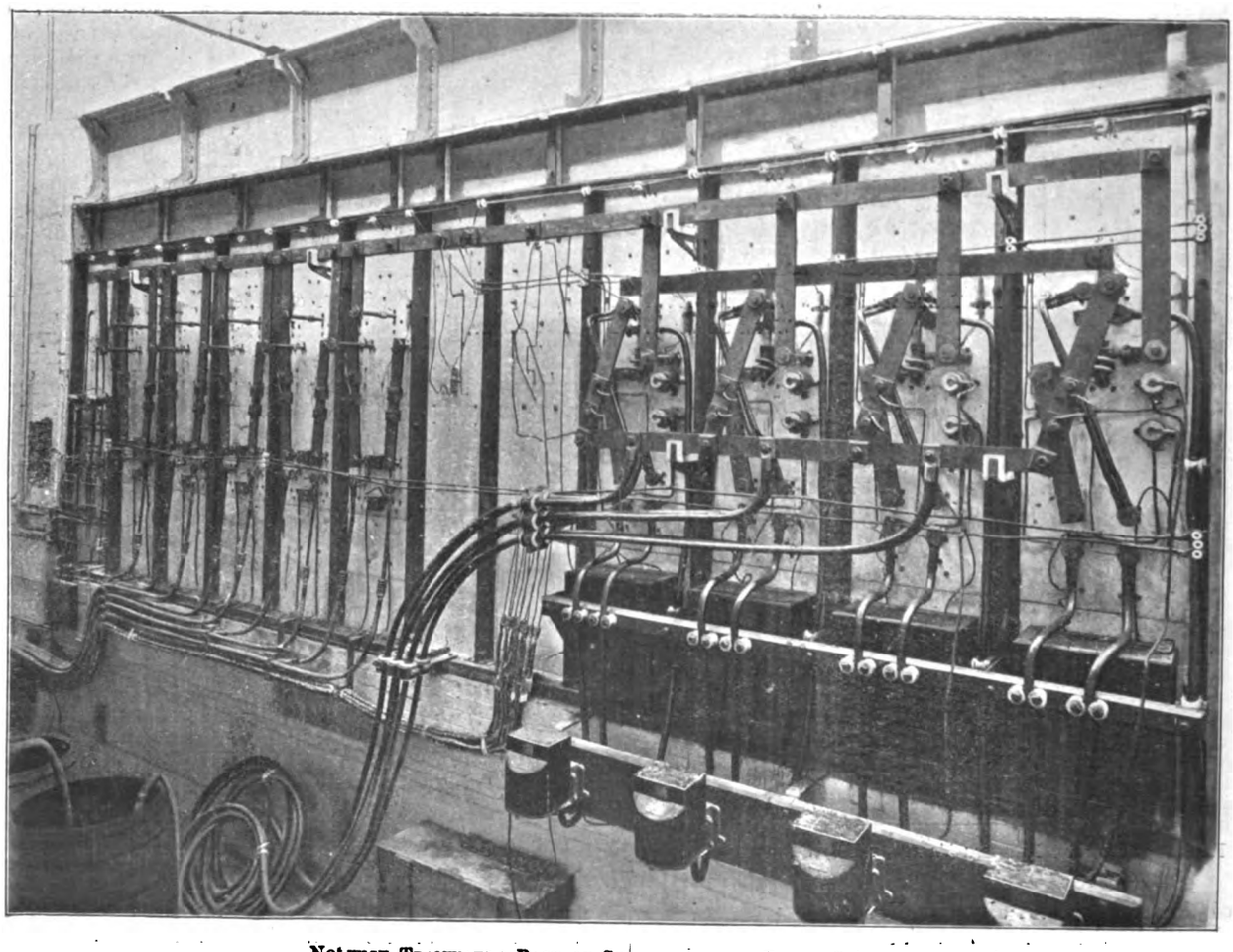


NORWICH TRAMWAYS: FRONT OF SWITCHBOARD AT POWER STATION.



NORWICH TRAMWAYS: BACK OF SWITCHBOARD AT POWER STATION.

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originally used it was found that the ancient builders of the houses had not used material sufficiently strong to withstand this unexpected strain; the rosettes came out and side poles had to be erected instead.

Most of the construction work has been carried out under sub-contracts, of which the various engineering firms concerned are as follows:—

Track, points, crossings, &c.	Askham Bros. & Wilson.
Track rails	Alex. Penney & Co.
Electrical equipment of track	R. W. Blackwell & Co.
Cast-weld joints of track	Do.
Peckham trucks	Do.
Cars	Brush Electrical Engineering Co.
Car Equipment, including motors, controllers, &c.	Westinghouse Electric Co.
Feeders	British Insulated Wire Co.
Section and distribution switches	Westinghouse Electric Co.
Switchboard	Do.
Generators at power station	Do.
Steam engines	Browett, Lindley & Co.
Boilers	Babcock & Wilcox.
Stoker and conveyor	E. Bennis & Co.
Economiser	E. Green & Son.
Pumps and condensers	Worthington Pumping Engine Co.
Steam feed exhaust piping, &c.	Babcock & Wilcox.

In the remaining portion of this article which, owing to pressure on our space, we are obliged to hold over until a future issue, we shall give to our readers a technical description of the various departments of the tramway system, together with additional scale drawings and plans of important parts of the work.

(*To be concluded.*)

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

BY C. E. GROVE.

(*Continued from page 49*).

Efficiency.—The mechanical efficiency of an electric motor is as a rule a few per cent. higher than that of a steam engine of corresponding power. The efficiency of the system as a whole involves the consideration of the generating and distributing arrangements, and here electricity has a marked advantage over either steam, compressed air, or hydraulics, the power taken being strictly proportional to load and the overhead efficiency from indicated horse-power of generators to brake horse-power on motor shafts averaging about 65 per cent. at full load. Efficiency, however, cannot be considered alone. The naval architect wants the relative advantages of competing systems expressed in terms of weight and space. In a given ship of war, the correct adjustment of weights and dimensions is correlated with the maximum offensive and defensive qualities involved in armour and armament, speed, and coal endurance. Hence, unscientific as it may appear in itself, an electric power distribution system of high mechanical efficiency may be a positive disadvantage to a warship if the weights involved conduce to an unfavourable design in the offensive and defensive qualities of the ship. Whether the change from steam to electric driving of auxiliaries involves the sacrifice of greater weight than is compensated for by the advantages gained is precisely the question on which authorities differ—the differences being chiefly due to the use of general terms for the sake of the argument instead of precise calculation. The main sources of loss in operating steam-driven auxiliaries are three: (*a*) The use of too great a range of temperature and pressure in the cylinders; (*b*) Leakages past pistons and valves due to wear; (*c*) Steam pipe condensation.

(*a*) As illustrating the uneconomical use of steam under the first condition, consider the case of winches and capstans. These must exert a powerful effort in starting, and hence must have very little lead and lap to their valves. If therefore steam at or near boiler pressure, say 250lb, be taken with cut-off at, say three-quarter stroke, and discharged into the condenser at the end of the stroke, it is obvious that the steam consumption per indicated horse-power must be very high. Steam engineers are well aware of this, and the increase in boiler pressures of the last few years has led to the introduction of several methods of utilising steam in auxiliary machinery to better advantage. One obvious but not-too-commonly-employed method is the use of reducing valves in the steam supply pipes of auxiliary engines. The favourite practice at present in the American Navy is to turn the exhaust from the auxiliaries into a feed-water heater, in which the latent heat is abstracted and the feed raised from about 80°F. or 85°F. to approximately boiling point; and when the power being developed in the main engines is too low for the feed to condense all the auxiliary exhaust steam, the surplus has been turned into a low-pressure evaporator. Notwithstanding the increase of back pressure on the auxiliaries by this arrangement, a saving of about 9 per cent, of coal used for auxiliaries is said to have resulted. In our navy, auxiliary feed heaters are being introduced for the same purpose. Other devices for economising steam are: the employment of compounding devices for using the steam in stages, as, for example, operating some auxiliaries by the exhaust from others, supplying auxiliaries at full pressure and exhausting into the intermediate receiver of the main engines, or drawing supply for the auxiliaries from the intermediate or low-pressure receiver and exhausting into condenser. All these systems have serious attendant disadvantages. Finally, some pressure is being put upon manufacturers of steam plant to improve the performance of the smaller engines by compounding, improving cylinder ratios, and so on.

(*b*) The losses that may occur in steam engines due to the effects of wear are most strikingly brought out by Mr. W. W. White, in his well-known Paper on the "Steam Consumption of the Main and Auxiliary Machinery of the U.S.S. 'Minneapolis.'"* These tests, which ultimately embraced all the machinery, were instituted in the first place to measure the steam consumption of the dynamo engines, which was known to be abnormally large, due to leakage past the pistons from the effects of wear. The pistons were originally grooved for water packing, and were without packing rings; new cast-iron pistons with snap rings were designed and fitted to one of the three dynamo engines, and tests made to ascertain whether the saving was sufficient to warrant the change in the remaining two. The engines were two-cylinder simple vertical inverted engines driving dynamos of 300 amperes capacity at 80 volts at 400 revs. per min. The engine cylinders were each 10½in. diameter by 5in. stroke, and were large for their work. Steam was supplied at 142lb. boiler pressure, and the exhaust condensed and weighed. The following results were noted:—

Set.	Load I.H.P.	Steam lbs. per I.H.P. per hour.	Remarks.
No. 1	21·873	123·27	Pistons water-packed and bad fit to cylinders cylinder bores rough and pitted.
do.	19·598	88·64	New pistons with 2 cubic in. packing rings
	33·601	68·25	in each, in use about ten days.
do.	29·184	69·33	New piston with packing rings in cylinders.
No. 2	19·012	108·71	Water-packed pistons, cylinder bores
	30·354	84·03	rough.
do.	16·791	102·73	Ditto ditto
	26·553	84·74	
do.	22·923	65·12	New pistons with packing rings, in use about
	35·237	56·45	nine days.
No. 3	17·324	97·75	Water-packed pistons; fit cylinders closely.
	26·234	79·48	Cylinders in good condition.
do.	18·241	81·62	New pistons with packing rings, in use about
	27·815	72·14	four days.
do.	20·40	97·92	Water-packed pistons.

The chief source of loss is evident enough here, but even the improved results leave much to be desired. How much loss was attributable to similar causes in the case of the other auxiliaries was not investigated, but the results were in all cases extremely bad. There is no corresponding loss due to the effects of wear in the case of electro-motors.

(*c*) Condensation in the steam pipes is probably the most serious of all the sources of loss. If we allowed that in the progress of design the average steam consumption in pounds of *dry* steam per indicated horse power of all the auxiliaries were brought down to the level of that of the dynamo engine—the most efficient auxiliary in the ship—the margin of loss from condensation to be got rid of by the extended use of electro-motors would go a long way to furnish the required set-off in coal saving to balance the necessary increase in weight of the electric system. For it is to be remembered that this loss occurs not merely when the auxiliaries are exerting power, but goes on the whole time the ship carries steam, whether the engines are working or not. To illustrate this point, an instance may be mentioned that has recently come under the author's observation. The new first-class battleship "Shikishima" carries 25 Belleville boilers, capable under full steam of developing over 15,000 I.H.P. in the main engines, besides working the auxiliaries necessary for steaming at full power, driving dynamos, &c. Thus each boiler at full power is equal to the supply of steam for over 600 I.H.P. When at anchor, one boiler under easy steam—*i.e.*, evaporating from 9lb. to 10lb. of water from and at 212°F. per pound of coal—was just able to work one 48 kw. steam dynamo at about half power, together with one feed-pump and the air and circulating pumps connected with the auxiliary condenser into which the dynamo engine exhausted, besides working a fire- and bilge-pump occasionally. If a capstan engine or boat hoist had to be worked in addition, a second boiler was necessary. The dynamo was about 160ft. of pipe length away from the boiler,

* Paper read before the Institution of Electrical Engineers, April 26th.

* *Journal* Amer. Soc. Nav. Engineers, February, 1898.

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the total range of steam pipe connected being 500ft. to 600ft. Performing the first-mentioned service with only one boiler alight, the coal burnt varied from 3½ tons to 5 tons per day of 18 hours for about 65 I.H.P., or about 7lbs. per I.H.P. hour at the best to 10lb. at the worst, the average being over 8lb.; which shows that more than half the fuel must have been expended in keeping the pipes warm. All pipes were well covered and below decks, and all machinery new and in first-class condition. Sir John Durston has published particulars of the coal consumption of certain auxiliaries of H.M.S. "Diadem," obtained when the ship was at rest in the basin, which bear on the same point.* He discovered that to run one main feed pump, one blowing engine, one auxiliary circulator, one electric light engine, and two distiller pumps consumed coal at the rate of 6·1 tons per day when two extreme forward boilers were employed, or 3·88 tons when two extreme after boilers were employed; the same machines with the addition of two evaporators, working compound, consumed 8 8 tons per day when supplied from the forward boilers, and 7 09 tons when supplied from the after boilers—*i.e.*, the elimination of the lengths of steam piping between the forward and after boilers alone resulted in a saving of from 20 to 30 per cent. of the total coal used for the machines in question. The same proportion of waste may be concluded to exist under sea-going conditions; for although more machinery would be at work, and therefore the steam would in some measure be used to better advantage, yet, on the other hand, the long lengths of pipes fore and aft of the ship would be connected to the steam mains, as well as branches going into colder regions above the protective deck. Hence it is clear that with short, direct connections to steam dynamos, and electric distribution to all the other auxiliaries for which electric driving is suitable, a considerable saving of coal—probably at least five tons per day—would be effected under this head. The total coal consumption for auxiliary purposes may be thus computed: Steaming at "economical" speed—about 12 knots—involving, say, one-fifth power, it is known that the coal consumption of a good modern first-class battleship or cruiser with Belleville boilers fitted with economisers is about 2lb. of coal per indicated horse-power-hour, which for 3,000 H.P. represents about 65 tons per day of twenty-four hours, of which the minimum number of auxiliaries employed under these conditions (*i.e.*, steering, engine pump, distiller, and one dynamo) consume on an average about 25 per cent. =16 tons. Supposing the engine-room pump continue to be steam driven, the principal auxiliaries used when the ship is cruising under ordinary sea-going conditions will be, besides those mentioned, ventilation fans, ash-hoist engines, and refrigerating machinery, together with air compressors and turret machinery for drill purposes. These machines work intermittently, and hence average coal consumptions are to some extent a matter of speculation; but it will probably be below the actual consumption of many ships to take the average total coal consumption of all the auxiliaries employed in an ordinary commission at 20 tons a day,† or, neglecting the dynamo, 15 tons.

Turning to the broad question of the mechanical efficiency of electrically-driven auxiliaries, notice must be taken of a couple of recent Papers by Lieut. Robinson, U.S.N.‡ For purposes of comparison Lieut. Robinson takes the average steam consumption of the best steam auxiliaries now produced at just below 70lb. per indicated horse-power-hour. He puts the best steam consumption of an electrical generator at 26lb. per indicated horse-power-hour, the exhaust being taken into a feed heater. He takes the efficiency of the engine at 93 per cent.; dynamo, 86 per cent.; line, 95 per cent.; and motor, 78 per cent. = overall efficiency, 59 per cent.; and on this basis shows that the steam consumption per brake horse-power on the motor shaft is 44lb. per hour, representing a reduction of 35 per cent. of the steam used by the best steam-driven auxiliaries. He then goes on to argue that if electric motors are used to drive the auxiliaries it will be necessary, in order to get the requisite torque at the highest speeds, to instal motors of 1·5 times the rated horse-power that would be required if steam auxiliaries were used; and hence, that as against a total of 1,500 I.H.P. of steam auxiliaries weighing (at 100lb. to the I.H.P.) 70 tons, a total motor capacity, is required of 2,250 H.P., weighing on the same basis 105 tons. The author ventures to join issues with this conclusion, which appears to be incorrect in several particulars:—

(i.) The I.H.P. of steam-driven auxiliaries is compared with the B.H.P. of motor driven auxiliaries, which is unfair. It would probably be liberal to allow an average mechanical efficiency for steam engines of the class used for auxiliary machinery of 70 per cent., so that if they consume 70lb. steam per I.H.P. this represents 100lb. per B.H.P. Hence the saving of coal due to electric driving is 56 per cent. instead of 35 per cent. (ii.) The only auxiliaries requiring maximum torque at highest speeds are pumps and fans, and it does not at all matter whether the torque exerted by motors on such machinery is equal to that exerted by steam engines, or not, provided the useful work done per minute is the same; on the contrary, services of this kind are excellently adapted to the capabilities of motors of comparatively small torque but high speed, the high speed allowing of a smaller and more compact machine than the slower running engine. (iii.) Winches, capstans, turret and steering engines, and, in fact, all in which inertia effects come in, require maximum torque *at starting*. Here the electric motor is distinctly on its own ground, for it is quite easy to build and control motors in such a way as to obtain from them a starting torque equal to two or three times that corresponding to their rated full power, which is not the case with steam engines; besides which the motor has the further advantage of exerting a continuous rotary effort in lieu of the fluctuating turning moment of the reciprating engine. (iv.) The argument as to the higher power rating of the motor drive appears to be drawn from the analogy of electrically-driven as compared with steam-driven machine shops, which is inapplicable to the case under discussion.

The conclusion appears to follow from the foregoing arguments that any appreciable increase in the horse-power rating of electric, as against steam-driven auxiliaries is unnecessary, and that if the whole of the auxiliaries of a 15,000 H.P. ship were electrically driven a saving of about five tons of coal used in generating the auxiliary steam would result from the suppression of pipe condensation, and (on the rather low basis of 59 per cent. overhead efficiency) a further saving of 56 per cent. of the balance of 10 tons = 5½ tons, due to superior mechanical efficiency—a total of 10½ out of the 20 tons of coal per day used by a good steam auxiliary equipment. The total bunker capacity of a ship of the power mentioned would be about 2,000 tons, representing the ability to keep the sea for about 25 days at economical speed. The saving in coal consumption in these 25 days represents 262 tons on the basis shown—an amount sufficient to more than counterbalance the necessary additional weight of generators and motors carried.

The questions next arising are: To what purposes is it practicable, having regard to all considerations, to adapt electric driving, what would be the changes in weight, space, &c., involved and what should be the arrangement of the installation for supplying the power? There is a broad difference at once to be recognised between machines directly co-operating with the main propelling machinery and those performing other duties. On the whole, present engineering opinion is, from considerations of reliability, decidedly in favour of continued steam driving for boiler-feed-pumps, circulating and hot-well pumps, fire and bilge and distiller pumps. It happens that these pumps are the worst steam-eaters in the ship; in the "Minneapolis," for example, the consumption ranged from 75·74lb. in a circulating pump doing 4·1 I.H.P., one cylinder alone taking steam, to 318·68lb. for a small pump developing 0·78 H.P., which was used for flushing purposes, the average for the 12 pump tests included in Mr. White's tables being 161·61lb. per indicated horse-power-hour. Experience with electric auxiliaries in other situations may eventually lead to the use of electricity for these services; but this contingency may be left out of account for the present. Starting and turning engines may be regarded as parts of the main engines themselves, and, of course, will be driven by the same power. The only auxiliary services within the engine and boiler rooms for which the use of electricity may be considered at present are ventilation and furnace blowing.

Fans for Engine and Boiler Room Ventilation.—In the "Canopus" class of battleships each engine-room is ventilated by a 7ft. 6in. fan driven by a direct-acting steam engine, while the boiler-rooms are supplied with air from four 8ft. fans at 240 revolutions, and two 6ft. fans at 320 revolutions per minute. These represent in the aggregate about 150 I.H.P., with a weight of between three and four tons. The "Duncans" will carry two engine-room fans, each 6ft. 6in. in diameter, with two 8ft. 3in. and eight 6ft. 6in. fans in boiler-rooms, the speed being about 300 revolutions. Fan driving, being a purely rotary movement, is a duty which electric motors have shown themselves excellently able to perform; they can run at at least twice the speed of reciprocating engines for the same power without noise or vibration, and can give the required deliveries with smaller fans, with higher efficiencies in both motors and fans, and therefore with less total power. It would probably be reasonable to take the total power of motors to perform the engine and boiler room ventilation of the most powerful ships at about 80 B.H.P. on the fan shaft, say, 100 E.H.P. input, which could be provided in enclosed type motors built for continuous work at 750 revs per min. for about three tons, or, allowing for the weight of the fans, an increase of not more than one ton on the above total weight.

Furnace Air-Blowing Engines.—These are high-pressure air-pumps adapted for delivering air at 15lb. to 30lb. pressure above the fires and into the combustion chambers of the boilers. A set of five such engines in the "Shikishima" weigh 5 tons 2 cwt., and develop an aggregate of 220 I.H.P. Pumping services of this kind are very efficiently performed electrically, but the substitution of geared motors for engines would result in this case in an increase of the total weight, probably to the extent of about three tons for 200 E.H.P.

* *Transactions* of the Institution of Naval Architects, 1889.

† The "Powerful" is said to have burnt on her voyage to China last year 40 tons a day for auxiliaries. The "Diadem" crusiers and the "Canopus" battleships are, however, much more economical.

‡ "Auxiliary Machinery for Warships," *Engineering Magazine*, October and November, 1899.

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Furnace air engines are generally placed in the boiler-rooms, but if electrical they could more conveniently be placed outside or above the boiler-rooms, air-pipes only being led into the firing compartments.

Considering next the auxiliary machinery outside the engine and boiler-rooms we find these include steering engines, capstan engines, boat, coal and ash hoists, ventilating fans, air compressors, refrigerators, workshop engine, turret-working machinery, and ammunition hoists.

Steering Engines.—It is convenient to consider these machines in this section, as they are usually placed in the after steerage flat adjacent to the tiller compartment. In some of the latest British ships they are placed in the engine-rooms and connected by long lines of shafting to the tiller mechanism. This arrangement saves carrying steam pipes aft, but seems to have nothing else to recommend it.

Next to the main engines these are the most important in the ship, and before every question of weight or efficiency the most reliable machine must be used here. Electric steering engines have, the author understands, been made, and there seems no reason, so far as the motors are concerned, why equally positive results should not be obtained with these and with steam engines. The controlling of their motion is the principal difficulty. The motors would be everlastingly starting, stopping, reversing, and altering speed; or, if the motors ran continuously, then such movements would be always being made by the gears and clutches. And whereas the steering engine is deep down in the ship, the control has to be operated from distant stations, of which there are usually five, inter-connected, the forward bridge and conning tower being the most important and the most generally used. Simple rheostatic control from a distance is not good enough; to secure the necessary sensitiveness, a large number of switch contacts and connections would be necessary; and an extensive system of cables, inter-connecting all the steering stations is inadmissible. A maker of steering engines once told the author he had invented an electric steering engine which he was sure met every requirement, but it required 79 wires! The reply was, of course, that 79 wires would kill any such project. Recourse must be had either to a pilot motor, worked by a small switch and two or three wires, operating in its turn the controller of the steering motor proper (indeed, it would probably be possible to employ the hydraulic telemotor, now so largely used, for working electric controlling switches alongside the steering motors, in similar fashion to that in which it reverses the valves of the steam steering engine), or to the interaction of two machines as in the Ward Leonard system of controlling turrets. If the difficulty of control be satisfactorily overcome, the gain in efficiency of electric steering mechanism ought to be very substantial, owing to its long periods of work. From its irregularity of working it is impossible to define the average H.P. of a steering engine. The motor to replace it must be a substantial affair, heavily geared, the torque required on the rudder-post of a big battleship being as much as 500 ton-feet. To move the rudder from hard-a-port to hard-a-starboard in 30sec., which is the usual requirement, a steering engine will make about 300 revs., and working at this maximum rate the I.H.P. will lie between 300 and 400, and the useful work done on the rudder-post will be at the rate of about 75 H.P. net, an overall efficiency of 20 to 25 per cent. Each steering engine with its gear weighs 5½ to 6 tons; two sets are carried. If each steering engine were replaced by one motor capable of exerting the same starting torque, the full load rating of each motor on continuous work might be taken at 150 H.P., though the starting current allowed would correspond to twice this power. With electric driving, an improvement in efficiency might be expected. The extra weight involved, using open-type machines, would be about two tons per set.

Capstans.—The principal capstan is, of course, the forward one, which has to operate the heaviest anchors. Besides other stipulations, its engines (usually duplex) are required by our Admiralty to lift a weight of 35 tons at the rate of 25ft. per minute = 60 actual horse power. The maximum indicated horse power may be taken at 200, and the weight of the complete capstan with engines and gears is about 47 tons. If electric motors were substituted for the steam engines with the same gears this weight would be increased by about two tons. But with better-designed worm gears the work could be done electrically on the same total weight. The after capstan performs similar but lighter work, lifting 15 tons at 25ft. per minute = 25 actual H.P., say 75 I.H.P. In our latest ships, while the forward capstan is still steam-operated, the after capstan is specified to be driven by two reversible watertight motors, performing the above specified work at speeds not exceeding 750 revs. per min., and so designed that the rise in temperature after one hour's run at full load does not exceed 80°F. This change involves an increase of total weight in capstan, motors, and gear of from one to two tons. In lieu of two motors, the Admiralty have accepted for the "Duncans" and other ships an electric capstan driven by one 50 H.P. motor at 350 revs. per min., the weight of the complete capstan, motor and gear being approximately the same as that of the steam after capstan of H.M.S. "Albion." Fig. 30 shows the general arrangement of the electric capstan of H.M.S. "Irresistible," by Messrs. Clarke, Chapman and Co.

It will require a somewhat protracted experience to determine whether, on the whole, the use of electric motors for capstans proves advantageous. To be quite safe, motors should be used with a large margin of power, notwithstanding the increase of weight involved, for the stresses involved in such work are apt to rise with great suddenness to many times their average value, and capstan chains have a habit of jamming in the stops. If steam driven, the engine will pull up, and is able to stand under the load; a motor cannot do this, yet it can neither be allowed to burn up nor to relinquish its work by cutting itself permanently out of circuit. Special devices are necessary to meet such a condition. Mr. Siemens dealt somewhat fully with this matter at Dover, so it is unnecessary to dwell further

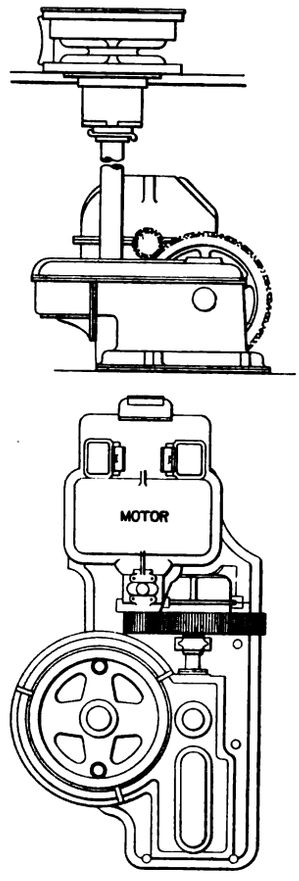

FIG. 30.—Electric Capstan, H.M.S. "Irresistible." (Clarke, Chapman & Co.)

upon it here. Neither in this case nor in that of the steering engines do there appear to be difficulties incapable of satisfactory solution electrically, and in these cases the longest steam-pipes in the ship are concerned.

(To be continued).

ON DISTANT ELECTRIC POWER TRANSMISSION.

The following is an abstract of the Discussion which took place at the Institution of Electrical Engineers on April 26th, in connection with Prof. George Forbes's Paper on the above subject:

The PRESIDENT (Dr. S. P. Thompson) said the Institution owed a great debt to Prof. Forbes for having read this remarkable Paper, which was the result of his own (Prof. Forbes') experience, and showed the reasons for his detachment from immediate connection with any one set of manufacturers or designers in whose favour he might otherwise have been biassed.

Prof. J. PERRY, who complained that he had not had time to study the Paper thoroughly, as it only reached him that same morning, asked for a little more information upon some of the practical points. For example, Prof. Forbes spoke of the use of synchronous motors for reducing the power factor. [Prof. Forbes: Increasing it.] One would like figures giving the actual size of the motor required. Again, there was very little information to be found anywhere about turbine details; lately, he (the speaker) had, only succeeded in getting civil engineering details about the position of turbines, and the dams for water, and so on. The old Paper written by Prof. Ayrton and himself about 20 years ago on the economy of conductors was very well worth study. There was another Paper published about the same time, which he believed had never been mentioned by anybody since it was published, and which referred not merely to the transmission of power to a distance, but to transmission of power by a conductor distributing power along the whole of its length, giving off equal amounts

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of power per mile. He had had to take the matter up in connection with a telpher scheme, and had got some most interesting results, which were well worth studying at the present moment. He was not sure that he quite understood why it was that Prof. Forbes was trying to keep up the voltage in this transmission of power. Prof. Forbes spoke of the enormous dvantages in the transmission when there was a less efficiency than 50 per cent. It was proved to both Prof. Ayrton's and his own satisfaction—he did not know whether to anyone else's—that it was not possible to transmit with a less efficiency than 50 per cent., and he would like to know whether it was not likely that Prof. Forbes had neglected a rather important thing in this matter of boosters—viz., that the power developed in a booster costs money.

Mr. S. Z. DE FERRANTI, having congratulated Prof. Forbes on his Paper, said that, according to it, Prof. Forbes did not know that air-cooled transformers of 1,500 H.P. capacity were made in 1889, and set to work to the extent of some 7,000 H.P. on the London Electric circuits. Although they were placed on special troughs to receive the air blast, this was unnecessary, for they kept quite cool without it. The air circulation was very perfect, and the machines had this interesting feature: The insulation, which was ebonite, was supported in the centre of an air space between the primary and secondary, and therefore the heat from the conductors was not directly transmitted to the delicate insulating material—viz., the ebonite. These machines had stood remarkably well. Experiments were also made with air cooling on the three systems—viz., natural, forced, and the latter. These had all been patented, and would have been patented in the United States as well, only the patent was refused for the usual reason—viz., that in those days inventors in that country were allowed to "swear back," and whoever could "swear back" the hardest and give the earliest date got the patent. He noticed nowadays that there was a very distinct tendency to drop rotaries in favour of motor generators, and he himself was very positive about the advantages of the latter. His opinion was that a rotary was a very difficult and tricky thing, and more suited to water-power transmission with perfect driving than to the ordinary type of electric generation from steam engines. He had seen American built rotaries with the features described by Prof. Forbes (viz., a short-circuiting piece between the poles to receive the currents induced in them), hunt about as badly as they could, and it was a clever business to keep them in step. Where the whole of the installation was perfectly planned out, perhaps, it was not such a difficult matter. Motor generators were quite the things to have when dealing with power at the end of a long line, when continuous current was wanted. He was at a loss to understand why people should use induction motors. The latter had bad power factors, and a bad power factor was the most serious thing it was possible to have in alternate-current working. He was very glad that Prof. Forbes had shown the fallacy of the idea that the way to transmit power was three phase, and that three phase had the wonderful gift that nothing else had of transmitting power at the least possible cost. It was quite certain that, as Prof. Forbes had stated, the best system of transmission need not be the best system for dealing with the general distribution as well, and the question was complicated when they had to use a system for many purposes instead of for one simple purpose. He was now going to make a statement which most of them would probably think a very silly thing, but he would make it all the same, and ask them to remember it, and see what they thought of it a few years hence. He considered that a single-phase low periodicity alternating system was the best of all the systems. All the details were not yet commercially complete for using it to the fullest advantage, but of one thing he was quite satisfied. If they wanted to transmit power to a distance, and turn it into continuous current, the single-phase alternate-current system was the best, and especially if they did it on some of the lines shown in the top diagram of Fig. 4, and earth the centre of the alternator and earth the centre of their transformers at a distance, so as to maintain the pressure on each wire at a constant potential above the earth, instead of having the contents of one conductor going to earth, and then jumping up the pressure to double the amount on the other conductor. Single-phase alternate-current generators worked just about as perfectly, and were just as strongly held in as two phase, and the working of these was much more perfect than three phase. In fact, they formed the most perfect means of turning alternate current into continuous. The only thing they had not satisfactorily got was a single-phase alternate-current motor. This, however, was much more perfect than was generally known, and the last tests he had seen of a 50 ∿ alternate-current single-phase motor was in the case of a 6 H.P. machine, where the power factor was 81 per cent., and the efficiency 81 per cent. They would, therefore, see that it was not necessary to go a great deal further to make these motors most valuable, and bring them up to the level of multiphase motors. The reason that he spoke so strongly in favour of this matter was because of its great simplicity. The switch gear and all the rest of the apparatus in multiphase systems was becoming a matter of almost alarming complication. At any rate, it was very much more complicated than a simple single-phase system, and the same applied to the conductors. It was always cheaper to use big conductors, especially when they were insulated, and of course if they only had a single phase to transmit there were less conductors than in any other system. He admitted there were many cases where multiphase working was, for certain purposes, a necessity, but all the same he thought fashion entered into the matter as much as anything else, and once having got the idea they seemed to go ahead with it without waiting to study it. He thought he was justified in speaking of power transmission in this country: They all knew there were many people who were struggling and working and risking their money to get powers to transmit high-pressure current all over this country for the benefit of manufacturers, and to put us on an equality with other nations who had these advantages. They also knew the legal procedure. Take for instance, the case of a man convicted of murder. It was always possible to find an able lawyer who, however well convinced he might be that the man had committed the murder, was ready to do his utmost to get the man off, and what he wished to draw their attention to was that while there were the people who were promoting these power schemes in Parliament there were others who were in opposition. He was not taking one particular case. There ought to be sufficient patriotism, honour, and good feeling in this country among a great profession like theirs to fight for that profession and the advancement of science in this country; it was a great misfortune if anyone could be found to come forward to say anything which would enable Parliament, or people interested in Parliament, to stop any of these great enterprises from being continued and put into practice, and being used for the benefit of the country. We were in a backward enough position; we had had a hard enough fight of it and we still had to fight a large number of vested interests, but surely amongst their great profession there should be no professional man found who would put forward a single word to prevent any of these schemes being rapidly brought into practice.

Mr. G. L. ADDENBROOKE said that the Paper dealt chiefly with long transmissions, longer, probably, than we should deal with in this country—at any rate for some years to come. From what he had seen in the colonies there was a vast field for such transmission of power. One reason of our having nothing of the sort here was probably that manufacturers had nothing to guide them in the construction of plant, and they had not that incentive to go into the matter which arises from close contact. Most of these great undertakings arose not merely from the manufacturers or users, but from a combination of the two. He did not see how any successful manufacture of plant on a large scale for this purpose could be made in England for use in other parts of the world, unless there were opportunities of seeing such plant at work on installations in this country. Manufacturers in Germany and America had these benefits, but on the other hand, it was, as Mr. Ferranti had pointed out, a most deplorable fact that experiment in this country was absolutely prohibited. They could do nothing in this country without going to town councils, which meant obstruction. Supposing in the early days of railways the whole of the companies had been put under municipal control. Where would the magnificent railway system of this country be? The electrical part of such schemes as these was a secondary consideration; the thing could be done, and we did not want to quarrel whether it could be done better one way than another. We could do it, and it was for Parliament to give facilities for doing it, and unless we got some such opportunities we would never get the capital of this country into such schemes. He had frequently been asked during the last three or four years whether the Central London Railway would work and succeed, and he had always replied that if the City and South London Railway succeeded so would the Central London, which was exactly the same thing. About 18 months ago he was on the Continent studying polyphase working, and he would like to correct the very general impression that it was not possible to do respectable lighting off three phase. On some of the installations he had inspected, where power and lighting were both supplied three phase without the use of motor transformers, the lighting was very good indeed—good enough for all practical purposes. And there was also this important fact which was not probably altogether appreciated—viz., if they had a first-class engine driving an installation at constant periodicity, they might have, with a rotary transformer, very large variations of pressure on the line without effecting the continuous-current wire, because as long as the periodicity remained constant the rotary transformer tended to go round at the same rate and took more current.

Mr. W. B. ESSON asked if the booster system had been tested in actual working. With regard to the inefficiency of Kelvin's law, might he ask if Prof. Forbes had taken into account the cost of the generators, because it might so happen that, in a case where 6 H.P. were generated, to get one they would spend in generators, transformers, &c., far more than they saved in copper.

Prof. FORBES: Then don't use the system.

Mr. ESSON: But what I want to point out is that you must take into account the whole of the cost.

Prof. FORBES: Of course you must.

Mr. ESSON then referred to the matter of phase rectifiers, and suggested that the reason the Oerlikon Co. adopted phase rectifiers was not the reason given, but was because their generators had such a tremendous drop they had been obliged to use these rectifiers to get the pressure up, or else burn out their generators. He also asked if Prof. Forbes had any figures to show the difference obtained by stranding the copper wire instead of having it solid for the factor given in Table VII.

Mr. ROBERT HAMMOND said the Paper was read at a very important juncture, as next week five power system bills would come before a committee of the House of Commons, and the question as to whether England was to have long distance transmission or not had some chance of early settlement. In discussing the Paper, he emphasised Prof. Forbes' opinion on the very grave importance of a proper appreciation of Lord Kelvin's law. The mere mortgage value of interest upon the copper would not do. Prof. Forbes had suggested that it might be 15 per cent., but he did not think that the most sanguine of the promoters of the power bills were looking for as much as that, but a good solid round interest upon the copper such as would tempt Mr. Addenbrooke's friends in the City to put their money into the schemes. However, Kelvin's law was something which had better be talked about on another occasion. The real choice at the present time lay between two and three phase. On three phase Prof. Forbes had given his opinion, but Mr. Ferranti had given single phase as being the best in his opinion; but there was a popular idea that the power schemes would have to choose between two and three phase. He (the speaker) had spent a most interesting time during the past fortnight in investigating two and three-phase systems on the Continent. Of course the Continent might be—and often was—wrong, but at all events they plumped for three phase in new work. There were many cases where there were large single-phase works in existence, and where many

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festly the network was very much more suitable for two phase split up into two single phases. At Vienna, where there were 19 plants all in a row, the works were being extended by two phase because this was more suitable for extensions to the present network, but in new places, where they had a clean sheet, such as at Mannheim, the system throughout was three phase. The author had mentioned that, in his opinion, a common return was an advantage in the cost of the cables, but he (the speaker) had made very careful inquiries among many engineers on the Continent, including Mr. Bláthy at Budapest, and there was a very strong objection to the use of a common return with two phase. This latter gentleman had also very strongly objected to two-phase work, and had gone so far as to say that if he had not got to transmit to a very long distance he would prefer to generate and distribute three-phase low-pressure current from a station in the centre of a town. When at Baden he was given particulars of what was to be done in the north of Italy. They were going to run a full-gauge railway, 100 miles in length, by three phase; generation was to be three phase, at 20,000 volts, with converter stations 10 miles apart to transform down to the lower pressure of 3,000 volts, and this 3,000 volts was to be introduced to the motors on the cars. His last point was to support Mr. Ferranti strongly in favour of motor generators rather than rotaries. He was in Frankfort on Saturday morning, where the whole of the tramways were being run by motor generators from a single-phase station. The single-phase current at 3,000 volts was brought to a central spot in Frankfort, and was there transformed by three 750 kw. motor generators distributing a continuous current of 550 volts to the tramways.

Mr. JAMES SWINBURNE said that when in 1881 Lord Kelvin's law was brought forward, people thought they had got hold of something new; but really the novelty consisted in its simplicity. Lord Kelvin happened to deal with a case where the laws were simple and they could get a simple mathematical expression which gave a good economy. But the general law—that the most economical arrangement was to invest capital in order to save revenue—had been known to every commercial man from the beginning of the world; the only difficulty was to calculate it. When they had something they could calculate definitely, then they had Kelvin's law, but as soon as they got into complicated departures from it they had not Kelvin's law. And a thing of that sort had happened that evening. Prof. Perry's illustration was purely a useless misapplication of arithmetic useful to professors, but of no earthly use to a practical man. There had been some little misapprehension about Prof. Forbes's remarks with regard to boosters. Suppose they were limited to use a maximum of, say, 10,000 volts. The booster enabled them to run that 10,000 volts all along the wire, and therefore they got the economy. They always used the highest volts they were allowed to instead of using the highest at one end and allowing it to drop at the other. He did not know whether any of the members ever beguiled away their leisure by tracing the origin of religious dogmas. It was a very interesting study, and he would like to deal a little in that direction with the rise of the three-phase motor. Some time ago, especially in Parliamentary inquiries, there was always the reproach against the alternate current that there was no alternate-current motor. The problem of the day was to solve alternate motors. Then came along Tesla and the people in Germany, and they professed to have solved the alternate motor problem. But they only introduced a new system of distribution which was capable of producing a motor which was not an alternating-current motor; it was another thing parading under the old name. But it gave us something on which to start, and people have used them for distribution in factories and so on, and the idea had grown. Then people—like Mr. Hammond—went to foreign countries, and came home and said "people are all using three-phase motors there, it must be right," and so they came home and used them. Then someone in this country said "here is Mr. Hammond's station using three-phase motors, it must be right," and so it went on. But of course there were really important questions in dealing with the size of conductors and mains; and the first thing was to be sure they were dealing with rational assumptions. The question of the size of the dynamo was not very important, but the case of working was enormously important. Freedom from breakdown was far more important than efficiency in most cases. In large transmissions, the capital spent in copper was most important.

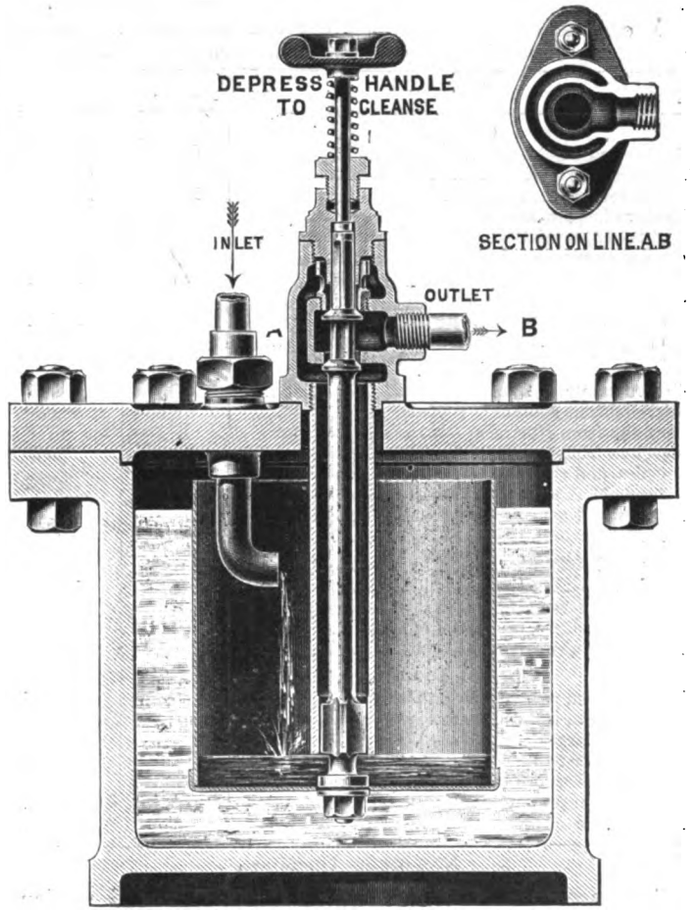
Prof. FORBES, in reply to Prof. Perry's request for more figures as to the size of phase rectifiers that must be employed for special work, said he had already disclaimed that he could act as professor, and teach the Institution as a class. Most of the members were surely competent to calculate for themselves. With regard to boosters, Prof. Perry had very aptly commenced his remarks by saying that he did not thoroughly understand, and his remarks made that still more obvious. He (Prof. Forbes) confessed his own ignorance was profound when he had traded upon the knowledge which he expected to exist about such elementary matters, and the remarks of several gentlemen had rather astonished him. He thought it was very elementary work, and that there would have been no difficulty in seeing the point. Mr. Swinburne had put the whole thing as clearly as daylight, and he need not say anything more about it. He was sure they would all feel indebted to Mr. Ferranti for his remarks, which were historical, practical, and prophetical. His remarks about the benefit of motor generators were very valuable, and should carry great weight; while he supported Mr. Ferranti in his soul-stirring words as to the future use of single phase for long distance transmissions, and would be quite willing to follow in Mr. Ferranti's steps when the question had been more fully studied. His reply to Mr. Esson was that he did not know of any booster system in actual working. With regard to the same speaker's remark that the phase rectifiers at Oerlikon were used in order to counteract the enormous drop due the self-induction of the generators, he said he thought it was generally known that manufacturers abroad in making tenders for such work proposed the adoption of such phase rectifiers to supply the so-called wattless current, and he also presumed that everybody knew that these phase rectifiers did work whether they were economical or not. He did not think there was any difference between stranded and solid wires so far as the effect he had been discussing was concerned. The great difficulty came in in the matter of skin resistance. Mr. Hammond had mentioned that since the Continent plumped for three phase, therefore three phase must be right. Although he (the speaker) was always getting tenders for three-phase plant, it did not follow in the least that three phase was the best system.

The PRESIDENT (Dr. S. P. Thompson) said that before he asked the meeting to return a formal vote of thanks to Prof. Forbes for this epoch-making Paper, he would like to say a few words on a matter which had struck him greatly. Prof. Forbes had struck a note concerning the national importance in this crisis, of electrical engineers appreciating the advantages of distribution on a large scale, a point which had been emphasised by Mr. Ferranti and others, and it was a matter which he felt very strongly at the present time—viz., these parliamentary schemes which were approaching discussion. Here was a problem that could not be faced from the small and parochial point of view, but which must be faced from the larger point of view. The last time he visited Paderno and Rheinfelden he also visited Vizzola where there was a water power station taking about 22,000 H.P. from Lake Maggiore. This was not for lighting the city of Milan, but it was to provide power for the industries in a large number of flourishing towns in that part of Lombardy, and he had been told that half the power was contracted for before a single engine had been installed in the station. With the exception of one of the towns (Legnano) included in the area of supply, he had never heard of any of them before he visited the place, but it had been explained to him that this part of the country was the Lancashire of Italy, and they were going to have their power distributed to them from one large central station: 20,000 H.P. distributed at high pressure, and by consent of the authorities there, and with legal authority from the Italian Goverment. And we had to compete in this country with those manufacturers in North Italy. Were we to be debarred by want of proper legislature from getting power from the coal fields economically and cheaply, the same as was being done at Niagara, Rheinfelden, Vizzola, and other parts of the world? If Parliament were to debar us from doing this it would be little short of a national misfortune.

A vote of thanks to Prof. Forbes was then passed.

THE TUNLEY STEAM TRAP.

The annexed illustration shows a new form of steam trap recently put on the market, and claimed to be one of the most compact and



accessible in use. The trap works on the float principle, levers and joints having been abandoned in this form of the instrument, in order to reduce the working parts to a minimum. The floating receiver is connected direct to the valve, and moves up and down with it; being balanced, the valve works independently of the steam pressure. On account of the small extent of the rubbing surfaces,

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situated only at the lower end of the valve stem, which is a loose fit, the friction is very small. It will be noticed also that it is practically impossible for any steam to pass out, as the outlet is by means of a vertical tube surrounding the valve spindle, the lower end of this tube being sealed up by the water in the receiver.

The action of the trap is as follows: Water enters through the pipe shown and drops into the floating receiver, causing it to fall as soon as its buoyancy has been overcome, thus opening the valve and allowing the water to discharge until the buoyancy is restored and the valve is closed again. Any dirt is got rid of by blowing steam through the vessel by means of the hand blow-off attachment, consisting of a plunger—independent of the valve spindle—carried through a stuffing-box at the top of the valve chamber, and provided with a handle and spring for raising it again. When first setting the trap to work the body is filled with water through a removable plug in the cover. Before being sent out from the works each trap is tested to stand a hydraulic pressure of 400lb. and a live-steam pressure of 200lb. For pressures higher than 200lb. the traps are supplied to cast-steel bodies.

These traps are being manufactured by Messrs. Fletcher Bros., of Ashton-under-Lyne, Lancashire, under license from the patentees, Messrs. A. E. and J. P. Jackson.

ELECTRICITY WORKS ACCOUNTS.

County of London and Brush Provincial Electric Lighting Co. (Ltd).

Out of the total authorised capital of £800,000 this company had, up to December 31st last, expended a total of £718,195 in respect of lighting works and plant in their London districts.

The proportion of this total expended in the northern districts, or those supplied from the City-road station, was £337,822. These districts include St. Luke's and Clerkenwell, Eastern and Western Holborn, and St. Giles. The southern districts are supplied from the Wandsworth station, and include Wandsworth, Camberwell, and Southwark. The total expenditure to the above date amounted to £380,373.

In the table which follows are given the more important particulars regarding the company's operations as a whole.

Items.	1898.	1899.
CAPITAL.		
Authorised capital	£800,000	£800,000
Share capital received	589,890	600,000
Loans received	101,000	254,957
Reserve (repairs and renewals) fund	5,000	11,915
Capital appropriated to Northern Districts Orders	273,442	337,822
Capital appropriated to Southern Districts Orders	2,889,145	380,373
Capital expended in lands, buildings, &c.	10,534	10,534
Capital invested in and advanced to the Bournemouth, Poole, Dover, Richmond and Coatbridge Electric Supply Cos.	138,208	99,101
REVENUE.		
Gross revenue	13,772	56,462
Miscellaneous sources of revenue	6,655	36,619
Revenue from Northern Districts department	2,159	6,718
Revenue from Southern Districts department	4,959	9,542
Repairs and renewals paid out of depreciation fund, Northern Districts	...	1,988
Repairs and renewals paid out of depreciation fund, Southern Districts	...	1,595
EXPENDITURE OUT OF REVENUE.		
Total	6,487	11,015
Directors' fees, rents, rates, taxes, insurance, wages and proportions of salaries	3,342	6,758
Miscellaneous charges	3,145	4,257
FINANCIAL RESULTS.		
Balance from revenue account	7,285	45,417
Balance from last account	10,091	5,776
Interest charges	...	5,033
Set aside for repairs and renewals	...	6,500
Sum available for distribution	17,376	39,661
Dividend on preference shares	6 per cent.	6 per cent.
Dividend on ordinary shares	Nil	4 per cent.

NORTHERN DISTRICTS.

The accounts of the working of the City-road station, supplying the northern districts, form the subject of our first table. The figures we are able to give show that most satisfactory progress has been made by this department during the period dealt with.

The equivalent lamp connections, it will be noticed, have increased from 36,303 to 61,188 8 c.p. lamps—an advance of nearly 69 per cent. The output of 1899 indicates an increase of 106 per cent. over that of 1898.

The load factor of last year at 8·14 per cent. shows that the load was less satisfactory in character than in 1898 when the load factor was 10·5 per cent. In view of this the reduction in the costs which has taken place is the more commendable. As they are, the costs are still slightly above what they might reasonably be expected to stand at. It is the works costs—more particularly the fuel and repairs items—that are the source of the failure to make a very satisfactory cost sheet.

The average revenue received stands at the moderate figure of not quite 5d. per unit sold. Unfortunately the margin between expenditure and revenue has only permitted of a working profit of £6,718, representing 2·2 per cent. of the mean capital expenditure. This, however, compares well with the £2,347 of 1898.

It may be mentioned that the supply of current in the Western, Holborn, and St. Giles district was commenced last summer. The plant erected for the generation of continuous current for power purposes has a capacity of about 2,000 H.P.

SOUTHERN DISTRICTS.

These districts are supplied by the Wandsworth station, the accounts of which are analysed in our second table.

Here, again, excellent progress is shown in respect both of economy of working and increase of business. The lamp connections have risen 89 per cent., and the output nearly 80 per cent. In 1898 the load factor was 8·17 per cent. Last year, however, this factor had risen to 12·4 per cent.

The aggregate costs have fallen from 3d. to 2·6d. per unit. As was the case in the City-road station, the Wandsworth station costs are still somewhat too high in the circumstances, and, in fact, taking into account the outputs and load factors, there is very little to choose between the two stations in the merit of the results for 1899. The management and property charges at both stations, as given, are below the average, but since there are charges which we generally include under this head appearing in the company's general accounts, it is useless to criticise closely or comment on the management or aggregate costs of the two departments as set forth in our tables.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 4, 1900	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, 1899	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, 1900	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 28, ,,	Richmond (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Salford (Municipal)	Feb. 23, 1900
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, 1900	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	May 26, 1899
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, ,,
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wandsworth (Company)	Aug 18, ,,
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, 1900
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Woolwich (Company)	Jan. 13, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 8, 1899
Kingston-upon-Hull (Mun.)	June 9, 1899		

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	CLERKENWELL, or Northern Districts.*		WANDSWORTH, or Southern Districts*	
Undertaking Worked by	County of London & Brush Provincial Electric [Lighting Co. (Ltd.)		County of London & Brush Provincial Electric [Lighting Co. (Ltd.)	
Date of Commencement of Supply	September, 1897.[d]		January, 1897.	
System of Supply	Alt.-curr. from trans. sub-stations for light, and con.-curr. at 500 v. for power.		High & extra high-press. feeders, alt.-curr. trans. sub-stat. under streets suppl'g low-press. 2-wire network.	
Chief Engineer	C. P. Sparks.		C. P. Sparks.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	604,092	1,199,094	581,270	1,068,230
„ SOLD (TOTAL)	447,078	920,094	471,397	846,421
„ sold to consumers	447,078	920,094	471,397	846,421
„ sold for public lighting, &c.	nil	—	—	—
„ used on works	31,279	29,584	19,560	26,301
UNITS SOLD PER 8 C.P. LAMP CAPACITY	7·95	9·98	16·8	30·1
Maximum supply demanded	484 kilowatts	1,290 kilowatts	659 kilowatts	781 kilowatts
Number of public lamps	nil	—	—	—
Number of consumers	—	—	—	—
Connections to mains in 8-c.p. lamps	36,303[b]	61,188	28,914	54,647
CAPACITY OF PLANT IN 8-C.P. LAMPS	56,300	92,200	28,100	28,100
CAPACITY OF PLANT IN KILOWATTS	1,800	2,950	900	900
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	—[c] —	—[c] —	—[a] —	—[a] —
Share	—[c] —	—[c] —	—[a] —	—[a] —
Loan (including Debenture charges)	—[c] —	—[c] —	—[a] —	—[a] —
RECEIVED (TOTAL)	£273,442[d] £152	£337,822 £115	£243,212 £270	£380,373 £422
Share	—[c] —	—[c] —	— —	— —
Loan (including Debenture charges)	—[c] —	—[c] —	— —	— —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	—[c] —	—[c] —	— —	— —
Share (unissued)	—[c] —	—[c] —	—[b] —	—[b] —
Share (uncalled)	—[c] —	—[c] —	—[b] —	—[b] —
Loan (including Debentures)	—[c] —	—[c] —	—[b] —	—[b] —
REPAID (TOTAL)	—[c] —	—[c] —	— —	— —
RESERVE OR SINKING FUND	—[c] —	—[c] —	—[b] —	—[b] —
DEPRECIATION FUND	—[c] —	—[c] —	—[b] —	—[b] —
EXPENDED (TOTAL)	273,442 152	337,822 115	243,212 270	380,373 422
Lands and buildings	71,566 39·7	73,674 25·0	63,344 70·4	66,445 73·8
Plant	109,056 60·6	135,248 45·8	61,646 68·5	84,066 93·4
Mains	88,357 49·1	121,204 41·1	117,065 130	227,382 253
Miscellaneous	4,464 2·48	7,697 2·61	1,158 1·29	2,480 2·76
BALANCE OF CAPITAL ACCOUNT	— —	— —	— —	— —
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£11,819 6·025d.	£19,050 4·972d.	£11,042 5·620d.	£18,712 5·310d.
Revenue from supply	10,529 5·653d.	18,054 4·710d.	10,593 5·390d.	17,996 5·108d.
„ meters, &c.	378 0·203d.	626 0·163d.	374 0·190d.	667 0·189d.
„ public lighting	— —	— —	— —	— —
„ sale of lamps, &c.	— —	— —	— —	— —
„ miscellaneous sources	312 0·167d.	370 0·100d.	75 0·038d.	49 0·014d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£8,872 4·764d.	£12,332 3·218d.	£5,896 3·000d.	£9,170 2·600d.
WORKS COSTS	6,943 3·726d.	9,324 2·432d.	5,184 2·640d.	8,077 2·290d.
Generation of electricity	*6,427*[e] *3·449d.*	*8,774*[i] *2·290d.*	*4,682*[e] *2·383d.*	*7,181*[h] *2·037d.*
Fuel (including cartage, &c.)	2,652 1·423d.	4,105 1·071d.	1,999 1·019d.	3,249 0·922d.
Oil, waste, water, stores	559 0·300d.	708 0·185i.	508 0·259d.	716 0·203d.
Wages at station	1,638[f] 0·880d.	1,812[f] 0·473d.	1,177[d] 0·599d.	1,580[d] 0·448d.
Repairs and maintenance at station	1,086 0·583d.	1,961 0·512d.	680 0·346d.	1,523 0·432d.
Distribution of electricity	*516 0·277d.*	*550 0·144d.*	*502 0·256d.*	*895 0·254d.*
Wages, &c.	432[f] 0·232d.	522[f] 0·136d.	405[d] 0·206d.	823[d] 0·233d.
Repairs, renewals of mains, &c.	84 0·045d.	23 0·007d.	97 0·049d.	73 0·021d.
Public lighting	— —	— —	— —	— —
Attendance	— —	— —	— —	— —
Renewals	— —	— —	— —	— —
MANAGEMENT AND PROPERTY CHARGES	1,929 1·036d.	3,008 0·786d.	712 0·362d.	1,092 0·310d.
Royalties	— —	— —	— —	— —
Rent, rates, taxes	*1,754 0·942d.*	*2,418 0·631d.*	*557 0·284d.*	*475 0·135d.*
Management	*175 0·094d.*	*590 0·154d.*	*155 0·079d.*	*617 0·175d.*
Salaries	—[f] —	—[f] —	—[d] —	—[d] —
Stationery, &c.	65 0·035d.	184 0·048d.	68 0·035d.	154 0·044d.
Establishment charges	— —	254 0·066d.	— —	225 0·064d.
Law charges, &c.	110 0·059d.	152[j] 0·040d.	87[d] 0·044d.	238[i] 0·068d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2,347 0·962%	£6,718 2·20%	£5,146 2·34%	£9,542 3·06%
Sum carried to Depreciation Fund	189[g] 0·078%	—[c] —	187[f] 0·085%	—[b] —
Sum carried to Reserve or Sinking Fund	—[c] —	—[c] —	—[b] —	—[b] —
Net interest on loans (incl. Debenture charges)	—[c] —	—[c] —	—[b] —	—[b] —
BALANCE FROM LAST ACCOUNT	—[c] —	—[c] —	—[b] —	—[b] —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—[c] —	—[c] —	—[b] —	—[b] —
Deficit	—[c] —	—[c] —	—[b] —	—[b] —
ORDINARY DIVIDEND PAID	—[c] —	—[c] —	—[b] —	—[b] —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	79·1%	64·7%	53·4%	49%
Expenditure per kilowatt capacity	£4. 18s. 7d.	£4. 3s. 7d.	£6. 11s. 0d.	£10. 3s. 10d.
REVENUE PER KILOWATT CAPACITY	£6. 4s. 7d.	£6. 9s. 2d.	£12. 5s. 5d.	£20. 16s. 0d.
Expenditure per 8-c. lamp capacity	3s. 1¾d.	2s. 8d.	4s. 2½d.	6s. 6½d.
REVENUE PER 8-C.P. LAMP CAPACITY	3s. 11¼d.	4s. 1½d.	7s. 10½d.	13s. 3¾d.
REVENUE PER 8-C.P. LAMP CONNECTED	6s. 2d.	6s. 2¾d.	7s. 7¾d.	6s. 10½d.
Price charged for lighting, per unit	7d. to 3d.[h]	7d. to 3d.[h]	7d. to 3d.[g]	7d. to 3d.[g]
Price charged for power, per unit	6d. to 2d.[h]	4d. to 2d.	6d. to 3d.[g]	6d. to 3d.[g]
Price charged for public lighting	—	—	—	—

CLERKENWELL.—REMARKS—* Includes the whole northern district of the company—viz., St. Luke's, Clerkenwell, Eastern and Western Holborn and St. Giles—all supplied or to be supplied from the City-road station. *a* Date of commencement of generation of electricity. *b* Includes motors aggregating 128 H.P. *c* The *total* authorised capital of the *company* is £900,000. The net revenue and capital accounts are not separately rendered from the totals referring to the whole of the company's operations. *d* Being the capital appropriated to the County of London (North) Electric Lighting Order, 1892, and Northern Extensions Order, 1897. *e* Includes £385 for station lighting and £107 general charges. *f* The engineers' salaries are included under "wages at station" and "distribution of electricity." *g* Being depreciation of meters only. *h* On maximum demand system, 7d. for first 1½ hours and 3d. after for lighting, and 6d. for first hour and 2d. after for power supply. *i* Includes £188 stores and works expenses. *j* Inclusive of £67 to insurance and £60 auditing.

WANDSWORTH.—REMARKS—* Including the parishes of Putney, Wandsworth, Tooting Graveney, Streatham and Clapham, also Camberwell and Southwark. *a* The *total* authorised capital of the *company* is £800,000. *b* The net revenue and capital accounts are not separately rendered from the total respecting the whole of the company's operations. *c* Includes £192 for station lighting and £125 general charges. *d* The engineers' salaries are included under generation and distribution charges. *e* Includes £42 to insurance and £45 to auditing. *f* Being depreciation of meters only (see note *b*). *g* For lighting, 7d. for first 1½ hours, 3d. after; for power, 6d. for first hour, 3d. after; by maximum demand system. *h* Inclusive of £114 to stores and works expenses. *i* Includes £51 to insurance and £60 to auditing.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

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LONG DISTANCE POWER TRANSMISSION.

Prof. George Forbes's Paper "On Distant Electric Power Transmission," recently read before the Institution of Electrical Engineers, touched on a subject of great interest and importance at the present moment, and despite the somewhat "scrappy" nature of the Paper itself, a good discussion was expected. The debate which took place, however, although not devoid of interest and entertainment, was disappointing, probably owing to the fact that proofs of the Paper were only issued to intending speakers a comparatively short time before the Paper was read, and because the reading and discussion had to be completed in one evening. We have already in a previous issue referred to the first part of the Paper, which describes briefly, and in a mannner which the author states is liable to mislead, a few of the existing examples of long-distance transmission. A letter in the correspondence columns of this issue also makes reference to this part of the Paper.

In the second part, the point to which Prof. Forbes appears to attach the greatest importance is the question of the applicability of Kelvin's law of economy in particular cases, and the possible advantages to be gained in reinforcing the voltage along the line by means of boosters. As Prof. Forbes correctly pointed out, Kelvin's law is only applicable in a special instance, and although the size of transmission lines and feeders may be chosen with due regard to similar principles, the law as it stands is not of universal application. Distributing networks have long been designed with no regard for this law, for, in the first instance, cables in accordance with it would occasion too large a drop in voltage; and, secondly, because the actual load on, and the load factor of, a supply network cannot be foreseen. This latter fact accounts for the phenomenon that not even feeders are, as a rule, calculated on a Kelvin law basis. An attempt, which can hardly be called thoroughly successful, was made in a more recent Paper before the Institution of Electrical Engineers, to calculate in the same way the size of feeders and distributors for a tramway system. In the case of many power transmission systems, however, a theoretical treatment is more likely to be useful, for it frequently happens that the amount of power to be transmitted is accurately known at the time the scheme is designed; yet, although we have no objection "to see an accurate volume published on the correct use and

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development of KELVIN'S laws of economy," as Prof. FORBES desires, we should side with Mr. SWINBURNE in not desiring to read it unless its practical bearing was evident. The booster system described in the Paper was, we were sorry to see, criticised rather too impetuously by Prof. PERRY. Given the problem to transmit electrical power at a stated pressure with a maximum percentage loss, it is evident that by keeping up the pressure from one end of the line to the other an efficiency lower than 50 per cent. can be obtained. There cannot be a doubt, however, that this case is one that would rarely occur in practice. It requires really only a cursory examination of the accounts published by electricity supply undertakings to reveal the fact that fuel is but one of many items in works costs and but a comparatively small proportion of the total costs. It might, therefore, be thought at first sight that the employment of twice as much fuel would often pay, if thereby a large capital expenditure in mains were saved—and there are, of course, many instances in the colonies and abroad where the actual water power costs nothing or practically nothing. But all, or nearly all, the items in the works costs are more or less proportional to the number of units generated, and the capital charges which go to make up the total costs vary with the kilowatt capacity of the plant, which would, of course, have to be augmented if the loss of energy in transmission were doubled. Thus the cost of the extra waste of energy which has to be taken account of when the cross-section of the conductor is reduced, *plus* the interest and depreciation on the cost of the line boosters for keeping up the pressure, has to be set against the saving in interest and depreciation in the conductors; and it is probable that this extreme measure of increasing the loss to over 50 per cent. would only be resorted to in practice in rare instances of transmission over extremely long distances, and for the most part in schemes whose realisation is also far distant. Possibly that was Prof. FORBES' meaning in choosing as the title of his Paper "On Distant Electric Power Transmission," instead of "On Electric Power Transmission over Long Distances."

The question of two-phase versus three-phase, or, in view of Mr. FERRANTI'S speech, the triangular conflict between single, two, and three phase, has not yet been settled, nor will it be settled merely by the drawing of triangles and stars and placing $\sqrt{2}$ and $\sqrt{3}$ along their sides. Prof. FORBES rightly states that the relative amount of copper in the two instances depends upon the conventional definition of the pressure employed, and assumes, to prove his case, the convention that the pressure to be taken in the comparison is the pressure between each conductor and earth. In this country, however, the Board of Trade kindly undertakes the task of defining such conventions, and deems that, "the expression 'pressure' means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth," implying naturally that the greater of these two is to be assumed in applying the regulations. Moreover, we believe that the Board of Trade has laid down, up to the present, that one of the conductors themselves is to be earthed at one point, a condition which would upset the balance of both of Prof. FORBES' diagrams in his Fig. 4. When it comes to the laying of the underground cables, moreover, the cost of insulation and the effect of capacity complicate the problem, and there is also the advisability or otherwise of a common return on a two-phase system to be considered. It is a pity that those who could speak from experience on these and similar matters were silent or not present at the Institution the other evening; and failing that, it was to be regretted that none of those present who had had the opportunity of viewing two or three-phase plants, and discussing their features with the designers, were able to add something to the discussion of pros and cons. That Mr. HAMMOND had travelled a considerable distance on the Continent in a week, and found that continental engineers "plumped for three-phase" was interesting, but if in his travels Mr. HAMMOND discovered the reason for the latter fact he did not disclose it.

Probably remembering that the meeting hall of the Institution was "not a class room," Prof. FORBES did not trouble to be accurate with regard to the employment of aluminium for underground cables. The increase in the cost of insulation on a cable varies approximately with the diameter in the case of thick cables with the small radial thickness of insulation suitable for comparatively low pressures, but, for the general case, it varies more nearly with the expression $(da + a^2)$, where d is the diameter of the conductor and a the dielectric thickness. For high pressures the second term in the expression may be more important than the first, so that a point may be reached when aluminium is economical for underground mains.

It remains to mention one important—in fact, the most important—feature in the discussion, namely, the expressions of opinion, notably by Mr. FERRANTI and Prof. S. P. THOMPSON on the attitude that electrical engineers should take up with regard to the power bills now before Parliament. We entered fully into this aspect of these power bills in our last two issues, and it is greatly to be regretted that several of the local authorities opposing the bills should be supported by electrical engineers connected with the Institution of Electrical Engineers, and, at the same time, men more or less prominent in their profession. We quote Mr. FERRANTI: "There ought to be sufficient patriotism, honour, and good feeling in this country among a great profession like ours to fight for that profession and for the advancement of science in this country."

A CENTURY OF CHEMISTRY AT THE ROYAL INSTITUTION.

(*Continued from page 96.*)

LECTURE III.

The third lecture of this course was delivered by Prof. Dewar, F.R.S., on Thursday, May 10, at the Royal Institution. He concluded his account of the important work which Davy carried out while still at the Royal Institution by references to his investigations on the nature of the diamond, and his experimental proof that it was merely a form of carbon, showing that the CO_2 produced by its combustion contained no trace of any other substance. The lecturer proved the same result in a different manner. A small diamond was strongly heated in a blowpipe flame, and when red-hot was dropped into a bath of liquid air, when solid carbonic acid was formed. Another important investigation of Davy's, carried out in consequence of his being consulted by the Admiralty, led to his advising that the copper sheathing of ships, which ordinarily underwent very rapid corrosion, should have applied to them small areas of another metal (Zn), which would be more rapidly attacked than the copper. While this remedy was effectual in preserving the copper sheaths, it was found that the bottoms of the ships became fouler than before, owing to the fact that the clean copper surface afforded a valuable situation for the growth of barnacles, shell-fish, &c.

The lecturer next referred briefly to Brande, who was connected with the Institution for over 50 years, and who occupied himself mainly in that branch of chemistry which lies just on the border-land of chemistry and physiology. Coming next to the work of Faraday, Prof. Dewar remarked that while his early chemical investigations were not

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very diffuse, they were remarkable for the experience in manipulation which they gave him, and for the nature and great variety of the subjects investigated by him. He made analyses of the chalks, and also investigated some properties of gases, such as transpiration, occlusion, &c. He examined also some properties of steel, and optical glasses, as a direct result of which investigations he produced palladium steel, and heavy glass. The latter substance has never been excelled as a solid insulating material, and is still extensively used in the laboratory. It is almost perfectly non-hygroscopic, and while ordinary glass very readily discharges an electrometer, "heavy glass" is not able to do so. About this time Faraday, acting with Davy, repeated Oersted's famous experiments on the mutual action of a current and magnet, and it was with the galvanometer which this discovery gave birth to, that Faraday continued the electro-chemical investigations of Davy, proving the relation between the gas formed in a water voltameter and the current acting, and also discovering the laws of electrolysis of metallic-salt solutions. Faraday's experiments proved, directly, that the cations deposited were proportional to the atomic weight of the metal; and Helmholtz, lecturing in the Royal Institution about 20 years ago, asserted that Faraday's experiments proved the atomic nature of electricity. Prof. Dewar observed that the property of electro-chemical equivalence, for the discovery of which we are entirely indebted to Faraday, was now used in defining our standard of current, and also assisted the chemist in checking the value of the atomic weight of any substance, found by some other method, although for chemical reasons it was not generally applicable.

Faraday also made experiments to discover whether there were any limits to the evaporation of liquids. He found that a surface of mercury, contained in a space which was cooled down to the lowest temperature then attainable, evaporated sufficiently to amalgamate a gold leaf suspended above it. For these experiments Faraday increased his vacuum by a method previously employed by Davy, viz., to cool intensely the vacuum space by such cooling agents as were then known. The effectiveness of this treatment in procuring the desired result was illustrated by Prof. Dewar by immersing a Geissler tube in liquid air, and passing an electric discharge through it, the changes in the nature of the discharge as the temperature is being lowered pointing to the high vacuum which this method will give. The lecture concluded with some remarks on the liquefaction of gases, in which branch of science Faraday was a pioneer.

(*To be concluded.*)

SOFTENED POSITIVE ACCUMULATOR PLATES.

It has often been noticed that, after a certain number of discharges, the active material of a peroxide positive plate becomes soft on the surface, and that this softening gradually extends inwards until it leads to the destruction of the paste. Dr. F. Peters, who was unable to find any explanation of the effect in the literature relating to secondary batteries, has made a number of experiments to determine its cause. From these he has obtained the following results, which he publishes in the *Centralblatt für Accumulatoren und Elementenkunde* in the hope that an exchange of views with other experimenters may lead to a satisfactory solution of the problem. His first experiments were made to ascertain whether the chemical composition of the surface layers of the old plates which had become soft was the same as that of new plates with a healthy surface. Samples were taken from the surface and the middle layers of the plates, and thoroughly washed to free them from sulphuric acid, and it was found that it made no difference to the results obtained whether the washing was done with hot or cold water. The samples were air-dried, and then the amounts of active oxygen and peroxide of lead which they contained were estimated by means of oxalic acid and permanganate of potash. The total amount of lead was determined by dissolving the substance in nitric acid and hydrogen peroxide, any excess of the latter being removed by electrolysis. The small difference which was observed between the amount of active oxygen and peroxide found in the normal plates and that in the softened one may be accidental, especially as the softened electrodes had stood longer without charge before the experiment than the normal ones. On comparing the amount of active oxygen and peroxide in the positive active material in the samples from the middle, with those from the surface, one sees from the following tables that it is approximately the same in the normal substance, but is considerably more in the middle than at the surface in the softened plates.

Soft Plates.

—	Surface washed with cold water.	Surface washed with hot water.	Middle.
1. Percentage of active oxygen	2·99 (Mean of 3 best.)	3·03 (Mean of 3 best.)	4·53 (Mean of 3 best.)
2. Percentage of lead peroxide (determined directly)	44·63 (Mean of 3 best.)	45·33 (Mean of 3 best.)	67·69 (Mean of 3 best.)
3. Percentage of lead peroxide (calculated from 4 and 5)	44·26	...	67·23
4. Percentage of lead oxide corresponding to the whole lead mass (including that present as peroxide	81·14 (Mean of 2 best.)	...	87·48 Mean of 2 best.)
5. Percentage of lead oxide corresponding to the quantity of lead present in the active mass as lead oxide	39·81 (Mean of 3 best.)	...	24·75 (Mean of 3 best.)
6. Percentage loss of oxygen and water on ignition	3·60 (Mean of 3 best.)	3·54	5·26 (Mean of 3 best.)
7. Percentage of water (calculated from 6 and 1)	0·61	0·51	0·73

Normal Plates.

1. Percentage of active oxygen	3·34 (Mean of 3 best.)	3·10 (Mean of 3 best.)	3·39 (Mean of 3 best.)
2. Percentage of lead peroxide (determined directly	48·04 (Mean of 3 best.)	47·59 (Mean of 3 best.)	53·67 (Mean of 3 best.)
3. Percentage of lead peroxide (calculated from 4 and 5)	48·75	...	53·65
4. Percentage of lead oxide corresponding to the whole mass (including that present as peroxide)	93·05	...	93·94
5. Percentage of lead oxide corresponding to the quantity of lead present in the active mass as lead oxide	47·57 (Mean of 3 best.)	49·73	43·88 (Mean of 3 best.)
6. Percentage loss of oxygen and water on ignition	4·19 (Mean of 3 best.)	4·18	4·61 (Mean of 2 best.)
7. Percentage of water (calculated from 6 and 1)	0·85	1·08	1·02

These differences cannot be ascribed to unequal formation, as this was the same for both sets of plates. The formation of the lead peroxide goes on at the same rate at the middle of the plate as it does on its surface, because in the former position the conducting supports of the plate are nearer together, while, in the case of the plates which become softened the loosening of the filling material has taken place owing to the constantly repeated expansion and contraction caused by charge and discharge. In the middle the loosened particles are kept in good contact with the supports by the layer of active material above them, and, owing to the greater porosity of the material, the transformation of a greater quantity of lead into lead peroxide becomes possible. But the particles of the surface layers which were first acted on become loosened from each other and from the supports, an action which is accelerated by the bubbles of oxygen formed. In consequence of this want of contact the conversion of lead into peroxide does not proceed as rapidly on the surface as in the inner layers of the plate, and as the loosened portions of the paste are more easily saturated by the acid they form a soft mass on the surface of the plate, and as fresh layers of the plate become softened the action penetrates deeper until the whole is softened.

If this explanation is correct, it ought to be possible to restore a plate with softened surface to its original hard condition, and experiments show that this can be done by discharging the plate and charging it up again in the reverse direction, which causes it to contract, thus restoring the contact between the particles of the plate and the supports, while the plate remains porous. A small portion of the surface material falls off in this process; but on again reversing the current and charging the plates in the original direction, the expansion of the particles fills up the pores left between them, so that the firmness and coherence of the active material is restored.

An experiment was made to ascertain if the discharge of the normal hard positive plate took place as readily as that of the softened one. Two cells were taken, similar in all respects except that one contained a softened, and the other a hard positive plate. The electrolyte consisted of sulphuric acid, 24°B., and they were both charged up for 12 hours with a current of 2·5 amperes before commencement of the actual experiment. The initial E.M.F. of the

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cell with the softened plate was 2·06 volts, and it yielded 17·2 ampere hours, whilst its potential difference fell from 2·002 volts to 0 volt, and it took 14·5 ampere hours for the potential difference to fall to 1·8 volts. The cell with the normal hard positive plate showed an E.M.F. of 2·043 volts and it gave a discharge of 20·8 ampere hours, whilst the potential difference fell from 2·000 volts to zero; but the potential difference of 1·8 volts was reached in 13·5 ampere hours, so that although the total capacity of cell was greater by 3·6 ampere hours, or 21 per cent., its useful capacity was 1 ampere hour less. But after the potential difference had fallen to 1·8 volts, its fall was much more rapid in the case of the softened plate than in that of the hard plate, because during discharge the contact between the active material and the supports was improving in the case of the softened plates.

The resistance of the active material on the two plates was found to be practically identical, the method employed being to wash the active material, dry it, and then compress it under equal pressure into columns of the same height in glass tubes of equal diameter.

CORRESPONDENCE.

HIGH VOLTAGE TRANSMISSION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the report of Prof. Forbes' paper on Long Distance Transmission, printed in *The Electrician* of May 4, the following paragraph occurs in reference to the Paderno plant (p. 50): "The only other plant in the world which can be compared in this feature (*i.e.*, high generated pressure) with Paderno is the transmission by the General Electric Co., U.S.A., from Mechanicsville to Schenectady, where both generator and motor are used at 10,000 volts without the intervention of any transformer."

Prof. Forbes must surely have overlooked the 20,000 H.P. Chambly-Montreal plant. The generators at Chambly are 2,000 kw., two-phase S.K.C. inductor machines, producing a pressure across each independent phase of 12,000 volts.

The writer was employed by the Royal Electric Co., of Montreal, by whom they were built, on much of the testing of these machines, and has therefore a fairly intimate knowledge of them.—Yours, &c., C. H. DOUGLAS.

Hargrave Vicarage, Chester, May 10.

EXTENDED POLE-PIECES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Under the title of "Johnson-Lundell Electric Traction Plant" (*The Electrician*, Vol. XLIV., p. 922), is given a description of a Lundell generator, the supposed novel feature of which consists in extending the field pole in the direction of revolution, so as to throw the gap between two consecutive field poles forward, instead of having it, as usual, midway between the field poles, and the field poles are also given slots which virtually divide the poles into two.

I would call attention to the fact that the extension of the field poles forward in the direction of revolution in generators is very old, as is evident by an inspection of the United States patent to E. J. Houston and E. Thomson, entitled "Dynamo Electric Machines," No. 219,157, and dated Sept. 2, 1879. There is also a corresponding British patent, the number and date of which I do not have at present for reference.

The expedient of dividing the field poles by slots, so as to make one or more sections of the field pole, is also quite old, as those who are familiar with the development of the art must know. Moreover, it is an expedient of very doubtful utility. I do not think it has any other effect than to increase the general reluctance of the field pole.—Yours, &c.,

Lynn, Mass., May 1. ELIHU THOMSON.

Verband Deutscher Elektrotechniker.—The annual meeting of this association will take place at Kiel from June 17th to 20th, and on this occasion it has been decided to add to the attractions a small exhibition of electrical novelties chiefly of interest in naval circles. A local committee has been formed for this purpose, with Herr Sartori as president.

LEGAL INTELLIGENCE.

Chamberlain and Hookham v. the Corporation of Bradford.

The first two days' hearing of this case were reported in our last issue, pp. 99 to 104, and abstracts of the important patents and articles referred to were also given. On Thursday, last week, the case was continued, when

Mr. JAMES SWINBURNE, cross-examined by Mr. CRIPPS, said the plaintiffs' machine consisted of two parts, the motor and the brake. He thought that, as to the motor, the substantial difficulty at the time was practically the question of friction.

Now, as regards getting rid of friction, do you suggest that defendants took anything from the plaintiffs' specification?—No, I think defendants got round the difficulty in another way.

Cross-examined as to the brake, WITNESS said the magnets must be constant. Constancy could be retained in a magnet in different ways. It could be obtained, if you used proper steel, by artificial ageing, and that was known before Mr. Hookham's specification.

Therefore, if anyone obtained constancy in a magnet by artificial ageing that would not be infringement or interference with plaintiffs' specification?—No, I think not.

Now I think the other point with regard to the magnet was to get it strong?—Yes.

Supposing you had a magnet made constant by artificial ageing and used two or three weaker magnets instead of one powerful magnet, would you say that would be interference with the plaintiffs' specification?—That would be a question of degree.

He was aware that the defendants formerly used three magnets and now used two. He thought that after the plaintiff brought out his specification any other person would, in future, be prevented from using a strong constant magnet on the disc brake of the meter.

So fas as power is concerned, do you really say that after the plaintiffs' specification no one is to use the common form of horse-shoe magnet?—Well, it is very difficult to say. There is a distinction between knowing how to do a thing and knowing how to do it without infringing.

I will put aside the question of artificial ageing for the present. Do you say that magnets of the ordinary horse-shoe kind are not to be used after the plaintiffs' specification?—That is a very broad question. Magnets like that had been used before the plaintiffs' specification, but not used on a meter. The question of ageing might be hypothetical.

Do you say that no one could use a magnet of that form and shape after the plaintiffs' specification for any purpose?—Of course it could be used for some purposes.

It was a known form of magnet?—Yes, there were lots and lots of magnets used with the 70 rule.

In reply to a question put by his lordship the previous day, WITNESS handed up the Electric Lighting Act, which he pointed out laid down that the variation of pressure in any consumer's terminal should not exceed 4 per cent. from the declared constant pressure.

In further cross-examination, WITNESS said the ageing of magnets to produce constancy was well known. In a report on Hookham's meter, made about 1892, he said, talking of the magnets, that "the field is made up of a bundle of bars of steel of a special character, properly hardened, with cast-iron pole pieces"—that was an accurate description of Hookham's magnets.

That would not be in any sense a description of the magnets which defendants use?—No; they now use cast-iron pole pieces.

Nor is there a bundle of bars of steel of a special character?—No, I believe there is a bar only.

Mr. FLETCHER MOULTON pointed out that the meter upon which the report was made could not be the one in the specification.

WITNESS said where the magnetic circuit was closed you had constancy and permanency, and the nearer you got to that, the smaller the extent to which you had broken the circuit, the greater would be the permanency and constancy. In Siemens' energy measurer* there was a brake by a fan revolving in a liquid. As regards the motor, Siemens' and Hookham's systems were practically the same. Marcel Deprez suggested the use of a copper disc revolving between the limits of a permanent magnet.

Mr. CRIPPS: All that defendants have done in modification of Siemens is to attach a copper disc revolving between the limbs of a permanent magnet?—Yes.

And the law of it, I think, was correctly stated below?—Yes.

Do you say, after that statement by Marcel Deprez, that the defendants ought to be prevented, in connection with a meter like Siemens', from introducing a copper disc revolving between the limbs of a permanent magnet?—It depends on whether you use Hookham's invention in so doing.

What is there to prevent the defendants from taking what Siemens and Deprez tells them in the year 1884?—Nothing.

Mr. Justice FARWELL: For my information tell me if you had had that put before you in 1884 could you have made a meter?—I do not know that I could have made a satisfactory thing. I might have gone in that direction, and might have discovered how to make a permanent magnet. The result of following those directions would be that you would have a thing with insufficient brake power.

Why? You can get a constant magnet by artifically ageing it. Do you mean to say there would be any objection to putting on three or four magnets if one was not strong enough?—No, I think you could put on a good many magnets, but I doubt if you could get on enough unless you knew how to make this special magnet.

Do you say defendant's magnet is aged or made according to anything in Hookham's specification?—No, I conclude from its working so efficiently that it is made from Hookham's specification.

* *See* p. 103 of the last issue of *The Electrician*.

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Mr. CRIPPS: Your Lordship will hear evidence on that point.

In further cross-examination WITNESS said Deprez's references on this point were to his magnetic-speed indicator.* Abel's magnet and the defendants' magnet were practically the same shape. If four of Abel's magnets were attached side by side it would be practically the same thing; there might, perhaps, be a little more permanency and power in Abel's.

An instrument was handed to Witness which was described as following Siemens for the motor, with a copper disc for the brake according to M. Deprez, and a form of magnet found in Deprez's figure of a speed indicator. WITNESS said he had little doubt it would work perfectly as an energy meter; how accurate it would be, and how long it would work accurately, he did not know.

I put it to you, supposing we follow what was pointed out by Siemens and Deprez years before Hookman, you do not suggest that we are not entitled to do that?—That is a matter of law.

Mr. Justice FARWELL: Is there any practical reason why an instrument made according to their anterior suggestions should not work?

Mr. CRIPPS: It does work.

Mr. Justice FARWELL: That he does not know.

WITNESS: This, I think, would certainly work as a meter now. Whether the magnet would be permanent I do not know without trial. If this meter had been brought out in 1887 I think you could have sold it.

Mr. CRIPPS: But the question of constancy or permanency is dealt with by ageing the magnets. Supposing you found one aged magnet was not sufficient, why not put on two or three?—If you put six aged magnets on, I should think it was quite possible it would work commercially. If a magnet was going to change it generally developed rapidly.

An ammeter of Ayrton and Perry's was handed up, which was stated to have been constructed about 18 years. In a measuring instrument for amperes, the WITNESS agreed they had in this exhibit what was a constant magnet in the right sense, and it had not varied for 18 years.

You can hardly get a more apt illustration of prior user as regards what either plaintiffs or defendants had done?—As regards constancy it is very good.

As regards power, if one magnet is not sufficient, why not put on four?—You can use as many as you like.

The WITNESS did not agree that a constant field produced according to Hookham's specification could not be used in connection with the measuring of alternating currents. It would not, however, be a good practical arrangement, and, so far as he knew, had not ever been done.

Questioned as to Handford's specification,† WITNESS stated that they had there described a constant field produced by permanent steel magnets. In Handford's patent one got a motor working in a constant field. The method of producing a constant field by saturation was known before plaintiffs' patent. It was known in measuring instruments, and was shown by Weston.

Re-examined by Mr. MOULTON: There were many thousands of specifications relating to electrical measuring instruments before 1887, and there were many thousands of papers relating to magnets and magnetism before that date. When one knew how to do a thing it was not difficult to look up literature and pick here and there and put things together to show how to make it, but in many cases to do that thoroughly was difficult. At that time there were hundreds of forms of magnets used. He (witness) thought you could get any form of magnet you wanted. Since the plaintiffs' specification it was known that power and permanence were not naturally exclusive. He thought that a permanent magnet such as Mr. Hookham referred to was perfectly constant and very powerful. In instruments that existed before the date of this specification constancy was sufficient without power, and power without constancy. There was nothing he could think of before the date of this specification which communicated the union of the two. In the case of a meter, if you did not have constancy it failed of its purpose. Strength was important for accuracy in a meter. Meters had very peculiar requirements.

Prior to the Hookham specification, do you know of anything which published to the world the way to get permanent magnets constant and strong?—No, I think the electrical world is indebted to Mr. Hookham for the way to make strong permanent magnets. This was one of the things wanted in order to make practical this type of meter, which was then theoretically known. There was nothing in the d'Arsonval galvanometer which would tell the world how to make an effective meter. Too much strength was a disadvantage there, and quite weak magnets were used.

Questioned as to a specification of Siemens, he said that Siemens was trying to obtain magneto-currents for telegraphic work, and constancy was not in the least necessary for that purpose. In Siemens' instrument the paraffin or liquid was intended to fill the whole apparatus. That would not be a practical or accurate measuring instrument. Viscosity of the liquid would vary with temperature. M. Deprez did not convert Siemens to his brake. Prior to Hookham, he found no suggestion that his type of magnet should be selected for the purposes of a magnetic drag. Weston was a well-known electrician, who devoted a great deal of attention to measuring instruments. His meter, so styled, was a wholly impractical instrument. In Abel, the active part consisted of two little pole-pieces embracing the mercury. In Jamin, again, the active part was the ends, not the sides. A practical meter must start, if possible, with one lamp. In order to improve the speed indicator Deprez gave a suggestion that would make it impracticable for the use of a meter. Plaintiffs' meter was mainly described in the specification for direct currents, but it was indicated that it could be used for alternating purposes. Defendants' meter would also work with alternating currents. The principle of Hookham's meter was that it was made on the straight-line law with a brake following the straight-line law. Weston's (No. 2) meter would not measure anything. As to the commutator, if constructed as Hookham described it, it was an instrument for accurate work.

Mr. DUGALD CLERK, examined by Mr. A. J. WALTER, said he was of opinion that Mr. Hookham's invention was the first practical meter which showed a simple mode of motor and a simple mode of brake. That was to say, a motor in which the twisting power was proportional to the current, and in which the resistance of the brake was proportional to the speed of rotation of the brake. He found for the first time a magnetic brake working in such a way as to give a powerful field as well as a constant field. In obtaining a practical meter to start with one lamp, it was necessary to have a strong field. That was pointed out by Hookham in his specification. The constancy of the brake was also important, and that the brake should have a long range. He had visited Bradford and, in company with the chief engineer to the Bradford Corporation, examined the system of electrical distribution.

What practically is the condition of the potential in the mains at Bradford?—They work at 230 volts nominal potential in the main, and the variation, from what I saw, does not exceed 2 per cent. I also examined the meter used in the Bradford circuits.

Is there in that meter any device for the purpose of starting the meter?—Yes, there is a separate small coil.

Is that the device pointed out in Hookham's specification—the winding round the magnets or armature for the purpose of starting?—Yes.

He had read through all the specifications introduced into the case, none of which, in his opinion, disclosed to the world the inventions contained in Hookham's specification. Siemens' suggestions for a motor-meter contained no provisions for eliminating the friction. M. Deprez had found no indication of the importance of (1) a powerful field, (2) a constant field for the brake, (3) a strong field for the brake, (4) provisions against friction.

Are those conditions which you do not find in Deprez's Paper of importance or not in the construction of a practical meter?—Of great importance.

In respect of claim 3 of the plaintiffs' specification, WITNESS found an infringement in the use of large pole pieces closely approaching each other.

In your view of the plaintiffs' specification, looking at it as an engineer, do you see any emphasis placed on independent pole pieces?—The "poles" described in the specification were additional poles, and were shown in the drawings as additional poles, but in that there was no limitation as to the poles being attached separately. This was a simple and convenient method of making them.

Cross-examined by Mr. GRAHAM: Ayrton and Perry failed in showing any practical details to enable any person to make an electricity meter. One of the great advantages of Hookham's specification was making the frictional force very small compared with other forces. Everybody agreed that that was what was wanted, but none of them could do it. Hookham did it by making a very powerful magnet and a very powerful brake, and thus reduced his friction. A powerful brake diminished the friction. Hookham made his magnet powerful, he supposed, by sending a large discharge round the wires which magnetised his magnets. There was nothing new in that. It was well known how to make a magnet powerful. Hookham obtained constancy by having large pole pieces closely fronting each other, and by this method of large pole pieces and close fronting he completed his magnetic circuit and kept it constant.

Had that not been pointed out before the date of Hookham's patent?—Not that I am aware of.

Mr. WALTER then read the *verbatim* report of the judgment of Mr. Justice Wills in the action tried in the Queen's Bench Division—Chamberlain and Hookham *v.* Johnson and Phillips—delivered some three years ago,* when the learned judge upheld the validity of the plaintiffs' patent.

That closed the plaintiffs' case.

In opening the case for the defendants:—

Mr. CRIPPS said there were one or two points it was desirable he should deal with at this stage. As regarded the judgment of Mr. Justice Wills, just read, there the conditions and circumstances were entirely different from those in this case, and the specific issues raised in that action were totally distinct from the issues raised in this action. Although it might be necessary in a certain event hereafter to raise the question of validity of plaintiffs' patent by reason of anticipation, he could not now ask his Lordship to disagree with Mr. Justice Wills's finding. But when new anticipations were put before his Lordship which were not before Mr. Justice Wills that was not entirely a question of construction, but a new issue, with which his Lordship could deal. It was impossible to patent a principle in English law. It was undoubtedly law that if anyone took those same old principles and placed them in a different way and produced a different result he was not infringing, and that was the defendants' case. The merit of the defendants' machine, and the use made of it, was that it measured energy. He could not see the weight of Mr. Moulton's argument upon that part of the case. You had to compare machine with machine, and if anyone liked to use a particular machine under conditions in which one of the factors was the same, that did not matter. Defendants' machine was a machine which measured energy. It was a machine which was different in its results, and was arrived at by an entirely different combination to what was found in the plaintiffs' specification. Defendants' combination was absolutely different and distinct from the plaintiffs', and aimed at a different object. Mr. Swinburne had said that the merit of the invention was so far as it got rid of friction in the motor part of the invention. Ayrton and Perry, in their energy meter, did not manage to get rid of friction, and so did not arrive at practical results, whereas Chamberlain and Hookham did. Mr. Hookham had explained that defendants used not one of those methods adopted by the plaintiffs. In Hookham's machine were a constant field and particular methods of getting rid of friction. Up to this point, he submitted, there could be no

* *La Lumière Electrique*, Vol. III. (1881), pp. 407 and 408.

† *See* p. 103 of the last issue of *The Electrician*.

* See *The Electrician*, Vol. XXXVIII p. 839.

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infringement. So far as defendants were concerned, a constant field was destructive. Another point remained—that of the brake, which had to be constant and effective. The two methods to which Chamberlain and Hookham directed attention were constancy and power. They described a particular form of magnetic application of a magnet to a brake which was not suggested to be new. What was new was the particular way in which plaintiffs arrived at a magnet which was constant and effective. That was only one part of the combination; but what the defendants did was not in contradiction of any claim made by Chamberlain and Hookham's specification at all. What defendants did was this: they got a magnet made in steel of a special form, and then artificially aged it in order to make it constant. That was common knowledge at the time, and there was nothing about it in Chamberlain and Hookham. This process of artificially ageing the magnet reduced its power by something like 15 per cent. So far there was no suggestion of contravention of plaintiffs' claims. It was said by plaintiffs that they showed the way of making magnets both constant and powerful. What was the answer to that? Defendants' magnet followed the horse-shoe form familiar to any schoolboy, somewhat modified no doubt. As regards strength and separation of the poles it was merely a matter of degree. They made it permanent by artificially ageing it. It was said that there was difficulty in getting a magnet both powerful and constant. That would not, in fact, be a difficulty as regards the defendants. For power, at one time they had used three magnets; now they used two. The form of their magnet entirely differed from plaintiffs'. It was obvious that so far as the magnet was concerned there could in no sense be said to be infringement, because supposing they took the poles a little nearer, or used five or six magnets to get the proper power, it was only a question of degree. In the same way it was well known that you could apply a permanent magnet to a copper disc in order to get brake power. It could not be claimed by Chamberlain and Hookham that they invented this. Although there was a mention of alternating currents by plaintiffs, there was no suggestion of applying the Hookham meter to alternating currents. No less a proportion than 90 per cent. of defendants' meters were used for alternating currents. Defendants' meter was the practical meter of everyday life, in use all over the world, and there were thousands of them in use in England. In the Hookham specification there were no directions or description whatever to enable alternating currents to be produced. There were 1,000,000 of the Thomson meters in use, and 90 per cent. of them had been applied to alternating currents. Therefore, upon that no question could arise regarding alternating currents whatever else his lordship might think the defendants had infringed. Nor was there any question that the defendants had infringed the plaintiff's armature. The next point was with regard to the commutator. So far as that was concerned, the defendants used a system absolutely distinct from what was suggested in Chamberlain and Hookham's patent. That patent said, "to avoid the friction of a brush." Now, the defendants used a brush, and got rid of the friction in an entirely different way from Chamberlain and Hookham. In plaintiffs' meter there were the mercury cisterns. In defendants' there was the silver. In the one there was the vertical arrangement, in the other the horizontal. Both got rid of the friction. In his evidence. Mr. Hookham himself admitted that defendants' commutator was materially different from his own. In fact, defendants' solution of the difficulty of friction was absolutely different from the description in the specification of Hookham's patent. The defendants did not employ mercury in any way. With regard to the point of constancy and power, what was charged against the defendants was that plaintiffs in their combination did use a magnet for braking purposes which was both constant and powerful, and the merit, or the claimed merit, of it was in the combination of constancy and power. Constancy could, of course, be obtained by ageing. So far as power was concerned. The greater the power you had on the magnet the slower were the revolutions of your meter. The advantage of that was in altering the measuring power of your instrument. In the one case the meter revolved more quickly than in the other, and wore out more quickly. There was no principle involved in that. It was merely a question of degree.

His LORDSHIP said he thought Mr. Swinburne said that, before Hookham, constancy and power were mutually distracting, and were co-existent.

Mr. CRIPPS said he thought that the effect of Mr. Swinburne's evidence was that constancy and power were well known in every sense, and what Mr. Hookham really did—he must be given every credit for this—was to invent, according to Mr. Justice Wills, a form of permanent magnet. Mr. Justice Wills, however, had never found that every magnet which happened to have constancy—of course, every magnet had some, as ageing was well known—was an infringement of what the plaintiffs did. It was only a question of degree. The defendants had constancy, and small power was sufficient for them. He supposed you could not have a magnet without power, and a magnet which must have power must have constancy. What Mr. Hookham did was to describe a particular form of magnet in which he had both constancy and power. It would really be incredible and impossible to say that no constant magnet was to be used by anyone except Mr. Hookham, because every magnet had some power.

His LORDSHIP: You say the idea of combining constancy and power was not patentable. You say you use an entirely different kind of magnet, and that you are entitled to do so.

Mr. CRIPPS agreed. He contended that plaintiffs were in a peculiarly weak position as inventors. All the principles were thoroughly ascertained and known, and the most they could claim was the particular form of application. Bearing in mind what he had said that power here was only a matter of degree whether the brake spun a little faster or a little slower, they got just the same recording instrument by either one or the other. Then Mr. Hookham said in his specification that for small installations he "preferred" a number of small magnets—bar magnets substituted for the large magnets in the drawing. There they had Mr. Hookham saying—very properly—that in place of electro-magnets he "preferred" a particular form of magnet, that form being a number of bars with artificial iron holdings. When that was done—that was to say, after this arrangement of bars and poles had been built up, the permanent magnet was practically constant. But that was not the essence of Hookham's invention at all, but merely a direction of a preferable way of carrying it out. The claim in the plaintiffs' specification was first, "An electricity meter for measuring currents, consisting of an electro-motor with constant field, arranged substantially as hereinbefore described and illustrated in the accompanying drawings, the said electro-motor being combined with an electric brake also moving in a constant or nearly constant field, preferably the same field as that in which the armature rotates substantially as herein described." Now, that was quite distinct from the defendants' meter, which was a meter for measuring energy, and which was absolutely distinct as a machine, and also distinct as to all the mechanical agencies employed. The plaintiffs' claim said, "An electro-motor with constant field." The defendants did not do that; it would be absolutely destructive to them. And then the plaintiff said, "Arranged as hereinbefore described." Well, but the defendants' whole arrangement was absolutely distinct in every feature from the plaintiffs so far as the motor was concerned. It was quite clear to his (Mr. Cripps') mind with regard to this first claim that there was no infringement. The defendants' arrangement was a different arrangement, applied differently, and for a different object. Then the third claim which was relied upon was this:—"In electricity meters, the use for the purpose of procuring a powerful and constant magnetic field of permanent magnets arranged as described, with very large polar surfaces closely fronting each other, so as to form a narrow slit, in which the disc armature revolves whether the same be magnetised in position or otherwise, and the means described for regulating the same when or if necessary, substantially as herein described and in part illustrated in the accompanying drawings." Mr. Moulton had carefully confined himself to only reading that claim, without making any comment upon it. That claim, however, did not carry the matter any further than the first claim, and everything therefore turned upon the first. The others were subsidiary incidents of the first. As to the disc armature, the defendants were outside that. The claim was for a disc armature—a powerful and constant magnetic field for the disc armature of the meter. In defendants' machine a disc armature was not the motor, and there was no constant field at all. So they came to the magnet point, which seemed to him to be the litigious point between the parties. On that point material evidence had been given in this court which had not been before Mr. Justice Wills at all, and he (Mr. Cripps) thought the evidence here given was absolutely conclusive on the point of infringement. Mr. Justice Wills found that the plaintiffs' specification contained all the theory on which Mr. Hookham based his invention, and that it had not been done before. But here, in this case, the defendants had shown that it had not only been previously disclosed in principle, but had been practically carried out before Hookham's specification appeared at all. If he (Mr. Cripps) could point out that what Hookham did by his patent had both in theory and practice, been previously disclosed, then what became of the suggested invention? It was clear that Marcel Deprez knew the theory. So far as the brake was concerned it was nothing but a question of degree. It merely meant whether the copper plate ran slower or faster. Those which ran the quicker wore out the quicker. Learned counsel submitted that these things were well known, and that the defendants were entitled to take advantage of public knowledge. He next referred to the magnet, which he said defendants had induced Prof. Ayrton to take out of an ampere-measuring meter made 18 years ago. This magnet he said had been in use for 18 years—long before Chamberlain and Hookham's specification—and had been perfectly constant for 18 years. As regards strength, it was, as he was informed, a great deal stronger than the magnet which defendants used. Prof. Ayrton had tested that magnet, which had been in use for 18 years, and found it was constant and more powerful than the magnet which defendants used. The answer therefore was, that there was no question of theory. Could it then be said that it was infringement for defendants to use a magnet of that constancy and power? Constancy could be obtained by a well-known method, and as regards the combination of constancy and power it was merely a question of degree. He would not trouble his Lordship with Ayrton and Perry's specification, because it was admitted on all hands that they disclosed the whole theory. He must take Mr. Justice Wills' judgment that they did not go beyond the whole theory. The difficulty Ayrton and Perry had to contend with was the friction theory. The learned counsel next referred to Abel's specification of 1884. He said that there was really no difference, in form between the magnet there and the one used by the defendants, as Mr. Swinburne had said if three or four of those magnets had been put side by side they got the defendants' exactly. There was also claim 5, which was—"The construction and arrangement of parts forming a commutator, making contact by means of mercury placed in insulated vessels, the axis of revolution of the commutator being vertical, substantially as hereinbefore described." He would not dwell on that now, but he mentioned it because it was a point that might be raised hereafter on the question of validity. But to sum up his argument, he would say this. He would not say it was admitted, but there was no serious dispute that the defendants' machine or combination was quite distinct from that of the plaintiffs'. It was for energy in one case and for current in the other. It was admitted also—or not seriously disputed—that the claim of the plaintiffs was entirely based on a law known at the time, and was for a combination carrying out what was then a well-known law. So far, again, as motor power was concerned, the machines were distinct. The real difficulty felt at the time was as to friction; and, so far as mechanical means for getting rid of the difficulty of friction was concerned those of defendants were entirely different from those of plaintiffs, and the

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theory of getting rid of it had been disclosed in an article published before the date of the plaintiffs' patent. As to the brake, the only matter claimed by Mr. Hookham was constancy and power, and Mr. Swinburne had told the court that both were matters of degree. So far as constancy was concerned defendants used a method well known before Hookham's; and so far as power was concerned, it did not matter whether one magnet was of a certain power as compared with another. Defendants used a magnet distinct in form and power from that of plaintiffs; defendants used simply the ordinary common form of magnet; and viewing all the facts, he submitted that there was no substantial kind of infringement here at all.

Evidence for the defendants was then taken.

Mr. S. Z. DE FERRANTI, examined by Mr. Cripps, said he was one of the first electricians to deal with the question of meters, his first attempt to make one being in 1882. He succeeded in his attempt at the end of 1883 or beginning of 1884. He then produced a continuous-current meter, and it had been very largely used since then.

It has been suggested that Mr. Hookham first solved the difficulty of measuring currents by meter. Is that so?—No. I saw his specification directly it was printed, and I thought at the time that it described a very inferior instrument to the one I had already produced. That might sound egotistical, but I did think that the patent was a retrogade step.

Continuing, WITNESS said the sale of electrical meters came into commercial use in the latter part of 1886. Very little was done before that date. There was no real commercial demand for electrical meters before 1888. The meter produced (one of Ferranti's) was made in 1884 and shown at work at one of the South Kensington exhibitions on a lighting circuit. It was found in practice that the meter would start with a single candle lamp, and measured up to 20 lamps with very fair accuracy. The business in these meters had rapidly increased, and at the present time there were perhaps 40,000 of these current meters being used in England of that pattern, but not of that particular shape. It was not really until 1888 or 1889 that electric lighting had made any advance in England. The defendants' meter was an energy meter. An energy meter was entirely distinct from a current meter, and was totally different. In a current meter you must have one element constant, viz., the field or armature. In the defendants' meter it was not necessary to have a constant field in connection with the motor. To have constancy in an energy motor would be destructive. He was acquainted with the arrangement of Mr. Hookham's meter with regard to friction. He thought it was a bad arrangement, and did not succeed in getting a low friction. He did not find any similar method of dealing with the friction in defendants' meter. The commutator in plaintiffs' meter was distinct from anything he found in defendants' meter. It was one of the elements which he considered unsatisfactory in plaintiffs' meter, and which was satisfactory and proved to be good in defendants'. Defendants' form of commutator was a very special form. The commutator was a very important factor in producing an effective meter. Before the Chamberlain and Hookham patent it was known how to make a magnet constant. In his view the question of friction was most vital. It was most necessary to get a meter to start readily with a small amount of load upon, and for this you must have low friction. There was nothing new in getting constancy. There were several processes of getting constancy of magnets known as ageing. Ageing reduced the power of the magnet perhaps some 15 per cent. For the purposes of the brake it was necessary, besides constancy, that the magnet should be powerful, so as to prevent the meter running too fast and so wearing itself out. Supposing defendants had a weaker brake to what they used, they would get a measuring instrument which would wear out faster. There was no difference in the principle whatever; it was only a matter of speed. It was a commercial element only, and did not affect the electrical law. He had made himself acquainted with the special form of magnet in the Chamberlain and Hookham machine. In defendants' machine a common form of magnet was used. In defendants' machine one could put in as many of those magnets as were wanted—two or four, or any number necessary to get the best speed for their meter and brakes. It was merely a commercial question. There was no difference between the motor part of Siemens' instrument* and defendants', except that the latter had got the silver commutator. Otherwise it was exactly the same. He had read the Deprez article.* That article, also, stated the general law on the subject with perfect accuracy. There was no difference between what he found described in Siemens' and Deprez's article and defendants' meter. It was at the commencement of the period of running that a meter would lose force; but if he found one going constant for six months then he knew that it had real constancy. He should have had no difficulty in producing an energy meter such as was used by defendants from the descriptions in these articles. Mr. Uppenborn also, in his article, showed that he had a perfectly complete and clear understanding of the whole subject.

Supposing you were dealing with the question of a powerful motor, you obtain it by plaintiffs' specification by means of a strong permanent magnet with a constant field?—Yes, and in defendants' you get it by another way. You get a permanent magnet in a constant field. The motor in defendants' meter is made of two parts—the armature and the field. The field in defendants' is a magnetic field in air and is formed simply by the passage of an electric current. No iron or steel is used in either the field or the armature in defendants' meter. In fact, the two machines are absolutely different things.

When the hearing was resumed on Monday, as Mr. Ferranti had been unavoidably detained, his cross-examination was deferred, and Mr. CRIPPS, for the defence, called

Prof. J. A. EWING, who said he had made himself acquainted with the meter used by defendants and had carefully studied plaintiffs' specification, and could not say that defendants' meter infringed the specification in any way. The specification was for a meter to measure electric currents, and defendants' meter was an energy meter. In order to get a current meter it was necessary to design the arrangements so as to secure a constant field for the motor. The variation was vital and essential. The energy meter could be used for all sorts of purposes. So far as there were special mechanical methods for dealing with the question of friction, defendants' machine was not an infringement of plaintiffs'. There was no resemblance between them. For instance, the commutator in defendants' machine was quite different from that described in plaintiffs' specification. Defendants used a form of commutator which was known for many years before the date of plaintiffs' specification. It was known how to get constancy before that date. Defendants' magnet in no way infringed that described in plaintiffs' specification. It was absolutely different. The use of a permanent magnet to create power was well-known before the date of the specification. After the article which was written by M. Deprez, which was very clear, an electrician with a knowledge of his subject could easily have made such a meter as that used by defendants. The power they wanted on the motors was the driving power, and they wanted a powerful motive power to reduce friction, so as to make the friction a negligible quantity. So far as driving power and motor were concerned, those of defendants' and plaintiffs' were quite distinct. A description given by Faraday of a magnet in his "Experimental Researches in Electricity" might be construed as describing something very similar to the magnet set forth in plaintiffs' specification. In order to get constancy they wanted a magnet which should be as nearly as possible a closed magnetic circuit so as to reduce the loss of power; but there were other conditions equally important. There was nothing in defendants' magnet which was not compatible with what had been known and described prior to plaintiffs' specification. Witness was shown a magnet which had been constant for 18 years, and said that, as compared with it, there was nothing different in plaintiffs' specification. There was a difference in the building up; but the principle was the same, and had been known for some years before. There was no basis for the suggestion that at the time Mr. Hookham made his experiments permanent magnets had been practically abandoned for the purposes for which compensation was required. They were in actual use. In Ayrton and Perry's specification of 1882*, there were described the principles of the law which was contained in Chamberlain and Hookham. It was common knowledge, and there would be then no difficulty in getting a magnet constant and of sufficient power. He had read in plaintiffs' specification the description of what had been called in this case the vertical commutator, but that idea was not novel. Witness was shown two models of earlier instruments than plaintiffs' specification, and said that each had a vertical commutator such as was described in plaintiffs' specification. Taking the words "disc armature," *per se*, in the specification, he, as an electrician, would at once understand that the words meant the armature of the motor. Witness pointed out that in the specification Mr. Hookham said that the armature consisted of so and so, the commutator consisted of so and so, and the brake consisted of so and so.

Cross-examined by Mr. Moulton: Defendants were actual users of their machine. In his specification, plaintiff stipulated for a constant field, or as an alternative an armature of steady power.

By his description in the specification it is plain that plaintiff intended to use the same connections on his magnet as you find in defendants'?—I think that is so.

The specification says that the electromotor might be of any of the ordinary kinds then in use. At that time there were alternating-current motors?—Yes.

And they were made exactly as in Siemens' meter or defendants' meter?—Yes.

Continuing, Prof. EWING said: Defendants' meter measured energy, and never measured anything else but energy. Not one particle of the general principle of defendants' meter was applicable to an alternating-current meter. He could point to many passages in specifications, &c., prior to the Hookham specification for getting constancy and power in permanent magnets. Witness cited Elphinstone and Vincent, Siemens, Faraday, Jamin, Deprez, D'Arsonval, and Ayrton. D'Arsonval's reference was a Paper on electric telephones with concentric poles. It referred to the shape of magnets which were found to give good results in speaking on telephone lines. One pole was in the shape of a ring, with the other pole coming up in the centre, both on the same side of the telephone plate.

How in the world could these instructions tell the world the right way to get a good magnet for your brake?—They showed the form of magnet which gave good results for whatever purposes they were used.

Is there any suggestion here that the magnet was constant or powerful?—Well, it gives good results.

I put it to you that the words "increases the effect" refer to the giving a clearer sound?—That might be so.

May I put it to you, that of all the things least of importance in a telephone, constancy is one?—Of course constancy is not of nearly so much importance in a telephone as in a meter.

Questioned with regard to Jamin's references to Magnets†, WITNESS could not agree that Jamin's work was merely directed to increase the portative power of magnets. Jamin spoke of an instrument in which constancy was important. He could not say whether Faraday, in the passage referred to above in his "Experimental Researches," was talking about bar or horseshoe magnets. He thought the whole of what Faraday said was applicable to magnets of all forms.

Prior to 1887, had you ever seen one of the specifications cited in this case?—Prior to 1887 I was not much interested in specifications, but I certainly had seen some of Marcel Deprez's writings.

Can you say you have seen one of these other publications?—Yes; I have no doubt that I read Faraday. I had certainly seen extracts from Jamin, but I had not read all his papers.

* *See* the last issue of *The Electrician*, p. 103.

* *See* the last issue of *The Electrician*, p. 103.

† *Comptes Rendus*, 1875, Vol. LXXX., pp. 360 and 361.

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I ask you about the actual passages cited here. With the exception of Faraday, can you say you had seen any one of these passages cited in this case?—I cannot at this date specifically refer to any of those passages as having been seen by me before, but I may say this there was nothing contained in those passages I was not acquainted with.

He had not suggested that ageing took out something like 15 per cent. He did not think it ever had the reputation of taking out the larger part of the magnetism. It would all depend upon the kind of steel used.

It does not take more money to make a good magnet than a bad one, if you choose the right form, does it?—Well, the process of ageing is, I think, one of cost—you have to pay more for good than for bad magnet steel. Defendants' was a cheap magnet so far as geometrical form was concerned.

Questioned further, WITNESS said: Abel's instrument was a current indicator. He had never seen an Abel meter. He thought the invention was practically the same as that by M. Lipmann which witness had seen.

Re-examined by Mr. Cripps: The saturation of an electrical magnet was in all cases a question of degree. No electromotor with constant field could be used for measuring alternating currents.

If you wanted a meter for alternating current could you use the same field both for the motor and the brake?—No, it is quite impossible.

Do you know within what range of power defendants use their magnets on different meters?—I am told it varies as much as 50 per cent. I have noticed there are wide variations in the power of the magnets they use.

Further re-examined, WITNESS stated he considered that from the directions given in the Paper of 1884 on "Siemens Energy Meter" any competent workman could have actually made the meter.

Prof. W. E. AYRTON, examined by Mr. Graham, said he had devoted a good deal of attention to the question of the constancy of magnets, which really depended in the first instance, and to a very important degree, on the chemical composition of the steel; secondly, it depended very materially on artificial ageing; lastly, but to a much smaller extent, it depended upon the geometrical form into which the magnet was made. At the date of the Hookham patent he knew how to make, and had made, a constant and powerful magnet. He had studied the manufacture of defendants' magnets in common with Prof. Elihu Thomson, at the General Electric Co.'s works in Lynn, Mass., U.S.A., where they were made in large numbers. The magnets were made out of steel heated to a dull red heat. Then there was a very special form of ageing. They were dipped 26 times successively into boiling water and into cold water, the operation occupying 13 hours. A large number of magnets were hung on a kind of chain arrangement which was kept rotating continuously. That was how the magnets were made constant. Prior to ageing, the magnets were made powerful. Defendants used a very injurious device to magnetise their magnets. It was not the fact that at the date of Hookham's specification, permanent magnets had been abandoned where absolute constancy was required. Mr. Hookham did not teach the world for the first time how to make a powerful and constant magnet. He did not teach the world how to make either a constant magnet or a powerful magnet, or the two combined. He (witness) knew how to do it years before Hookham's specification was lodged.

Referring to the Ayrton and Perry specification of 1882, WITNESS stated that the only thing which prevented them from making a successful commercial meter was their not knowing how to make the armature and brushes with sufficiently small friction. The difficulty of getting a constant and powerful magnet did not stand in their way. He was in Court when Prof. Ewing was examined, and agreed with him that Hookham's specification gave no directions how to make a satisfactory alternating current meter. He did not think that an intelligent workman could have made a successful alternating-current meter after reading Hookham's specification.

Cross-examined by Mr. Moulton, WITNESS said that the plaintiffs' meter consisted of an electric motor with constant field. It was not a sufficient description, in his opinion, to say it consisted of an electric motor and brake.

It has those two parts in it?—Yes; with an addition which is vital—the constant field. Electric motors, both for direct currents and alternating currents were both known. If it were wanted to have an electric motor with alternating currents you must have the alternating current both in your field and in your armature. He hoped every electrician would know that. Supposing you wanted to get an electric meter for alternating current a permanent magnet could not be used. In plaintiffs' meter the mercury commutator did not work. He found, for example, that by putting a little mercury into the clip he changed the reading by 15 per cent. There was no indication on the meter how much mercury to put in.

On Tuesday Prof. AYRTON was further cross-examined by Mr. Walter. WITNESS said that defendants' magnet was reduced in power by two processes, but still it was a strong magnet.

Mr. Justice FARWELL: Is there any definition of "strong" in connection with electricity?—There is no definition of strong. There might be 900 lines or 1,000 lines. They were both powerful. But the term strong was only relative to something else with which it was compared. Defendants' was a magnet which had not a third of the braking force of his (witness's) 16 years old magnet.

Mr. WALTER: You have spoken to this effect—that for the purpose of braking you prefer concentrated poles?—Yes.

Concentration at the expense of magnetism is a disadvantage?—I do not know what you mean by concentration there.

I ask you to assume that concentration can only be attained by the loss of magnetism. The widening of the poles then would be an advantage?—It is not so. Assuming what you state—which I must qualify as not being true—then it would be a mistake to have concentration, because constancy is of great importance; but my own experiments show that you can get concentration and constancy.

With a strong magnet?—Yes

Continuing, WITNESS said Dredge, in his book,* showed how to make a Siemens armature to work with a mercury commutator. The model before him showed how to use the pools of mercury higher in the middle than at their sides.

Re-examined by Mr. Cripps, WITNESS said defendants' magnet was of a form well known to him before the date of plaintiffs' specification. There was no reference in plaintiffs' specification to the use of silver for the purposes of a commutator. Defendants' meter was merely the Siemens meter with the Deprez addition, and with silver used in the commutator, no reference to which appeared in plaintiffs' specification.

Mr. S. Z. DE FERRANTI was then re-called. In answer to Mr. Cripps he said that in plaintiffs' specification the meter described would not work at all with alternating currents. He did not think the thing could have been understood when it was written.

Cross-examined by Mr. Walter, WITNESS said that in 1887 it was not generally known how to make alternating-current motors, but present knowledge showed that, with the then existing descriptions of instruments, they could have made instruments which would have worked with alternating currents.

You have spoken about the constancy of permanent magnets. Before the date of Hookham's specification, what do you say as regards what was known of the constancy of permanent magnets combined with strength? As I gather, what had been done was to expose the magnets to some of the conditions to which they would be exposed in use—such as temperature—until they got down to the condition in which, when in use, normal circumstances would not affect them?—Yes, they were subjected to conditions whereby, when put in practical use, they would not be affected by similar conditions afterwards. The silver brushes were very important, and more durable and certain than copper ones. The meter would work for a short time with copper or brass brushes, however. He allowed that he himself was an inventor, yet he did not say he could have invented Hookham's meter at the time; but, speaking from knowledge common at the time of the specification, the instrument could have been made. The information others had given left nothing to the imagination. Deprez, Uppenborn and others had fully described the theory and how to carry it out in every detail for a commercial meter. There was no suggestion as to making the brushes with silver which, witness considered, added to the life of the meter, but otherwise the knowledge before the specification was sufficient.

Re-examined by Mr. Cripps, WITNESS said that both the theory and practice of the instrument were set forth by Deprez most completely. Siemens would have worked for a long time with copper brushes, but silver was better. It was a refinement of practice. Plaintiffs' commutator was intended to be an improvement in practice, but it had not proved so. Witness would not measure alternating currents by an arrangement consisting of an electro-motor with constant field. The arrangement in the specification was, in his opinion, entirely wrong. The difficulty of the Hookham meter as an alternating current meter was that the magnet proposed did not vary at the same time as the current in the armature. This was quite a complex electrical matter to anybody but a technical person, but if anybody tried to construct an alternating current meter on the lines shown by Mr. Hookham he would get something which was utterly and hopelessly wrong.

Prof. SILVANUS P. THOMPSON was then examined by Mr. Bousfield as to the construction of a meter according to the plaintiffs' specification, and answered a few questions put by Mr. Walter in cross-examination.

This closed the evidence in the case, and Mr. BOUSFIELD addressed the Court on behalf of the defendants. He first recalled the fundamental difference between a current meter and an energy meter, and then said that the difference between this case and that before Mr. Justice Wills† was this. In the case before Mr. Justice Wills defendants had the current meter. They had a meter with a permanent electro-magnet built up with pole pieces at the ends; and the armature was of the plate type, so that they had the arrangement which Hookham had described in his specification as using a disc or cup at once as a motor and a brake. They had, therefore, absolutely the identical elements which made a current meter—a constant field with an armature developing force proportional to the current The defendants had not in that case the Siemens meter. They had infringed with a current meter. But in the present case the defendants had an energy meter identical with Siemens. The substantial points which differentiated the two instruments were these. In the plaintiffs' they had first a constant field; next, special arrangements for minimising friction; and third, strong power in order to reduce friction. Every witness, he thought, agreed that the difficulty of overcoming friction was the real practical difficulty at the time. Hookham made his driving-force very large and the friction consequently very small. In defendants' meter, so far from having constant field, theirs was a field one component of which varied with the current, and the other component varied with the electromotive force; and their method of reducing friction was now very different from that of the plaintiffs'. Mr. Justice Wills had treated permanent magnets in the case before him as if they were not an essential of the first claim, which only dealt with the constant field.

Mr. Justice FARWELL: Mr. Moulton puts it forward that what you have done is a breach of claims 1 and 3, and Mr. Justice Wills said it was a combination of all the elements.

Mr. BOUSFIELD thought that Mr. Justice Wills did not mean that. When he said it was a combination, he was referring to the combination in the first claim, and he went on to say that he had come to the conclusion that there was substantial identity—in other words, that a case of infringement of the first claim was made out, but on the sixth claim—improvement in pole pieces—Mr. Justice Wills found that defendants had not

* "Electric Illumination," Vol. I., pp. 74, 75, and 76.

† Hookham and Another *v.* Johnson and Another: *The Electrician*, Vol. XXXVIII., pp. 601, 617, 622, 665, 830, 839.

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infringed. Therefore combination of all the elements of the whole of the claims could not have been meant. And as to claim 3, that was a claim for something less than the whole thing which was claimed in claim 1. But having regard to the fact that that third claim dealt with something not in the provisional specification at all, he (Mr. Bousfield) submitted that it was a claim which could only be infringed if one used a motor such as was substantially described in claim 1. He submitted that if defendants did not infringe claim 1 they could not infringe claim 3. Claim 3 was only a detail in the working out of the invention in claim 1. Plaintiffs had a magnet with big ends in order to get a powerful motive force; and defendants had a very different arrangement, for although they also obtained a powerful driving force they had no iron, and they relied on two coils—the coil which carried the current and the inner coil. The difficulty of getting over the question of friction was met by defendants also in a very different way from the arrangement adopted by plaintiffs. Their defence with regard to infringement might be summed up in the broadest way in saying the plaintiffs' was a patent for a current meter and defendants' was an energy meter. Defendants also said that they did not infringe, even if his Lordship took his learned friend's point about its being used in a constant circuit so as to be a current meter. Even if his learned friend was right about that, still he (Mr. Bousfield) should say it was not an electro-motor substantially as described, because it had a constant field. It had not got an arrangement for giving a powerful driving force and for minimisingfriction, which were really the features which governed the construction in plaintiffs' specification so far as the motor was concerned. Up to a certain point defendants' was accurate as an energy meter, but after that point it ceased to be a meter at all. Counsel next referred to the third claim, and the question of infringement on that head—the disc armature. He said that really this claim was never intended to cover either the use of permanent magnets for the motor or for the motor and brake combined. The case actually illustrated was the motor and brake combined—one disc. The claim had no application for magnets used solely for braking purposes. Of course this was an additional point to the other points.

His LORDSHIP: I thought you did not take this magnet?

Mr. BOUSFIELD said that was so, but a great many points were raised about that, and it was necessary to deal with them all. He submitted that the claim in question was never intended to apply to the use of constant and powerful magnets in connection with the brake, but only in conjunction with the disc armature. Referring to the magnets, counsel said it could not possibly be said defendants used the form of electro-magnets invented by Mr. Hookham. Defendants' principle was to let the magnets down to such a point as to make them sufficiently constant. That was to say defendants got their constancy in the old way, and got the requisite power, not by any special construction of magnet, but by having two magnets, or if necessary three or more. He contended that although Mr. Hookham mentioned an alternating meter in his specification, he excluded it in his claim. Referring to the alleged anticipations of plaintiffs' patent by Siemens and Deprez, so far as the principle of constancy and power in the magnet was concerned, defendants' point on that was that they were following the line laid down by Siemens. If plaintiffs said their specification excluded the defendants', the plaintiffs destroyed their own specification, because what defendants did was like Siemens.

Mr. FLETCHER MOULTON, in replying on the whole case, said he began the case by stating that plaintiffs accused defendants (the Bradford Corporation) of using a meter in which there was a constant field, and in which permanent magnets used for the brake were powerful and constant according to that which plaintiffs claimed in claim 3. The difference between his learned friends and himself as to the third claim was one very much more of law than of fact. So far as fact went his learned friends had never met the evidence of Mr. Dugald Clerk that the circuit on which this was to be put was a circuit of practically constant potential and the consequence of that was that the armature in this case was practically of constant strength. Defendants said their instrument was designed to measure energy and not to measure current, and even that when they used it under circumstances where, in fact, it measured current, it could not come within plaintiffs' patent. But he would say, further, that plaintiffs' instrument was constructed on purpose to be used under circumstances such as those of the Bradford Corporation. There was a device mentioned in plaintiffs' patent which they did not claim, because someone else had done it before, and that was the starting coil. That was a coil which would destroy the serviceability of a meter if it were put on any circuit of higher electromotive force. Plaintiffs worked their meter in a constant field and got it by permanent magnets. Supposing that Bradford worked their meters in a constant field, they might get it from any source. If they kept their mains constant, the field was constant, and they had not denied it, and so they had been taking a convenient source for a constant field. But how did a field obtained from those mains differ from one obtained from secondary batteries? Bradford had used it as a constant field, and therefore had used the meter as a current meter; and with regard to the third claim, the Bradford people had obtained their effective brake by means of magnets of the type described in plaintiffs' third claim. The case against plaintiffs was one of invalidity and non-infringement, and neither had been substantiated. In fact, in spite of three or four more years of searching for fresh material, the present case was substantially the same as that which was tried before Mr. Justice Wills. So far as invention went, the combination of arrangement in plaintiffs' specification was novel and had not been published to the world in any way by anything which had been put before the Court now of date prior to Mr. Hookham's specification. Half a dozen people might have worked at the idea of trying to get a meter and failed, but the plaintiffs had succeeded, and the fact that the magnets used by plaintiffs had been used for other purposes did not tell the world that they were suitable for the purposes of meters. What defendants had done here was, with present later knowledge, to take hints from Deprez that they could not have appreciated at the date of the publication of Deprez's Paper. Dealing with the alleged anticipations, counsel, referring to Marcel Deprez, said his paper was purely theoretical and did not carry the matter further than Ayrton and Perry except that he simply pointed out that fluid friction would not do. There was not a hint in Marcel Deprez to anybody that magnets of any particular form should be used. There was merely a general statement and reference to the magnetic speed indicator, or only a reference to the law of the current. Dealing with Siemens' specification, Mr. Moulton said Siemens put his commutator at the ends of his magnets, which were neither permanent nor powerful, and he had got a wrong idea of the law. Siemens was practically at the head of the electrical world at this date, and it was important to point out that he never saw the importance of these matters. Counsel said he did not think it necessary to deal with the other alleged anticipations, because it was idle to suggest that because a man found a magnet of a particular form, which worked well in a telephone, that that told the world how to make the brake of a thing which had got to work accurately and to measure quantity. Plaintiffs' specification, counsel claimed, was the first working out of a practical meter rendered practical by two things—viz., a frictionless motor and a powerful and constant field. Mr. Hookham claimed the procuring of a powerful and constant magnetic field by permanent magnets arranged as described, with the large polar surfaces closely fronting each other. He (Mr. Moulton) could find no anticipation of this method of the application of magnets of that kind to electricity meters in the papers before his Lordship. The question of the magnets being built up was not really the question in the case. The plaintiffs said, to succeed you must have an extraordinary form of magnet, and without it you could not succeed. If that was so, and Mr. Hookham told the world how to succeed, that was a useful invention. Mr. Moulton submitted that defendants had clearly infringed plaintiffs' third claim. In Abel's magnet there was no suggestion how strongly he magnetised, and nobody suggested that Abel's magnet was used with the large polar surfaces having the function of plaintiffs' polar surfaces. There was nothing in Abel's specification to show that his magnets would be suitable for the brake of a meter. And there was no other magnet which counsel knew of which was like the magnet plaintiffs described. Magnets like the one of Prof. Ayrton had been produced. As Prof. Ayrton's magnet existed, it would not be within plaintiffs' description. What Prof. Ayrton did was to add something to it in the course of the case, so as to bring up one of the poles very close to the other. Supposing he produced a good field by such a magnet plaintiffs had no opportunity of testing the magnet or its permanency, or anything of the kind. That magnet was not what defendants used. Defendants' magnet had got those flat pieces brought up very near to one another, and he submitted it came within the words, "Large polar surfaces closely fronting each other, so as to form a narrow slit in which the brake revolves." He, therefore, contended that defendants had infringed plaintiffs' third claim.

At the conclusion of Mr. Moulton's address on Wednesday, his Lordship said he would give judgment as soon as possible.

Judgment was accordingly reserved.

Castner-Kellner Alkali Co. (Ltd.) v. Commercial Development Corporation (Ltd.).

On Tuesday, the House of Lords, consisting of the Lord Chancellor (Lord Halsbury) and Lords Macnaghten, Morris, Shand and Brampton, heard the arguments in this Appeal by the plaintiffs from an order of the Court of Appeal discharging a judgment of Mr. Justice Bigham. The action was brought to restrain infringement of a patent for an improved electrolytic apparatus for producing caustic soda or caustic potash from suitable salts by a continuous electrical process. The defendants denied infringement and alleged that the patent was invalid on the ground that the invention was neither new, useful nor subject matter for letters patent; and also that the complete specification described and claimed inventions not comprised within the provisional specification. Mr. Justice Bigham decided in favour of the plaintiffs, holding that there was sufficient invention to form subject matter for letters patent, that there was no disconformity, and that the defendants had infringed. He accordingly granted the plaintiffs a perpetual injunction. By a majority the Court of Appeal reversed that decision, the Master of the Rolls (Lord Lindley) and Lord Justice Rigby holding that the patent was invalid on the ground of disconformity, and Lord Justice Rigby adding that in his opinion the patent was invalid also for want of subject matter, while Lord Justice Vaughan Williams though the patent was valid and had been infringed. From that decision the plaintiffs now appealed.

On Oct. 23, 1894 a patent (No. 20,259 of 1894) was granted to Carl Kellner, of Vienna, for "Improvements in electrolytic apparatus for decomposing metallic salts."

The COMPLETE SPECIFICATION was as follows:—

"This invention has reference to an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode, in which the amalgam formed by electrolytic action has its location changed from the decomposing chamber, in which it is produced, to a combining chamber, in which it is decomposed and the cation combined with water, an acid, or other body, by the shifting of a partition which is adapted to be moved to and fro in the mercury and serves to separate the two aforesaid chambers from each other. The partition is in this case made in the form of a bell closed at its lower edge by a mercury seal and enclosing the decomposing chamber, so that the amalgam formed in the latter is caused by the shifting of the bell to have its location alternately on one side and on the other side of the bell without itself changing or moving its position, and is thus caused to gain access to and become situated in the combining chamber, whilst the mercury on the other side of the

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partition, which was previously situated in the combining chamber, effects in the decomposing chamber the amalgamation of the metal that is being separated by the electrolytic decomposition of the electrolyte. In this way, a considerable output can be obtained from the apparatus with a comparatively small quantity of mercury, because both operations can take place simultaneously and uninterruptedly. In the drawings filed with my provisional specification, Fig. 1 is a vertical section taken through one cell of an apparatus constructed according to this invention; Fig. 2 is a longitudinal section, to a smaller scale, taken through the whole apparatus; Fig. 3 is a horizontal section on the line y—y of Fig. 2; and Figs. 4 and 5 are sections through the bell showing two different forms of construction of the latter. In the accompanying drawings, Fig. 6 is a longitudinal vertical section illustrating a modified construction of the apparatus shown in Fig. 2. Fig. 7 is a vertical section, and Fig. 8, a horizontal section, taken in different planes, showing a further modified construction of the said apparatus Fig. 9 is a vertical section through a cell of the apparatus, similar to that shown in Fig. 1, but provided with a short-circuited secondary electrode for the purpose of rapidly removing the alkaline metal from the amalgam that has been formed. The apparatus shown in Figs. 1, 2 and 3 comprises a vessel A for the reception of the electrolyte to be decomposed, and a trough B inserted or suspended in the vessel A, this trough having in its bottom openings b which are surrounded by projecting borders b^1 that serve to prevent the escape, through the said openings, of the layer of mercury C which serves as a cathode and covers the bottom of the trough. The anodes D are arranged in the electrolytic space of the vessel A, horizontally or vertically, and in the latter case may, as shown, also project through the openings b into the trough B. Each of the trough openings is covered over by a bell E of non-conducting material, such, for example, as glass, stoneware, porcelain, or ebonite, which dips at its lower free edge into the mercury, and is of greater width than the opening b, so that it can be moved to and fro through a certain distance over this opening, the extent of this movement being limited by the upwardly projecting border b^1. The bell thus encloses the decomposing chamber communicating with the vessel A, and forms an electrically non-conducting partition between the decomposing chamber and the combining chamber of the trough B, which is charged above the mercury cathode C, which constitutes the seal, with water, acid or other substance with which it is desired to cause the cation, previously taken up by the mercury cathode, to combine. In order that the mercury shall not become displaced by the lower end of the bell E sliding over the bottom of the trough B when the bell is being moved, slots or notches e or b^2 are provided respectively in the lower edge of the bell (as in Figs. 1 and 4), or in the bottom of the trough, as in Fig. 5. A gas exit pipe F leads from the decomposing chamber to the exterior of the vessel A. The anode D and the mercury cathode C are connected to the terminals of a suitable source of electricity. In an apparatus of large size, such as is intended to be employed on an industrial scale, the whole of the bells E are preferably united to form a cover which is provided with partitions and is adapted to be moved to and fro in the trough B, the spaces E^1 between every two bells being arranged to communicate by means of lateral openings with the trough B, as shown by Fig. 2. The gas exit pipes F are then arranged in such a manner that the generated gas is led through all the bells in succession and is drawn off from the last bell. The manner of working the apparatus is as follows:—The electrolyte, for instance, a solution of common salt, within the vessel A and the decomposing spaces or chambers becomes decomposed by the electrolytic action which takes places under the bells E, the liberated chlorine gas being led off through the pipe F, whilst the metallic sodium forms an amalgam with the mercury cathode C, which is situated within the bells E on one side of the anodes D, viz, on the right hand side in Fig. 1. If now the bells be shifted to the left, into the position shown in dotted lines in Fig. 1, the stationary mercury cathode together with amalgam becomes thereby situated in the combining chamber of the trough B which is charged, it may be for instance, with water. The sodium separates out from the amalgam and combines with the water to form sodic hydrate. At the same time, by the shifting of the bells, that portion of the mercury which was previously situated outside the left hand side portions of the bells, that is to say, in the combining chamber, will now be located in the decomposing chamber, and acts as the cathode to again produce an amalgam with the sodium which is continually being separated in the said decomposing chamber. If the bells, after a suitable interval of time, be shifted back into the position shown in full lines, *i.e.*, to the right hand, the mercury on the left hand side of the anodes, together with the amalgam formed thereon, again becomes situated in the combining chamber of the trough, and consequently within the sphere of action of the water in such chamber, whilst on the other hand the mercury situated on the right hand side of the anodes, and the amalgam portion of which has been acted upon in the meantime by water to remove the sodium therefrom, becomes again situated in the decomposing chambers for the purpose of forming fresh amalgam. It will thus be seen that by the to and fro movement of the bells, the transposition of the amalgam formed in the decomposing chambers to the combining chamber, and the practically continuous formation of caustic soda in the latter, are caused to take place alternately on the one side and on the other side of the anodes, whilst the mercury cathode itself remains at rest."

[The provisional specification was verbatim, the same as the complete specification, down to this point except that in the place of "in the drawing filed with my provisional specification," it read "in the accompanying drawings," and it did not contain a reference to, or drawing of, Figs. 6, 7, 8 and 9.]

"It is obvious that the arrangement of apparatus hereinbefore described can be modified by causing the generation of chlorine to take place outside, and the decomposition of the amalgam to take place inside the bells E. In this case, the decomposing and forming chambers are merely interchanged. Fig. 6 illustrates a construction of apparatus of this kind, in which the vessel A contains the mercury cathode C and the solution of common salt to be decomposed, whilst the bells E, that dip in the mercury, are charged with water, with which the sodium that becomes separated from the amalgam on the shifting of the bells, combines to form sodic hydrate. The vessel A is provided with a cover, A^1, that is adapted to close gas-tight, and from which leads a pipe, F, that serves to carry off the chlorine gas generated in the said vessel. The cover is provided at a suitable place with an opening which is closed by means of a movable cover, A^2, that preferably dips into a sealing liquid for the purpose of making a gas-tight joint at this part. Through the cover A^2 there passes a pipe H, which serves for discharging the hydrogen that forms in the bells E, and is supplied to the pipe H by connecting pipes H^1. The bells are rigidly connected together, and, as in the previous case, are so arranged that they can be moved to and fro in the vessel A, this movement being shared by the pipe H and the sliding cover A^2. The positive terminal wire leading to the source of electricity is electrically connected by a conductor that is inserted in a tight manner in a glass tube, I, capable of movement in a stuffing-box in the wall of the vessel to the upper part of each of the bells E, such upper part being made of electrically-conducting material, whilst the lower part of each bell, which dips in the mercury, is either made of, or covered with, a non-conducting material. The upper part of the bell thus constitutes the anode. The negative terminal wire is connected to the mercury. Instead of being slidden along rectilinearly, the bell E, or the vessel A, or the bottom of the latter, may have a rotary motion imparted to it. An arrangement of apparatus of this kind is shown in Figs. 7 and 8. Here the vessel A, which contains the mercury cathode C, is constructed in the form of a disc provided with an upwardly projecting edge and the hub of which is fixed on a vertical shaft K that is rotated by suitable means. The decomposing and combining chambers are formed by means of fixed radially arranged bells E which are connected together so as to form a cover provided with partitions, as in the arrangement shown in Fig. 1. The decomposing and combining chambers follow each other in succession and are respectively provided with the chlorine discharge pipe F, and with pipes H for discharging the hydrogen. A number of such disc-shaped vessels A, with radially arranged bells E, may be mounted one above the other upon one and the same shaft. Also the disc-shaped vessels A may be fixed, and the bells E be mounted on the shaft K so as to rotate therewith, which is equivalent to the more reversal of the apparatus described with reference to Figs. 7 and 8, and requires no further description. The manner of operation is the same as before described, in all cases. If it be desired that the alkaline metal shall be rapidly removed from the amalgam formed, then in the case of apparatus of the kind herein described, there may be employed the method specified in claim 7 of the specification of my British patent No. 17,169 of A.D. 1892, whereby the heat liberated in the formation of amalgam is converted into electrical energy. For this purpose, into the trough B of the apparatus (Fig. 9), or into the bells E (Fig. 6), or into the combining cells of the bells E (Fig. 7), that is to say, always in the chamber in which the separation of the sodium is to take place, there is suspended a third electrode G which is electrically connected in any suitable way to one of the terminal wires—viz., that extending from the mercury cathode (Figs. 6 and 9), thereby forming a short-circuited secondary element composed of the mercury cathode C and the electrode G, which element effects the rapid separation or removal of the alkaline metal from the amalgam. Each third electrode G may be carried either by the corresponding bell E, or by the bottom of the vessel A, through any suitable connection which should be of non-conducting material, or be covered with such material.

"Having now particularly described and ascertained the nature of the said invention, and in what manner the same is to be performed, I declare that what I claim is:

"1. An apparatus for the electrolysis of metallic salts with the aid of a stationary mercury cathode, in which partitions or bells capable of being moved to and fro, and dipping into the said mercury cathode, are arranged to separate the decomposing and combining spaces or chambers from each other, and by their to-and-fro movement to cause the mercury cathode to be located alternately within the sphere of action of the electrolyte and of the substance to be combined with the cation produced, substantially as hereinbefore described with reference to and illustrated by Figs. 1 and 2 of the drawings referred to.

2. The modification of the apparatus specified in the preceding claim, in which the movable petitions or bells are provided with pipes, H H^1, for carrying off hydrogen, and are arranged in a closed vessel, A, which contains the mercury cathode, and is provided with a pipe, F, for carrying off chlorine, substantially as hereinbefore described with reference to and illustrated by Fig. 6 of the accompanying drawings.

3. The modification of the apparatus specified in claim 1, in which one or more vessels, A, is or are mounted on a vertical shaft, so as to be capable of rotating relatively to the fixed partitions or bells that dip into the mercury cathode carried by the said vessel or vessels, or in which the said partitions or bells are capable of rotating in a fixed vessel or vessels, substantially as hereinbefore described with reference to and illustrated by Figs. 7 and 8 of the accompanying drawings.

4. In apparatus of the kind specified in the preceding claims, the arrangement of a third electrode G in the combining-chamber or in each such chamber, the said electrode G, or each of them when there are more than one, forming with the mercury cathode a short circuited secondary element, for the purpose of rapidly removing the alkaline metal from the amalgam substantially as hereinbefore described with reference to and illustrated by Fig. 9 of the accompanying drawings.

5. In apparatus of the kind specified in the preceding claims, the arrangement of slots or notches e or b^2 in the edges of the partition or bells, or in the bottom of the vessel that contains the mercury cathode, for the purpose of obviating displacement of the mercury when moving the partitions or bells relatively to the vessel, substantially as hereinbefore

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described with reference to and illustrated, by Figs. 4 and 5 of the drawings herein referred to."

Mr. Fletcher Moulton, Q.C., M.P., Mr. Bousfield, Q.C., M.P., Lord Robert Cecil, Q.C., Mr. J. C. Graham, and Mr. A. J. Walter appeared for plaintiffs; Mr. T. Terrell, Q.C., Mr. Astbury, Q.C., Mr. W. Dixon McConkey, and Mr. J. H. Gray represented defendants.

Mr. MOULTON, in opening the appellants' case, said they had brought the action for the purpose of obtaining an injunction to restrain the respondents from infringing the above-described letters patent, granted to Carl Kellner, for an invention entitled "Improvements in electrolytic apparatus for decomposing metallic salts," and for the delivery up of all infringing apparatus. So far there had been no infringement by the respondents, and for that reason these proceedings were curious, for in order to get the question settled whether, if the respondents proceeded to do that which they stated they intended doing, it would or would not be an infringement of the plaintiffs' rights, the defendants had admitted that they intended to use an apparatus similar to that described in the Specification of Letters Patent 21,509, of the year 1896, granted to Rhodin.

The LORD CHANCELLOR: Then the action was brought to restrain the use of such apparatus by the defendants which the plaintiffs alleged, if used, would be an infringement of the two patents—the Castner-Kellner patents—which the plaintiffs are now the holders of?

Mr. MOULTON replied in the affirmative, and, continuing, said before the date of the invention, which was the subject of Kellner's patent, there were many methods of obtaining by chemical action caustic soda which were in more or less common use, and were never the subjects of any patent: but they all had this disadvantage, that the soda obtained was never really pure. Kellner's related to an apparatus for the manufacture of caustic soda by passing a current of electricity through a solution of common salt (chloride of sodium) in water which had the effect of liberating chlorine at the anode and sodium at the cathode. It was known that in such an apparatus if the cathode was a layer of mercury the sodium would enter into combination with the mercury, forming a fluid amalgam of mercury and sodium, and that this amalgam might be subsequently decomposed by the action of water into mercury and caustic soda. In all the apparatus which had been in use prior to the date of Kellner's patent, the arrangements depended upon causing the mercury to circulate by means of pumps and the like through pipes or suitable passages, so that the mercury took up sodium in one chamber and was then caused to pass into another chamber where the mercury was wholly or partially freed from sodium; the mercury being then returned to the other chamber to take up a fresh charge of sodium, and so on. In Kellner's invention the provisional specification described the charging of the mercury with sodium and its subsequent discharge as being effected in this way.

It was common ground that caustic soda was produced by a process which, shortly described, was this:—A solution of common salt in water was subjected to an electric current while in contact with mercury, the effect being that the sodium in solution was precipitated into the mercury and formed an amalgam, while the chlorine, which was also contained in solution, was driven off in the form of gas. This amalgam was then subjected to the operation of water, the chemical effect being that the sodium in the amalgam of mercury and soda combined with the oxygen of the water forming oxide of sodium. The water thus impregnated was then evaporated or otherwise dealt with, the product resulting being caustic soda. The chamber in which the amalgam was produced was known as the "decomposing chamber," that in which the sodium was extracted from the amalgam as the "combining chamber." Thus the mercury was charged with and discharged of the sodium, and the operation could be repeated with the same body of mercury for an indefinite number of times. Now, one of the apparatus devised for carrying out the process was one which Castner took out a patent for in 1892. It provided a means of producing caustic soda by a continuous process, carried on by means of a quantity of mercury moving round and round in its containing vessel.

The LORD CHANCELLOR: I gather that the essential characteristic of that invention was a moving body of mercury. The respondents contend—and it was so found by the Master of the Rolls and Lord Justice Rigby—that by the words "stationary mercury cathode," used in Kellner's provisional specification, the patentee meant a mercury cathode which was stationary with respect to surrounding objects, and that as the mercury as used in Kellner's complete specification was situated in a rotating vessel, this apparatus so described and claimed was such a departure from the invention disclosed in Kellner's provisional specification as to render the letters patent invalid.

Mr. MOULTON: That was a part of the argument that would be dealt with later. But he would point out that the apparatus which was claimed in the complete specification was not only a legitimate but a very obvious and natural modification of the apparatus described in the provisional specification, and that unless such a modification could legitimately be covered in the complete specification, the invention would practically be left unprotected.

The LORD CHANCELLOR: In this provisional specification the invention consists in moving "to-and-fro" the mercury; in the complete specification the mercury, or at any rate the vessel containing it, is kept stationary. I understand that the defendants said the patent is bad on the ground of disconformity, and that is the view that the court below took of it.

Mr. MOULTON: That is really the only ground that the Court of Appeal decided against us on. I shall contend that the complete specification is simply an amplification of the provisional specification.

Lord MORRIS: There are two peculiarities in this case: first, the plaintiffs' patent has never been used for any commercial purpose, and its non-user is not explained by the fact that although new and useful when obtained, it has been superseded by a later invention; and, secondly, that the defendants have not begun work, so that no infringement, in fact, can be proved by what they actually have done.

Mr. MOULTON explained that the defendants were about to put an apparatus on the market which the appellants believed was covered by their patent. When the two processes were being described in court, Mr. Terrell made this admission. He said, "If there is no distinction between a rotatory movement and the to-and-fro movement described in Fig. 1 of Kellner's specification, then there is no other practical distinction between my (Rhodin's) apparatus and theirs." Kellner showed in his provisional specification one mode of carrying out his invention, namely, by a "to-and-fro" motion of the vessel or bell containing the salt solution. But it was quite competent for him to point out in his complete specification any better method of presenting the mercury first to the salt water and then to the fresh, provided he kept the mercury as quiescent as possible.

Lord MORRIS: In his judgment, the Master of the Rolls said, "I am not prepared to hold . . . that the mere substitution of a rotary motion for a to-and-fro motion of the bells would not be equally within Kellner's invention, as described in his provisional specification, provided always care were taken to keep the mercury still. But there has been an entire departure from the essential feature of his invention as originally described. Here the mercury is intentionally not kept as still as possible, but may be moved and disturbed to any extent. This is quite inconsistent with the original idea. An invention for keeping the mercury still is not an invention for keeping the mercury moving. Claim 3 covers both inventions, and is such a departure from, and such an extension of, Kellner's real invention as to render the patent sued upon invalid as it stands."

The LORD CHANCELLOR: Does not the real question we have to decide come down to this:—Whether your patent—whether it is good in itself or not—is not too wide, and therefore bad? Your patent is for a mechanical arrangement by which the mercury previously stirred about was reduced to a state of stillness.

Mr. MOULTON submitted that the patent rested solely in the arrangement of the apparatus. Therefore, in the complete specification Kellner was justified in describing a modification of his apparatus which was shown in Figs. 7 and 8, and claimed in the first part of the third claiming clause. According to this form of Kellner's invention the mercury was still allowed to be at rest relative to its containing vessel, but the vessel containing the mercury was moved while the bell remained stationary instead of the converse arrangement previously described. It was a modification of the invention, against the use of which by others the inventor was entitled to be protected.

The LORD CHANCELLOR: I see on this point Mr. Justice Bigham said, "I think what Dr. Kellner meant to convey was that the mercury was to be stationary with respect to its containing vessel."

Mr. MOULTON: Yes, my lord. "Stationary with respect to its containing vessel" is the point on which the argument really turns, having regard to the fact that up to 1894 a flowing body of mercury stirred about had always been in use, and that before the date of "Castner" the mercury had been run off into another vessel. "Castner" took a vessel and divided it, keeping, however, the amalgam continuous in the two parts, and transferring it from one part to the other by means of a paddle.

The LORD CHANCELLOR: Yes, he kept it stirred up.

Mr. MOULTON: But Kellner obtained his result by moving one part of the cell relatively to the other. That was a striking novelty to move about in the middle of a fluid an electrolytic cell which contained another fluid. He gave to the public a means of obtaining a movement by means of moving rigid parts instead of moving a fluid, which in some cases, as where the apparatus is large, might be of the highest importance.

The LORD CHANCELLOR: I cannot help feeling that the result is obtained by contradictory methods—rest and motion—and you say the defendants have taken all that is shown in this provisional specification.

Mr. MOULTON contended that stationary cathode in the provisional specification meant that without moving the cathode the effective motion could be produced of one part of the cell relatively to the other, without the need of employing fluid motion. An inventor was free to amplify his invention between the times of filing his provisional and complete specifications, provided that the principle was the same in both. "Woodward v. Sansum," 4, R.P.C., 174. An amplification was here necessary because the inventor saw that someone might use his invention without infringing his patent; for, as the provisional specification stood, the movement of the bell might be in any direction and to any extent, and he might have any number of them. Again, it would have been an infringement of this provisional to have kept the top still and moved the bottom and, to avoid it, the patentee described and claimed it. It was no objection to a patent that there was invention between the provisional and complete specifications so long as it was the development of the same idea.

The LORD CHANCELLOR referred to the case of "Newall *v.* Elliot and Glass," 4 C.B.N.S., 269, in which it was laid down that the office of the provisional specification was only to describe generally and fairly the *nature* of the invention, and not to enter into all the minute details as to the manner in which the invention was to be carried out, which was the case when the complete specification was filed.

Mr. MOULTON said that was a case in his favour, although it was distinguishable from the present case. There, in the complete specification the rings claimed were not mentioned at all in the provisional specification. In the present case nothing was mentioned in the full specification that was not also mentioned in the provisional. The only difference was the addition of another way of working the apparatus in which the same result could be produced. The nature and the character of the invention were described the same in both specifications.

The LORD CHANCELLOR: In his judgment, Mr. Justice Byles said: "But the office of the provisional specification is only to describe generally and fairly the *nature* of the invention, and not to enter into all the minute details as to the manner in which the invention is to be carried out; otherwise the provisional specification must be as full as the complete specification, and drawn with as much care and deliberation. Indeed, the statute itself indicates this distinction between [the provisional and the

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final specification, for it calls the latter the *complete* specification, implying that the former is or may legally be, in some respects, executory and incomplete. Moreover, it enacts that the provisional specification is to describe the *nature* of the invention, and no more; but when the statute comes to speak of the complete specification its language is altogether different. It enacts that the complete specification shall describe not only the nature of the invention, but also the manner in which it shall be performed, and not only describe, but particularly ascertain it." It was that last sentence that I have read this passage for to the court, for it seems to me all important.

Mr. MOULTON submitted that Kellner was not by his provisional specification limited to a particular form of moving bell, and it could not be an unfair development of a moving bell to move the bottom and keep the bell still. He contended that the method in which the plaintiffs' invention was to be performed as described in the complete specification had, in fact, been so described in the provisional specification.

The LORD CHANCELLOR: There, at present, I am not with you. I should like you to read now the judgments of the courts below.

Mr. MOULTON then read the judgments given by Mr. Justice Bigham and the Lords Justices in the Court of Appeal.

The LORD CHANCELLOR: As I before pointed out in the provisional you claimed one thing, and you made your complete specification so large that it included something that was not in the provisional specification at all. What have you to say on the second point—that of infringement?

Lord MORRIS: If Kellner's patent of 1894—the one sued on—can be shown to be invalid, the second question as to infringement does not arise.

Mr. MOULTON replied: In that case the discussion on infringement no doubt would be academical merely; but he desired to go through the evidence given at the trial before concluding his argument.

The LORD CHANCELLOR: In order to support what proposition?

Mr. MOULTON replied he desired to refer to the evidence with a view of showing that there was absolutely no difference in the effect produced by moving the mercury under the chamber and moving the chamber over the mercury. The learned counsel, having referred at some length to the evidence given by Lord Kelvin and other witnesses on this point, submitted that the invention described and claimed in the complete specification was not larger than or different from the invention described in the provisional specification, which was valid and properly the subject matter of a patent. In conclusion, he repeated the reasons given in the judgments delivered by Mr. Justice Bigham and Lord Justice Vaughan Williams as those upon which this appeal should be allowed.

Yesterday (Thursday) the arguments were continued, and

Mr. BOUSFIELD said their lordships would remember that there were three chief matters at issue. The respondents alleged that the specifications were imperfect, insufficient, ambiguous and misleading; that gave rise to the second question of disconformity; and third, there was a question of infringement. Mr. Justice Bigham and the Master of the Rolls and Lord Justice Vaughan Williams held, although deciding against the appellants, that Kellner's invention was a good, novel, and useful patent; Lord Justice Rigby on this point, although in favour of the respondents, also differed from the Master of the Rolls. Mr. Justice Bigham and Lord Justice Vaughan Williams held, on the second question, that the modification in the working of the apparatus as stated in the complete specification was within the provisional specification; while the Master of the Rolls and Lord Justice Rigby took a different view. Then, on the question of infringement—

The LORD CHANCELLOR: Is that question substantially in issue?

Mr. BOUSFIELD said it certainly was. At one stage this question for a time was shelved, but before this House it would be necessary to consider and decide it. He desired to take for his text, on which to argue, a passage from the judgment of the Master of the Rolls, as giving very clearly the definition of the appellants' patents. The Master of the Rolls said: "I pass now to consider the first point which arises in this case, and that is the nature of Kellner's invention as disclosed in his provisional specification. The invention is for an improved apparatus. The real nature of that invention is, in my opinion, quite clear. It is an apparatus for moving an open-mouthed vessel containing an electrified solution of salt over a stationary layer of mercury covered with fresh water. The vessel is to be moved in such a way that the electrified salt solution shall be in contact with part of the mercury for a time, and then be shifted to another part, whilst the mercury first acted upon by the salt water, and converted into an amalgam of mercury and sodium, shall be brought into contact with the fresh water, so as to decompose the amalgam into mercury and soda in solution. That was Kellner's invention, and, so far as I can judge, it was novel and useful."

The LORD CHANCELLOR: The real issue between the parties appears to me to be this. Do the words "stationary mercury cathode" in the specification mean a stationary cathode composed of mercury, *i.e.*, a stationary mercurial cathode or a cathode composed of stationary mercury? The Master of the Rolls took the view that the word "stationary" referred to the vessel in which the cathode was contained. So far you will, I take it, accept his definition; but you will contend that the Master of the Rolls was wrong when he went on to say that one of the essential features of Kellner's invention was the keeping of the mercury as quiet as possible consistently with moving the bells of salt water over its surface.

Mr. BOUSFIELD replied in the affirmative, and said the specification spoke of "flowing" mercurial cathode. He desired to explain the method employed by Castner by which the mercury was kept stirred up, whereas in Kellner's the process was one of quiescence. The Court of Appeal treated this question as purely academical, and viewed it from a jurist's and not a scientific standpoint. The cathode which, he contended, had not necessarily a relation to the vessel that contained it, was the medium through which the electric current passed, but that cathode, as far as mechanism could produce it, was kept perfectly still. The vessel that contained it might be whirled round, but the cathode, as far as possible, was kept in a state o quiescence. Kellner wanted to keep the mercury as still as possible during the operation. He brought the mercury into "contact" with the bells, which just dipped into the fluid. Thus it would be seen that the *modus operandi* of his apparatus depended on allowing the mercury to remain at rest within its containing vessel. By the motion of the bell the mercury was alternately brought into contact with a salt solution and with water surrounding the bell. Castner did not move any part of the bell, but he had a stirrer, shaped like a screw propeller, for the express purpose of stirring up the mercury in order to obtain a uniform richness of sodium. This result could also be obtained if the cell were kept stationary and the containing vessel moved from the bottom about the bell. Objection was taken that the plaintiffs did not use Kellner's apparatus, but there was nothing in that objection, for they used a rocking apparatus instead as being more convenient. He then referred to Lord Kelvin's evidence in support of his contention that there was no practical difference between a "to-and-fro" and a "rotatory" motion of the mercurial cathode. On the objection that the complete specification went so much farther than the provisional specification as to describe a different invention from the one described in that document, he cited a passage from the judgment of Lord Justice Lindley (as he then was), given in "Gadd and Mason *v.* Mayor, &c., of Manchester," 9 R.P.C., at p. 526, where he said, "Although it is quite true, as observed by Sir H. Davey and Mr. Carpmael, that the object of the patent [an improvement in gasometers] being old the patentee must be tied down to the modes of obtaining that object described and claimed by him, it is, in my opinion, wrong in point of law, even in cases of this kind, to tie him down to the particular methods shown in the provisional specification. But it is only by so tying him down that his patent can be held bad for want of conformity. Even under the present law the court may be driven to hold a patent invalid on the ground that the invention described and claimed in a complete specification is not the same as that provisionally protected. . . . If a case is on the border line, the patent ought to be held good rather than bad."

The learned counsel was about to argue the third issue when their lordships intimated they did not desire to hear the question of infringement at that stage in the proceedings.

Mr. TERRELL, Q.C., for the respondents, then addressed their lordships. After Mr. Terrell came Mr. ASTBURY, Q.C., on the same side, who had not concluded his argument when the Court adjourned until Monday.

Bulstrode and Others v. Julius Sax and Co. (Ltd.)

In the Queen's Bench Division, on Friday last, before the Lord Chief-Justice and a special jury, an action was heard, brought by Edward Bulstrode, Thomas Wilson, Emil Bahter, Wm. Krause, and John Plumb (carrying on business under the style of the Saxon Electrical Engineering Co.), to recover damages from Julius Sax and Co. (Ltd.) for libel. Defendants admitted publication, and the jury was asked to assess damages.

Mr. RAWLINSON, Q.C., for the plaintiffs, said the five plaintiffs were, previously to July of last year, in the employment of Julius Sax and Co. and afterwards of Julius Sax and Co. (Ltd). Mr. Bulstrode had been in the employ of the company for 20 years, and the other plaintiffs also held positions in the old firm. Towards July last year it became clear that the old company would not be able to continue their business for long, and at the beginning of August plaintiffs made up their minds that in case anything happened to the old firm they would set up on their own account as electrical engineers. The company were in difficulties, and sold their business to Mr. H. M. Salmony, who practically had formed a new company, which took over the business. At the beginning of August Mr. Salmony, who was in negotiation for the purchase of the business, approached plaintiffs with a view of their staying on in his employment, but these negotiations fell through, and on August 12 plaintiffs gave notice to leave. On August 19, their notice having expired, the company put up a notice saying they had gone into voluntary liquidation and all the employés of the company might consider themselves dismissed. The plaintiffs then sent a circular to various persons they knew in business stating that the firm of Julius Sax and Co. (Ltd.) having gone into voluntary liquidation, they (plaintiffs), who had been the heads of certain departments of the old company's business, had formed themselves into a syndicate to carry on the business of electrical engineers and electric light contractors, assisted by several other of the late employés of the old company. On September 4 defendants published a circular letter (which was the libel complained of) to the effect that it had come to their knowledge that certain discharged employés of the firm had sent out to the company's customers a circular containing misleading statements which might possibly be injurious; that the matter had been placed in the hands of their solicitors, who would take steps to put an effective stop to such statements; that the firm of Julius Sax and Co., which had been established for 50 years, was recently reconstructed with a view of introducing additional working capital and more rigorously prosecuting the business, which would be carried on as theretofore, while the services of such of the former staff who had proved themselves capable and competent had been retained. On behalf of plaintiffs, Mr. Rawlinson submitted that that circular suggested that plaintiffs were discharged, that they had made misstatements, and were incompetent, and that defendants did not think it right to retain their services. Plaintiffs had failed to obtain an apology.

For the defence, Mr. H. M. SALMONY said he negotiated for buying the business of the old firm, and ultimately did so by an agreement of July 27, 1899. He re-sold it on August 24, and it was still carried on as Julius Sax and Co. (Ltd.). He had had many consultations with Mr. Bulstrode about the purchasing of the business, and told him he was going to form a company to take over the business and carry it on just as it was before. He had an interview with Mr. Bulstrode about his staying on, but they could not come to terms. The question of offering an apology to plaintiffs

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was left in his solicitors' hands. Evidence was also given by Mr. Arbuthnot, manging director of the defendant company.

Mr. RUFUS ISAACS, Q.C., said the plaintiff Bulstrode had no possible justification for using the list of defendants' customers in sending out his circulars. The retort of the defendants was, under the circumstances, perfectly reasonable, as he had imputed in the circular what was not the fact, namely, that the company was defunct. Again, the name of plaintiffs' company was extremely similar to that of defendant company, and he thought Mr. Bulstrode had some idea that by means of his circular he was going to get the benefit of Julius Sax and Co.'s business. This was a war of circulars, and while defendants had sent out a circular which could not be justified, he submitted that plaintiffs had done exactly the same thing.

Mr. RAWLINSON said there was no evidence of this imputation about the list of customers or similarity of name, and if the plaintiffs had done the defendants any wrong in these regards, the defendants could bring an action against them now, and it was also open to defendants to be counterclaimed in the present action.

In summing up, the LORD CHIEF-JUSTICE said in this case the libel is not denied, and it is not pleaded that there is justification. In considering the point of damages, the jury are entitled to take into account the circumstances of the case, and the conduct, not only of the defendants, but of the plaintiffs also, and to what extent the plaintiffs conduct may have suggested that which is here complained of as libel, especially in relation to what amount of damages the plaintiffs were entitled to get. In actions for libel—and often in cases of most serious libel, too—it is impossible for plaintiffs to prove pecuniary loss, but damages may be given although not a farthing of pecuniary loss is proved. In this case plaintiffs had been for a number of years in the employ of the original firm of Julius Sax and Co. During a portion of this time that firm, it was admitted, was not in a healthy financial condition, and Mr. H. M. Salmony came forward to buy the whole business, wind up the old company and form a new company. With this object the old company went into voluntary liquidation in July, 1899, and Mr. Salmony entered into a contract to buy, for £3,000, all the assets of the old company, which shortly afterwards disappeared from existence. Then the new company was registered. This being the state of affairs the five plaintiffs met together for a perfectly legitimate purpose—to co-operate to form a new firm and to carry on the same kind of business which they had assisted in carrying on whilst employés of the old firm of Julius Sax and Co. This they had a perfect right to do. They gave notice to determine their service with the old company, and it was, therefore, untrue that they were discharged by the old company, and this is a most important point to bear in mind in this action. The defendants did not justify that statement and it was not true that any of these five persons were discharged employés of the old company. The five plaintiffs thereupon issued a circular, and it would be for a jury to decide how far that circular went, not to justify, but to palliate the libel complained of. Defendants complained that this circular was calculated to do injury, not to the old company, which was not in existence, but to the new company, which had taken over the business and goodwill of the old, and he (the Lord Chief-Justice) held that however the wording of the circular might have been arranged, the same amount of injury might have been done to the new company. But the plaintiffs had a perfect right to form themselves into a syndicate to carry on a similar business, and the language used in their circular was literally true. Again, the defendant company were perfectly justified, within certain lines, in counteracting any injurious impression which such a circular might have created, so long as the lines of such circular were the lines of truth. But instead of this a circular was distributed which contained statements that were untrue. The new firm of Julius Sax and Co. (Ltd.) did not discharge the plaintiffs. The statements made by the plaintiffs in their circular were not misstatements but were true statements, and the announcement made by defendants that "the matter has been placed in the hands of our solicitors, who will take steps to put an effective stop to such statements" was calculated to injure the new firm legitimately formed by the plaintiffs. If the defendants' contention that an improper use had been made of the list of the old firm's customers, or by the use of the word "Saxon" in connection with the title of the plaintiff's new firm, then the defendants had, and have still, their remedy against the plaintiffs. When the jury had given such damages as they thought right to the plaintiffs, it was still open to defendants, if any legal wrong had been done to them, either by the use of this list or by the use of the word "Saxon" to take such action as they might be advised to take. The most vicious part of the libel was, however, that part of defendants' circular which notified that "the business will be carried on precisely as heretofore by a thoroughly competent staff, and under the guidance of well-known electricians, while, at the same time, the services of such of the former staff as have proved themselves capable and competent have been retained," and, further, "in order to prevent servants, whose services we have not thought it right, in the interests of the company, to retain, from prejudicing our customers, we think it is only necessary to call your attention to the above facts." Here it was undoubtedly intended to convey that the new company had got rid of the riff-raff employés of the old company, only retaining the competent and capable men; therefore the men (the plaintiffs) who are sending out the circular calling attention to the establishment of the new syndicate are incompetent and incapable. He (the Lord Chief-Justice) need not point out that such statements were not justified. Therefore the plaintiffs are entitled to such damages, as, taking into consideration the action of both parties, the jury might consider adequate.

The jury returned a verdict for plaintiffs for £250—£50 for each of the plaintiffs—for which judgment was entered.

It transpired that defendants had paid £10 into court as sufficient to meet the plaintiffs' claim.

Dobell v. Marshall and Another.

This case came before Mr. Justice Lawrance and a special jury in the Queen's Bench Division on Tuesday, and was an action to recover £90 for arrears of salary from June 9 to October 13, 1899, and also damages for wrongful dismissal.

It appeared that plaintiff, an electrical engineer, was interested in some patents for obtaining electric energy direct from coal. He assigned the patents direct to the defendants, in whose employment he was for some years, and a syndicate was formed, and plaintiff was paid £5 a week and employed his time in experimenting with a view to bringing the invention to perfection. The experiments, however, were interrupted between the dates mentioned, the plaintiff receiving no salary. In October more money was obtained and a fresh arrangement made by which plaintiff was to receive a salary of £7 a week and 5,000 shares in a syndicate or company to be formed. He proceeded with the experiments until the end of October when he was sent an agreement to sign which contained terms different from those which had been previously arranged. Plaintiff declined to sign and was shortly afterwards dismissed at a week's notice, and now claimed damages for wrongful dismissal. The syndicate was a failure, and was wound up on April 21, 1899.

Mr. TINDAL ATKINSON, Q.C., for defendants, said that during the period for which shares and salary were claimed the plaintiff was not conducting experiments at all. The money in the hands of the syndicate had given out. Defendants denied employing plaintiff for a fixed term.

The jury returned a verdict for defendants.

PARLIAMENTARY INTELLIGENCE.

MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

The Select Committee of the House of Commons, over which Sir John Kennaway presides, on May 5 began the consideration of the bill of the Manchester and Liverpool Express Railway Co., by which power is sought to incorporate a company for the construction of an electric railway on the mono rail system between Manchester and Liverpool. It is intended to run one-car trains at a speed of 110 or 120 miles an hour. Petitions against the bill were lodged by the Cheshire Lines Committee, the Lancashire and Yorkshire Railway Co., the London and North-Western Railway Co., the Corporation of Salford, and others.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said the proposed railway would begin almost in the centre of Manchester, and terminate in the centre of Liverpool. There would be no intermediate stations, and it was only proposed to run express trains for passengers between the two towns, so that there would be no competition with the other railway companies as to the local or goods traffic. There was a growing feeling in favour of rapid transit, but it was agreed that the limit of speed in the present system of railways had been almost reached. Electric traction had, however, opened up a new field and offered great advantages compared with steam traction. On the ordinary railway the cars and the locomotive were only kept on the way by comparatively small flanges on the inner tire, and the centre of gravity was far above the wheel base. In 1891 two Continental engineers were able to obtain a speed of 150 miles an hour on a railway from Vienna to Budapest, constructed on the present system; but to allow that speed the line had to be perfectly rigid, and the cost of construction was practically prohibitive. Mr. Behr, the originator of the new system, had for many years considered that to obtain great speed a change would have to be made in the construction of the permanent way and carriages, and he was the first to bring into vogue the mono-rail system, which would be that adopted in the propored undertaking. A single rail was laid on the top of trestles about 4ft. high, on which the weight of the car was carried. Below the top rail were two guiding rails, which bore the lateral pressure when the car was rounding a curve. In 1886 a line was constructed on this principle from Listowel to Ballybunnian, in Ireland, on which steam locomotives were used. It had been proved that curves of 54ft. radius could be safely rounded at considerable speed. The trestles would be of steel and bolted into sleepers. The motors would be carried under the lower part of the car, and the centre of gravity would be 14in. below the top rail, making derailment absolutely impossible. The centrifugal force was met or taken up by pressure on the guide rails. Trials were made in Brussels in 1887 which demonstrated that the system was practically successful. A road 3 miles long was laid in the exhibition grounds, 75 per cent. of which consisted of curves, and, with only 500 H.P. of electricity, a speed of 83 miles an hour was attained without difficulty. The car on that occasion weighed 70 tons, but it was proposed on the new railway to construct cars of a weight, including motor, of 45 tons, which they considered would be quite sufficient. A special commission appointed by the Belgian Government had thoroughly tested the line at Brussels, and the chief engineer of the State railways would inform them that it would be quite possible to attain a speed of 120 miles an hour with perfect safety. This immunity from risk was one of the special advantages of the new system. Following a lecture delivered by Mr. Behr to the Chamber of Commerce of Liverpool in 1899, a committee of investigation was appointed and a company formed to promote the construction of a railway on the new system between Manchester and Liverpool. The electric power station would be at Warrington, and the electric current would be carried by conduits along the line. At the transformers the voltage would be reduced from probably 10,000 to 500 or 600. The electricity would then pass along the guide rails to be taken up by the guide rails and conveyed to the motor in the car. The length of the line, which would be double—an up and down line—was 34 miles 4 furlongs 5 chains, and the cost was estimated at £1,750,000, of which £401,600 was set down for land and buildings. This did not include the equip-

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ment. The capital proposed to be authorised was £2,000,000 in ordinary shares and £660,000 in debentures. With the consent of the authorities of the House, the engineers proposed to show the Committee a model of the train at work. As to the danger of collision, there would be a separate up and down line without junctions, stopping places, or level crossings, and the only possible danger was of one car overtaking another on the road. By a system of automatic "lock and block" signalling this danger would be avoided, as the signal would be reproduced in view of the engineer travelling on the car. The working of the railway would be much cheaper than on an ordinary railway, the experience of the Overhead Railway at Liverpool and the City and South London Electric Railway proving that the cost of electric traction was 1s. 3d. or 1s. 4d. per train mile, as compared with 2s. 9d. to 3s. 3d. cost of steam traction on the Great Western and London and North Western railways. On the proposed railway they expected to run at the rate of 110 miles an hour, covering the distance between Manchester and Liverpool in 20min., and they would have a 10-minute service. As to the prospects of the company, at the present time there were on the various railways 4,500 passengers daily, and with increased speed and frequent services they considered the number would largely increase. They calculated that assuming their estimates of cost were correct they would be able to pay 5 per cent. on the share capital of the company. Counsel then dealt with the opposition to the bill, and concluded by calling

Mr. HAWKSHAW, C.E., vice-president of the Institution of Civil Engineers, and joint engineer with Mr. Behr in laying out the proposed line, who said the line began at Deansgate, Manchester, and terminated at the Bluecoat school in Liverpool. The construction of the line presented no engineering difficulties, and the estimate of the cost was ample. Taking into consideration the construction of the railway, he did not think there would be any danger of derailment in rounding sharp curves even at the speed of 110 miles an hour. The absence of points and crossings diminished many of the sources of danger on ordinary railways.

Mr. F. BEHR, the originator of the system, and the joint engineer of the proposed line, said he had for 14 years considered the development of the mono-rail system for electric traction, and he and his co-workers had spent £200,000 in experiments. Under the present system of double rails it would, in his opinion, be impossible to get a high speed owing to the presence of points, level crossings and signals. He had arrived at the conclusion that the maximum of speed had been attained on the existing railways—60 miles an hour; and that it was impossible to apply electricity to double rails with any hope of very high speed. From his experience of the trials at Brussels, upon which £60,000 had been expended, he thought that on a properly constructed line on his system, it would be possible to attain a speed of 110 or 120 miles an hour. In this experiment they reached 83 miles per hour, but the line was only three miles in length. The experiment had excited so much interest that the Belgian Government had appointed a commission to inquire into the subject. He had brought the question under the notice of commercial men at Liverpool and Manchester, and the result was the formation of a committee, who reported that the system had stood as severe a test as any new invention could be put to short of practical application on a commercial scale, and that it was possible, without extra risk, to reduce the period of travelling between Manchester and Liverpool to 20 minutes. They further reported that if the terminal stations could be arranged near the exchanges there would be a large increase of traffic. He had selected Liverpool and Manchester because they are just at the right distance to prove the commercial value of his scheme. As this district was chosen for the experiment of the two-rail system, he thought it desirable it should be selected for the experiment of the mono-rail system. They proposed an improved communication. The express service between the two towns was as well done as it could be, but it was done at the expense of the local service. At present the goods traffic was neglected, and the docks were greatly congested. All the cars would be double-flanged. As to the danger of collision, electrical brakes could be made to act even at a high speed; and he had invented an air brake which would reduce the speed of a train going at the highest speed. The danger of derailment would be very much reduced by the absence of points and level crossings. The dangers of an ordinary train were derailment (which on his system was impossible) and collision (which on his system was very improbable). The signals under his system were reproduced before the eyes of the conductor, and it was very unlikely that any collision could occur. So by his system he decreased many of the dangers and increased the general safety. Witness described the route of the proposed line, which, commencing at Deansgate, Manchester, proceeded almost parallel with the lines of the Cheshire Lines Committee to Liverpool. He had made a deviation at Liverpool to meet the wishes of the Lancashire and Yorkshire Railway Co. and the Mersey Docks and Harbour Board. His proposal was to start a carriage with 64 passengers, propel it to Liverpool at a high speed, and follow it every 10 minutes by a second carriage over the same route, the only danger of a collision being a breakdown in the signalling or in the power to stop. In that way the service would be twice as quick and three times as frequent as at present.

Mr. S. POPE, Q.C., for the opponents of the measure: Do you suppose that everybody wants to be shot through the air at 100 miles an hour?—I have travelled at the rate of 90 miles on my own line at Brussels, and I did not feel any different sensation to that I experience when I travel in any ordinary express train.

When you were dealing with the possibility of some wicked boy or of some member of the public putting an obstruction on your line, you said that the existence of a line heavily charged with electricity would be such a colossal danger, that no one will be likely to go near enough to put a stone on the line. What would be the damage if he did?—It is obvious that unless he knows where the current is and is technically informed of the danger, he would run great risks from two sources—the electric current and a train travelling at 110 miles an hour rushing suddenly upon him.

What voltage do you propose to use?—The Board of Trade will settle that ultimately, but if I could get all I want, which I very much doubt, it would be 1,000 volts.

Let us consider what you are really asking. Take Salford. Do you expect that the municipality of Salford can see that colossal danger carried through their borough without remonstrance?—In the case of Salford, this colossal danger is carried on a viaduct without steps, the lowest part of which is 24ft. high and the highest 60ft., so that in order to be affected by it a person would have to be a really clever acrobat.

You admit, I presume, that the presence of this electric current and of a train rushing through the air at 110 miles an hour would constitute a real danger unless care was taken by the public?—Yes, but in exactly the same way that every existing electric railway must be a source of danger.

Concluding his evidence, Mr. BEHR said he had estimated the passenger traffic quite irrespective of the number of people carried at present. He estimated that 7,500 passengers would be carried daily. That was not a large estimate for a population of nearly 2,000,000. In his opinion, in the end, when the people get accustomed to travelling, they would not be able to carry all the people with the service they now proposed, and many would have to go by the present train service. As a proof of this he could give the figures of the Liverpool Overhead Railway. In the old times about 2,000,000 of people travelled by the omnibus service; in 1895, the first year of the railway, 5,000,000 of passengers were carried, and last year the number had risen to 10,000,000. Taking the present traffic, he estimated the revenue would be sufficient to pay interest at 5 per cent. on the ordinary share capital. Electric traction, carried out on the system of light and frequent trains, was much cheaper than steam traction. He had put down 50 per cent. of the receipts for the expenses, but he believed the cost would be nothing like that amount. In his opinion, this railway would cause such a relief of the through traffic that the other railway companies would not suffer, and they would be able to give extra facilities to their goods and local traffic. He thought everything had been done to test the invention which could be done without Parliamentary authority.

The LORD MAYOR OF MANCHESTER (Mr. Thomas Briggs) said he was of opinion that greater dispatch was necessary in the traffic between the two towns, especially in the cotton trade. The time taken by the express train was 45min., and if this could be reduced to 20min., and the number of trains increased, there would be certainly a large increase in the passenger traffic.

Mr. R. E. COOPER, C.E., said he had had large experience in railway works and had examined the plans of the proposed railway and the details of the construction of both the permanent way and the cars. He considered the proposal feasible. The line would convey passengers with perfect safety at a high rate of speed. The electric traction offered many advantages over the steam railway. The ordinary locomotive had to carry its own fuel, which the electric car had not. On an American railway, between Buffalo and New York, the Empire State Express had attained a speed of 70 miles an hour, but this was quite exceptional. He knew the Budapest railway, which was nearly straight, an advantage that could not be obtained in England. The benefit of the mono-rail system over the double-rail was that on going round a sharp curve at high speed the outer rail on the double-rail system would have to be raised to overcome centrifugal force. Neither of these disadvantages applied to the mono-rail system. By the present system a speed of over 60 miles an hour was commercially impossible. The new line seemed to him to offer a more than ample reserve of safety. He had examined the estimates which had been submitted by the promoters, which he considered were sufficient.

M. ERNEST GERARD, engineer-in-chief of the State Railways of Belgium, gave evidence of the results on the experimental line near Brussels. This line was three miles long in the shape of an ellipse, and 75 per cent. of the line consisted of curves. In his opinion the proposed line avoided the danger of derailment and would give greater safety than the ordinary permanent way. The weight of the carriage at Brussels was nearly 72 tons, but with a carriage properly constructed the weight could be largely reduced and the speed very much increased. In his opinion, a speed of 100 to 110 miles an hour could be easily and safely attained. The present Belgian Government did not consider it expedient to incur the expense of railways on Mr. Behr's plan to extend the present railway system. It was, however, quite possible that another Government might have a different opinion. At Brussels the highest speed attained was 94 kilometres an hour. After travelling through the circle once it was not possible to attain the maximum speed on account of want of power and the somewhat sharp curves. At certain points he had himself observed a speed of 120 kilometres.

Mr. F. C. Dawson (F. C. Dawson and Co., Liverpool), Mr. J. H. Macmillan (managing director of Messrs. Sales, Schwabe and Co., Manchester), Col. Robert Bridgford (J. R. Bridgford and Son), and Sir W. H. Bailey (W. H. Bailey and Co., Salford) spoke of the strong desire in the district that the scheme should be carried out.

Sir W. H. PREECE said he had carefully studied the plans of the proposed railway which was to be worked by electricity on the mono-rail system. It was proposed to have a generating station at Warrington, almost at the centre of the line, and a most convenient place for coal and water. The current would be generated on the high-tension multi-phase principle at Warrington and there transmitted by transformers located along the line. The correct term for the system proposed is rather tri-phase, because it consists in transmitting from Warrington to each end of the line three alternating currents following each other in succession. The advantage is that these three currents following each other prevent any external disturbance. That system of distribution was eminently suitable for the purpose. They had ample experience of working it in America, in Switzerland, and in Dublin. The cable would carry 1,000 H.P. and would be laid about two or three feet below the surface. In the case of viaducts it would be in iron troughs built into the viaduct. After the current got to the transformers it would be trans-

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formed into a current of very much less pressure. At intervals of three or four miles along the line there would be sub-stations. These sub-stations would be brick-lined pits in the ground. In these sub-stations would be placed transformers which would either be fixed transformers, transforming the voltage from 10,000 to 1,000 or may be rotary transformers, transferring the tri-phase currents into continuous currents. The transforming would be done by induction, and the currents so transformed and reduced in pressure would be picked up by the train to actuate the motors. If the line was properly constructed, and the conditions of the Board of Trade complied with, there could be no danger to human life. There would be no interference with the electrical signals of any other railway. They were now working a section of the Metropolitan Railway where there were delicate electrical signals at work, and there was absolutely no disturbance from the currents of that line. In this scheme the weight of the electric train proposed to be run would be about 45 tons, and the speed 110 miles an hour. To attain that speed as soon as possible there would be a down gradient from the stations at each end. The departure from a station would be downhill, and the approach to the station would be uphill. That aided very much in the acceleration of the train, and enabled the high speed to be kept up till nearly the end. Electric traction had two merits over steam or locomotive practice. The first great merit is that you can at once apply through your motors the absolute maximum power required to produce a certain acceleration. They could at once apply, if needed, either at Liverpool or Manchester, at the starting of the train 2,000 H.P. The second was that the electric motor is a constant application of force. The wheel bites the rail with a constant grip so long as your current is on. With a locomotive the grip is reciprocating, or rather it is variable. The grip is not constant, that is why the driving wheels slip. Witness gave an interesting illustration of this fact. On the Metropolitan District Railway, he stated, on the line between Earl's Court and High-street, Kensington, there happens to be a very awkward incline of 1 in 43. We selected that length for the preliminary test because it contained that awkward gradient. Our train weighed 180 tons. We weighted it up with pig iron to 220 tons, representing a train carrying 800 passengers. The locomotive people were rather anxious to try their locomotive against an electric motor. The locomotive weighing 50 tons was attached to the train, which thus weighed 270 tons. We went on this incline and stopped. We shut off our current and then asked the locomotive authorities to put on their steam. They did. The wheels slipped, but the train did not move. They could not move the train. So our turn came. The current was put on, the train walked up nicely with the 220 tons plus the locomotive of 50 tons. Then, to show the power we had on this incline, we set the two against each other. The locomotive was put in opposition. So the electric motor had not only to take its 220 tons, but it had to work against all the power the steam could bring against it. We walked up. Electricity was victorious.

Continuing, WITNESS said one of the great advantages of electric traction was that you could generate the power at a central station and with the greatest possible economy. If the proposed train was run throughout the day at a 10 minutes' interval there would be a very constant load; and with constant loads and large stations they could produce the power at the cheapest possible rate. He was quite sure it was perfectly possible to attain the high speed desired. There was certainly no electrical risk, and he could not see any mechanical risk. The question of brakes was one to which he had given considerable attention. It was very difficult to give an opinion because they had no experience of brakes on trains going at the rate of 110 miles an hour. The experience of air brakes did not extend beyond a speed of 70 miles an hour. How the brake would act at 110 miles an hour was a question of experience and not of opinion. He certainly thought it possible, as Mr. Behr proposed, to throw out louvres or shutters in front of the train to increase the air resistance. In his opinion they would be able to stop a train going at 110 miles an hour in 1,500 yards. An electric brake was possible. It was theoretically easy to apply the current on a brake, but that of course was a thing which was quite the subject of experiment. As to the signalling there would be no need for any signals except at Manchester, Warrington and Liverpool, which would be on the lock-and-block system of automatic signalling. On the line everything would be done by electricity: the signals would be raised, the switches worked, and everything done by the current. Then they could automatically, if necessary, have a section of the line without any current at all, so that if a train passed its signals it could not move. By that means he thought security would be made more secure. There would also be along the line—from end to end—a telephone circuit which would give the driver of the train the power at any time to communicate with Warrington, or Manchester or Liverpool. And it was possible, and even easy, to give the driver, by wireless telegraphy, the means of communicating to his two terminal stations from any point of the line when he was in motion.

Mr. BALFOUR BROWNE: Apart from wireless telegraphy it is possible to telegraph from trains in motion at the present time by induction?—That is what I mean by wireless telegraphy. People seem to imagine that whenever they hear the word "wireless" telegraphy that it is the Marconi system. Wireless telegraphy existed as a practical thing long before Hertzian waves were heard of, and long before Mr. Marconi came to this country. We at the Post Office have for the last 18 years (since 1882) been working very carefully and very assiduously on that very subject.

WITNESS proceeded to deal with the estimate of working expenses. Taking the trains as running every 10 minutes in the morning and night, and every quarter-of-an-hour during the middle of the day, the car mileage would be 1,500,000 miles a year. He estimated the cost of locomotive power would be 5·57d. per car mile, and the total cost of working 11·97d. per car mile. These estimates were based on a car mileage of 1,500,000 miles a year, and on the assumption that the energy required from the the generating station per car mile would be 7·5 kilowatts. Witness gave a long and detailed statement of the connection between horse-horse and currents and the construction of motors. At 110 miles an hour the driving wheel would have to go at the rate of 750 revolutions per minute. These revolutions were well within the margin of safety. There are many machines at work, working up to 10,000ft. per minute, and Parsons' and Laval's steam turbines work at 30,000 revs. per minute.

In cross-examination by Mr. Worsley-Taylor, Q.C., WITNESS said the greatest speed got by electric traction had been 85 miles an hour, on the experimental line at Brussels. He believed they had got to 60 or 70 miles in America, but the highest speed he had known in his experience was 39 miles an hour on the Metropolitan line.

Mr. S. B. COTTRELL, who attended in pursuance of an order of the Speaker, said he was engineer and general manager of the Liverpool Overhead Railway. That railway was about 6½ miles long and was carried al ng the whole dock front of Liverpool and Bootle. He had been a member of the sub-committee appointed to enquire into the feasibility of the present proposal, and in his opinion by the mono rail system the risk of derailment was overcome, and a much higher rate of speed could be secured than was possible on the two-rail system. He thought the anticipated speed of 110 miles a little high, though they could possibly at short intervals and with short sections attain 100 miles. As to the question of brakes, electrical brakes were used in America, and on the General Electric Co.'s system, in New York, they stop the train at the rate of 5½ft. per second. His experience of electric traction proved that with a frequent service the cost was very much below steam traction. On his railway what might be called the locomotive cost was 4½d. per train mile, whilst on the great railways the cost varied from 8d. to 11d.

Mr. H. F. PARSHALL said he was resposible for the designing of the electric plant on the Central London Railway. He had read the proposals of the bill, and was satisfied that a speed of 110 miles an hour could be attained without any excessive expenditure of energy. There were a good many lines in America at the present time where they got a speed of 60 miles an hour, and they were becoming more popular and the rate of speed was being increased. They could get a speed of 45 miles or 50 miles an hour on the Central London Railway if they desired, but they had only half-mile runs. That line was 6 miles long, and the whole journey would take 25 minutes. To make that speed the trains had to get up to a speed of 30 miles an hour between stations to make an average running time of 15. He saw no reason why 110 miles or even 150 miles should not be attained. The only limit to speed was the cost of obtaining it.

Dr. EDWARD HOPKINSON said he had no doubt whatever that the trains could run on the line as proposed with safety and economy at a very high speed. He considered 110 miles an hour a practically safe speed. The system of construction called the mono-rail was a highly advantageous system for the purpose. He should place the limit of speed to be obtained on any electrical system at from 120 miles to 130 miles an hour. This limit was governed by the strength of the materials used. The cost of the electrical equipment of this line would be between £450,000 and £500,000.

This was the whole engineering evidence and numerous witnesses were examined to prove the desirability of the railway from a business point of view, and as to the estimates for land and property to be acquired (£451,600).

Mr. W. MATHER, M.P., said he was of opinion that the Brussels tests had been conducted on an unusually large scale for experiments, and that the next step that should be taken was the construction of a railway under such conditions as was here proposed in this case. He thought this scheme provided an opportunity that should be seized by the railway companies in order to discover by what means in the future they could accelerate their express traffic, and run the traffic at a cheaper rate, at the same time relieving the congestion upon their lines. He had thought they would desire to know how far electrical power could be used to move express trains, and had hoped that, instead of opposition, they would have given every encouragement to the enterprising men proposing to make this railway. He looked upon this railway, in fact, as a pioneer scheme, and an important object lesson to the whole country, and with the hope, indeed the anticipation, that for the sake of its benefits the companies would be willing to run the risk of some reduction in their passenger traffic. He (Mr. Mather) would be glad to invest money in the scheme, and would advise his friends to do so.

This concluded the case for the promoters.

Mr. R. SMITH, for the District Council of Irlam, contended that it was unfair that for some theoretic advantage to Manchester or Liverpool the interests of his large district should be seriously and permanently injured. This bill, which did not pay any attention to the interests of the district through which it passed, should not be favoured by the Committee. Parliament should require that a railway traversing a district like theirs should provide for the local as well as the terminal traffic.

The MAYOR of SALFORD (Ald. S. Rudman), Ald. PHILLIPS, and Mr. J. CORBETT (borough engineer) stated that the new railway would disfigure the borough and depreciate property.

Mr. BEHR was recalled and examined by the Chairman as to the possibility of carrying the railway in a tunnel through Salford. He said the tunnel, unless of enormous sectional area, would not allow of the speed being attained, and would cost three times the money. Moreover, the public would not like to travel in a tunnel at 110 miles an hour. With a tunnel the journey would probably take 25 min. instead of 20 min.

Yesterday (Thursday) Mr. FREEMAN, Q.C., addressed the Committee on behalf of the Salford Corporation, and Mr. LITTLER, Q.C., for the Cheshire Lines Committee. The latter urged that the measure was an ill-considered one. Mr. SQUAREY spoke for the Garston District Council, and called two witnesses to prove there was no public demand or necessity for the proposed railway, Sir WILLIAM POLLITT, general manager of the Great Central Railway Co., gave evidence, and the proceedings were adjourned.

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METROPOLITAN DISTRICT RAILWAY BILL.

The Select Committee of the House of Commons, presided over by Col. Cotton Jodrell, on Thursday last commenced the consideration of this bill, which, among other objects, authorises the erection of electricity works at Lots-road, Chelsea, for the generation of power for the operation of the Metropolitan and Metropolitan District Railways by electricity, and the laying of mains for the distribution of current at points near Warwick-road and West Brompton stations. Opposition to the bill came from the London County Council (who object to the one main running through the public streets) and the West London, Great Western, and London and North Western Railway Cos. (who object to the other main running over ground belonging to them *en route* to Warwick-road).

Mr. S. POPE, Q.C., for the promoters, said the Metropolitan District and Metropolitan companies had a general power of working by electricity, but the real difficulty in electric traction was in dealing with lines where ordinary locomotives had also to be used. It had not been found that the question of the movement of heavy goods by electricity had yet been solved. The question of the use of electricity on the railways had been engaging the attention of the two companies, and since 1897, with the assistance of Sir J. Wolfe Barry, they had been engaged in experiments to solve the problem. They thought they had now arrived at a solution, and it was hoped that, if the present bill passed, electric traction would within a short time supersede steam. It was sought to acquire a site on the banks of the Thames, at Lot's-road, Chelsea, for the erection of a generating station, from which the electric power would be conveyed for use on the railways by means of two lines of pipes conveying cables, which would prevent any question of electrolysis of gas pipes. One of the cables would run by way of the public streets to a point on the railway at Warwick-road, and the other would pass by the west side of Chelsea, past Brompton Cemetery, to near West Brompton Station. The two lines were necessary to provide an alternative power in the event of failure or obstruction. To the second line there was opposition from the West London Railway, over some of whose unoccupied land it was proposed to pass.

Sir JOHN WOLFE BARRY, K.C.B., described the experiments that had taken place between Earl's Court and High-street, Kensington, which he said had proved so great a success that trains would within a week be run for passenger traffic between those points. The cost of substituting electricity for steam traction over the portions now scheduled would be £500,000. Electric traction would be used between Putney and the Mansion House, or perhaps Whitechapel, but not at present on the Hammersmith route. Its use would be confined to the underground lines. The site for the generating station was a most convenient one, providing plenty of condensing water, and coal could be brought to the works at the least expense. It was under consideration to take another site at the North of London for the supply of the Metropolitan Railway.

Sir WILLIAM PREECE, K.C.B., said he had given evidence before Lord Cross's Committee of 1898, which had recommended the use of electricity on these lines. The experiments, he considered, had shown that electricity would revolutionise underground railway travelling in London, solve the question of ventilation, make the trains more comfortable, cleaner, lighter and quicker, and many people who now used cabs and omnibuses would then travel by them. The proposed site for the generating station on Chelsea Creek was considered with great care. Before Lord Cross's Committee he had pointed out the serious consequences of the multiplication of generating stations in London. Last year there were applications to Parliament in respect of 43, and this year there were many more. There was the smoke nuisance, as Welsh coal could not always be obtained. Then, in addition, there was the congestion of traffic caused by the delivery of coals and the removal of ashes, which traffic through the streets was an objectionable one. Taking London altogether, with its 70 or 80 generating stations, the matter was a serious one. These objections were removed by placing a generating station on the river, as was now proposed, as the coals and ashes could be dealt with by water. The nuisance was also prevented of the clouds of steam passing into the air, and dropping in the form of rain into the adjoining streets, as plenty of water was available for condensing purposes. Each of the proposed mains would carry 1,000 H.P. Ordinarily there was a magnetic influence from a cable, so much so that the currents on the South London Railway affected the instruments at the Greenwich Observatory so that certain investigations had to be abandoned. But by the conductors proposed to be used there would be no external field, no disturbance of any sort or kind. There would be no electrolysis, and the West London Railway might feel absolutely assured that the laying down of these mains alongside their line would have no disturbing influence either upon telegraphs or telephones. This was due to the fact that the currents to be used would be alternating—in turn each conductor would become a return for the other. This was known as the tri-phase system, and each conductor in turn being subject to alternation of current prevented all outside influence. There would be a dynamo at the station generating three currents following each other, which would work at 10,000 volts, and the current would be transmitted to Earl's Court. There would be ten sub-stations along the route of the lines where the 10,000 volts would be reduced to 500 volts, at which pressure the trains would be worked. Another source of disturbance was leakage to earth from bad joints or defective insulation, but any leakage in this case would simply be from one wire to another affecting nothing outside. The cables would be laid either in another pipe or, as he preferred, in iron troughs filled with pitch. He did not believe inspection would be necessary once in five years.

This closed the case for the promoters, and after hearing witnesses for the London and North-Western Railway Co., the Great Western Railway Co., and the London County Council against some of the clauses of the bill.

On Monday the Committee decided to pass the preamble of the bill The clauses were afterwards considered, and the bill ordered to be reported to the House.

CITY OF LONDON ELECTRIC LIGHTING CO.'S BILL.

This bill came on Wednesday before the Select Committee of the House of Commons, presided over by Mr. A. H. Brown. The opponents of the bill were the Corporation of London and the Vestry of St. Saviour's, Southwark, but the latter opposition was, early in the proceedings, settled.

Mr. BALFOUR BROWNE, Q.C., in opening for the bill, said the company were authorised under several provisional orders to supply electricity within the City of London. When the company was first authorised to supply electricity the Commissioners of Sewers were the authority with which the company had to deal, and all their orders were founded on contracts obtained with the Corporation of the City of London. Under those agreements the company were laid under most onerous burdens, but they got what they thought was a *quid pro quo*, that was, the exclusive right to supply electricity in the City. By the agreements the City of London Co. were obliged to set aside various reserve funds. First of all, out of the revenue of the Company they had to take 7½ per cent. on the value of the capital for a depreciation fund, to be used for the maintenance, renewing, or replacing the machinery and appliances necessary to the undertaking. In addition, 5 per cent. had to be laid away for reserve fund—not applicable to dividend—before any profits could be divided. Under these provisions very large sums had been laid away. The 7½ per cent. depreciation reserve No. 1 now amounted to £71,826. 2s. 2d., and the depreciation reserve No. 2 to £37,107. 18s. 10d., and the reserve fund to £16,349. 6s. 6d., a total of £125,283. 7s. 6d. The whole of this was invested in gilt-edged securities. If it could be used in the company's undertaking it would be there used at the ordinary rate of percentage, but as it had to be invested, they were practically getting nothing upon this enormous sum of money. It was the bargain that these monies were to be set aside, but for doing so, the Company were to have an exclusive right of supply in the City, and until last year they had enjoyed that right. At that time the Charing Cross and Strand Electricity Supply Corporation were allowed to obtain powers to come into the City, the Corporation being advised that the agreements entered into with his company were void. A week or two ago Mr. Justice Farwell had decided that those contracts were not void, but the mischief had been done. The Charing Cross Co. had got into the City, and competed with the City of London Co. free from the obligations that had been imposed on that company. What was now asked was that as the Charing Cross Co. had been let in the City of London Co. should be put on the same basis as that company, and freed from those obligations. It would be in the interest of the consumer that this should be done. If the £125,000 could be put to capital account it would bear no dividend, and therefore the company would be able to manufacture electricity more cheaply, and sell to the public more cheaply. The only other provisions of the bill were for the extension of the company's generating station in Southwark, and for erecting certain workmen's dwellings.

Mr. J. CECIL BULL, manager and secretary to the City of London Electric Lighting Co., gave evidence in support of counsel's statements. The subscribed capital of the company on Dec. 31 last was £400,000 6 per cent. preference shares and £800,000 ordinary shares. In addition to that there were £400,000 5 per cent. debentures, making £1,600,000 in all. The company had 1,900 customers, and supplied 460,000 8 c.p. lamps. The gross revenue of the company was, in 1899, £187,253, and the net revenue £87,323.

Cross-examined for the City Corporation, WITNESS said he did not say that nothing would be put aside as a depreciation fund if the proposals of the bill were passed. The majority of the electric lighting companies invested what they placed aside in their business, and that was what the City Co. desired to do.

The promoters' case being closed, counsel for the Corporation addressed the Committee against the restrictions on the company as to the reserve funds being abrogated.

The Committee ultimately decided to pass the preamble of the bill, but limited the application of the reserve funds to capital purposes, not allowing them to be applied to dividend.

A clause was brought forward by the City Corporation for the restriction of the company's charges for electricity to such as were authorised in the case of the Charing Cross Co., but this the Committee rejected, but decided to insert a provision giving the Corporation certain powers of purchase over mains and so forth outside their jurisdiction but necessary to the supply of electric light within the City.

GOVERNMENT TELEGRAPH MESSAGES.

In the House of Commons yesterday (Thursday), Sir Edward Sassoon asked the Secretary to the Treasury if he would state the total amount paid during 1898-99 to the Eastern, Eastern Extension, Indo-European, and other associated cable companies for messages sent and received on Government service by the Foreign, Colonial, Indian, War, Admiralty and other Government offices.

Mr. HANBURY: There is no official knowledge except in the case of the India office of the amount of charges on telegrams sent from abroad over these lines to Government departments in this country during 1898-99. The charges on telegrams handed by the Post Office to these companies amounted to £21,976. This includes charges which the companies would have to pay out to various administrations for terminal and transit charges, but it does not include telegrams handed in direct to the companies and not through the Post Office. The War Office paid £3,016. 19s. 1d. direct to the companies in 1898-99, and the India Office £5,777. 11s. 1d., while the payments to India for Government messages home (including transit) are estimated at about £29,000. The Colonial Office and Admiralty never pay anything direct to the company. I have no figures available as to direct payments from other Government departments, but, excepting the Foreign Office, they are, presumably, of relatively little importance.

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COUNTY OF DURHAM AND TYNESIDE ELECTRIC POWER BILLS.

The Special Committee of the House of Commons on Electric Power Bills recommenced, on Friday last, its inquiry into the partially-competing schemes of the County of Durham Electric Power Supply Co. and the Tyneside Electric Power Supply Co., Sir J. Kitson again presiding.

Mr. C. McLAREN, M.P., chairman of Palmer's Shipbuilding Co., Jarrow, supported the Tyneside scheme and favoured the idea of competition between the Durham Co. and the Tyneside Co.

Mr. EUSTACE SMITH, chairman and managing director of Smith's Dock Co. (Ltd.), South Shields, supported the Tyneside Co.'s Bill, and said he reckoned that if that company were allowed to serve the south side of the Tyne as well as the north side his company would save about £1,800 a year, on the schedule of prices proposed by the promoters.

Mr. SIMPSON, chairman of the Ryton District Council, and a large colliery proprietor, stated that water accumulated in one of his pits, and he had considered various methods of getting rid of it. Steam-power was not practicable, compressed air-engines were rather expensive, and electricity was found to be the cheapest power to employ. If he could obtain a supply of electric energy from the Tyneside Co. it would be of great advantage and would save enormous expenditure.

Lord KELVIN said he had satisfied himself that electrical power at a very high voltage could be safely transmitted for great distances. A current with a pressure of no less than 10,000 volts was being constantly transmitted between Deptford and Trafalgar Square, London, without danger. He regarded the scheme of the Tyneside Co. as a well-devised one and believed that it would provide electrical power in the cheapest and most efficient form. The compactness of the area on the two banks of the Tyne was an advantage, and it would be disadvantageous to plant the system on the edge of an area. The adoption of separate systems on the north and south sides of the Tyne would destroy in a great measure the desirable compactness of the area and would injure both the supply companies and the consumers because it would increase the expense. To limit the Tyneside Co. to the north bank of the river would be objectionable, especially having regard to the needs of the chemical industry. He was of opinion that, while competition in regard to detailed distribution was sometimes bad, competition for supplies in bulk was not bad. As to the allegation that it would be unfair to start a large electric power supply company in a district in which there were already bodies having powers of supply, he was of opinion that it was quite fair to allow anything to be done which would result in any benefit to the public. He thought it desirable that Parliament should, as far as possible, endeavour to facilitate the use of electric energy. The smallest quantity of plant by means of which electricity could be produced at an economical rate was that which would be represented by 1,000 H.P. In a scheme like this he thought that a start should be made with 3,000 H.P. or 4,000 H.P.

Mr. JAMES SWINBURNE said that, generally, he agreed with the evidence of Lord Kelvin. It was certainly desirable to establish large generating stations from which a cheap supply of electric energy could be given. A company could begin to supply really economically at from 4,000 H.P. to 5,000 H.P., and the greater the horse-power the more economical the supply would be, though the saving would not be very large, except in the case of a very large supply. He did not think there would be any harm in allowing the two companies to compete on the south side of the Tyne.

On Monday Mr. SWINBURNE again went into the box, and said there seemed to be some little confusion with regard to the size of the plant which could be worked economically; he wished to say that from 1,000 H.P. to 5,000 H.P. was the minimum at which electric plant could be worked with economy.

Replying to Mr. Ashton, Mr. SWINBURNE said the sliding scale proposed by the Tyneside Co. was in such a form that he did not think there would be any difficulty in working it.

Prof. S. P. THOMPSON agreed with Mr. Swinburne that from 1,000 H.P. to 5,000 H.P. was the minimum, so far as coal consumption was concerned, at which electrical plant could be worked with economy. He knew of no generating station which had grown so large that it had been found economical to reduce its size. He was of opinion that, in the interests of the district, the area of the Tyneside Co. should not be restricted to the north side of the Tyne. It would be obviously advantageous to the more economical working of such a station that the district to be supplied should be divided longitudinally. He had inspected some large power stations abroad, including Niagara and Rheinfelden, and in such cases it had been found very advantageous that the districts should be large and that the centres should be large. It had been of very great importance to the manufacturing industries that had grown up in and around Niagara, Rheinfelden, Paderno, and elsewhere, that the works should be on a large scale. In all these cases, no doubt, the power used was water power, but he apprehended that the economy would be the same in cases where steam was substituted for water power.

In answer to Mr. Bartley, WITNESS said it was the case that no generating station at present existed where 10,000units, mainly for power purposes, were produced by steam power. He thought it would be more advantageous to divide the Tyneside district by a line drawn from north to south, and to adopt the division of the river.

This closed the cases for the promoters of the two bills.

For the Tynemouth Corporation, Mr. J. F. SMILLIE, borough surveyor, stated that in 1891 the Corporation obtained a provisional order for supplying electricity for public and private purposes, but there was then no demand for current. In 1898 a firm of engineers advised them in regard to the setting up of an installation for the town. The works had now been begun, and unless the Tyneside Electric Power Co. were allowed to encroach on their area there was every reason to believe they would have to meet a very good demand for electric lighting. It would be possible to increase the supply if the demand increased. The Corporation would be in a position to supply current in a couple of months. He was of opinion that there ought to be a local monopoly, so far as the distribution of power in their own area was concerned. The Tyneside Co.'s schemes meant unfair competition, and to that the Corporation strenuously objected. The Corporation were willing to extend their works to any extent that might be necessary. They had already expended £35,000 on them.

Mr. SQUAREY, Q.C., having addressed the Committee on behalf of the Corporation of Tynemouth,

The CHAIRMAN said the Committee wished him to inform those of the petitioners against the bill who were local authorities, that the position of a manufacturer who was within the district of a local authority, and who wanted a supply in bulk was occupying their attention. If the local authority was unable or unwilling to give such a supply or to give it only at a prohibitive price the manufacturer under present circumstances must go without.

Mr. PAGE, Q.C., addressed the Committee for the Gateshead Corporation, supporting the Durham Co.'s bill and opposing that of the Tyneside Co. He called

Mr. N. TEMPERLEY, vice-chairman of the Parliamentary Committee of the Gateshead Town Council, who said that the Corporation had a right to buy, after the expiration of a certain period, the entire undertaking and goodwill of the companies which supplied Gateshead with electric energy for tramways and lighting. They thought it would be unfair that the Tyneside Co. should have a right of competing with the Durham Co. in the supply of electric energy in Gateshead, and they objected to the Tyneside Co. being allowed to put mains in their streets.

Mr. SHORTT then addressed the Committee on behalf of the petitions of the Gosforth and Wallsend District Councils against the Tynemouth Co.'s bill.

On Tuesday the CHAIRMAN said: I desire to state the procedure of the Committee. We propose to hear the promoters and the opponents of each bill before we give our decision. We shall give no decision on the Tyneside and the Durham bills until we have heard the cases for and against the other bills in our list. We have practically the direction of Parliament that there shall be uniformity in the clauses. As the cases are different, we might find principles in some bills which were not to be found in the others. The Committee therefore resolved to hear the whole series of bills before giving their decision.

Evidence was then heard in support of the petitions of the Hebburn and Felling District Councils against both the Durham and Tyneside bills, and Mr. PEMBER, Q.C., addressed the Committee for the Corporation of Newcastle. He stated that there were two electric lighting companies supplying Newcastle, and the Corporation had power to supply their own tramways with electric energy and to light their own streets. Though as a general proposition they could not oppose the laying of mains through their streets, they thought there were special circumstances in this case which rendered it unnecessary that they should be put to this undeniable inconvenience. If the promoters of the Tyneside bill had chosen the western side of Newcastle as a site for their generating station instead of selecting Wallsend, which was on the eastern side, it would have been unnecessary to lay mains in the streets of the city.

Mr. MORETON SMITH, for the Walker District Council, contended that, inasmuch as Parliament had given that body the right to supply electric energy and light, no other authority ought to be allowed to go into the district and compete with it. If the Committee tampered with existing companies and local authorities by passing a bill of this kind it would create a competitive supply of a most dangerous character.

Ald. J. M. REYNOLDSON, for the South Shields Corporation, said that in 1891 that Corporation applied for and obtained an order, under the Electric Lighting Acts, for the supply of electricity. The tramways belonged to them, and at the end of the present lease—which had five years to run—they proposed to substitute electric for horse-power. The Corporation's generating station was established and the supply was commenced in September, 1996. They began with only four or five consumers, but the demand steadily increased, and before the end of the first winter it was found necessary to increase the plant at the station and to extend the mains. In 3½ years their capital expediture had increased from £30,000 to £100,000. The Corporation were prepared to put in the proper plant for supplying at the cheapest possible rate all the large works within their area. They had been most anxious from the first to supply electricity for power purposes. The effect of allowing the Tyneside Co. to compete with them would be to jeopardise their electric power undertaking, in which the ratepayers' money was invested.

[Pressure on our space compels us to leave over Wednesday and Thursday's proceedings to our next issue.—ED. *E.*]

UNDERGROUND TELEGRAPH WIRES.

In the House of Commons on Friday, on the vote to complete the sum of £3,770,330 for the Post Office Telegraph Service, Mr. CALDWELL drew attention to the importance of underground telegraph wires. Owing to storms, the North of England and Scotland were frequently without telegraphic communication, and he suggested the laying of underground wires in order to meet cases of emergency, not entirely for the purposes of the telegraphic service. This system had been adopted on the Continent and worked well.

Mr. HANBURY said the underground wires laid between Birmingham and London were the only underground wires at present in this country, and were laid because that route was the principal course which the storms followed. It was an experiment, and if successful would probably be extended in other directions. The method of insulating wires was now better than it used to be and more economical.

Sir W. C. GULL drew attention to coast communication around Devonshire, and said there were several places where telephonic communication

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was defective. He hoped proper arrangements would be made for the telephone service to be fully utilised when the coastguard was mobilised, and for the purpose of surprise practice with the lifeboat, especially at night. He asked that the lifeboat committee should be allowed to use the telephone.

Mr. HANBURY said that much had been done recently to extend telegraphic facilities. With regard to the use of the telephone at coastguard stations in connectious with lifeboat surprise practice, fears had been expressed that the alarm might be given too frequently, but he would see what could be done in this relation.

MUNICIPAL TRADING.

The Joint Commmittee appointed to consider the question of Municipal Trading held a meeting at the Lords Committee Room yesterday (Thursday), when the Earl of Crewe was elected chairman, and it was arranged to hold a further meeting to consider the course of procedure and to fix the date of the first meeting of the Committee.

PARIS EXHIBITION NOTES.

(FROM OUR CORRESPONDENT.)

PARIS, *Friday, May 11.*

As a set-off to the general unreadiness of the main exhibits, mentioned in my previous notes, a word of praise must be given to the German sections. Up to May 7 the only machinery at work in the electricity section were those installed by German firms, and in other sections of the exhibition the German exhibits showed a decided forwardness compared with those of other nations. This forwardness was taken advantage of when the lighting up of the exhibition was attempted on Sunday evening, May 6, after the thunderstorm. The success of this attempt, which could only have been partial in any case, was rendered almost futile, so far as the splendid electricity building was concerned, by a dastardly act on the part of a discontented workman (whether French or German did not transpire), who placed a quantity of sand in place of lubricant in one of the main lubricators of the fine 150-H.P. engine installed by the Vereinigte Maschinenfabrik Augsburg.

Another legitimate cause of complaint is the absence of official catalogues. The list issued by the British Commission is of some help to the visitor, although not by any means all that could be desired. It is all very well to set out that a certain exhibit is in "the gallery," but when the aforesaid gallery extends over a large area this direction is not sufficient, and my own patient endeavours to locate the Accumulator exhibits in "the gallery" were, after an hour's careful search, fruitless. Certainly, if the sectional catalogues to the Paris Exhibition are to be of service to foreign visitors they should receive considerable revision and be furnished with more adequate direction-marks. The expenditure of a little extra time and labour on the part of the compilers of these publications will merit and doubtless receive the benedictions of visitors. These remarks fully extend to the altogether inadequate sketch maps which accompany the British section catalogue, which, devoid of lettering, are of little service. A final word as to the catalogues. I learn there are to be 22 volumes in all, and that the price is to be 3fr. 50c. each, a trifle of, say, £3 sterling!

The outside shows form a conspicuous and attractive feature of the exhibition, and by far the most conspicuous, and at the same time the most popular, are those of an electrical or mechanical character. The "Plateforme Mobile," with its no-speed, half-speed, and full-speed tracks, is well patronised, and at 50 centimes per head must be a great success financially. It maintains its monotonous course with almost unfailing regularity, only occasional stoppages occurring—one on Sunday, May 6, lasted for about 15 minutes. Needless to say, during these occasional stoppages the motionless crowd looks very foolish, and has its work cut out to appear unconcerned. Such contretemps afford occasion for merriment to those who are not at the moment patronising the "Plateforme Mobile."

The electric railway, which circuits the fringe of the exhibition grounds, is immensely popular, and well it may be so, for here for 25c. a good view of the exhibition exterior and of the environs of the extensive area covered by the exhibition can be obtained with ease and comfort. There are five stations on the electric railway. The trains, which are very compact, consist of three covered carriages, with accommodation for about 200 passengers. The distance covered by the line is 4 kilometres of single track throughout, except for the short section required for the "yard." A 2-minute service is given, the entire journey occupying about 25 minutes. But few interruptions to the regular running have so far occurred, and singularly, one of these stoppages happened on May 6, at the time of the interruption to the moving platform, and passengers by both were able to regard one another for a brief space of about five minutes in unexpressed but no less heartfelt sympathy. The situation was not devoid of humour. The fare of 25c. covers the entire journey by the railway, and there is nothing to prevent ve passenger retaining his seat from early morn to dewy eve, except, fc some, the necessity for food and drink. This remark applies alss to the "Plateforme Mobile," which is open from about 9 a.m. to 7 or p.m., and traverses a course, for most of the distance, on the outsic of the electric railway. A few seats are provided on the full spee platform, and the number might with advantage be increased. We shall doubtless see more of the "Plateforme Mobile," which, like tl terrible switchback, has come to stay, and it is advisable, therefor to make it as comfortable as possible. Both the electric railway and the moving platform afford an easy means of getting from one point to another of the exhibition grounds.

So far there is no sign of the automobile within the exhibition, although means are at hand for easy wheeled progression. Outside the grounds, in every part of the city, the motor-driven vehicle is much in evidence. Hundreds (many hundreds) of two, three, four and five-wheeled vehicles, holding from two to eight passengers, are dashing through the noble thoroughfares of this the gayest of gay cities. And the public, ladies especially, patronise these smart turn-outs, which have caught on in Paris to an extent which is as general as it is surprising—and, moreover, as gratifying as it is extensive. Seen in considerable numbers, all the novelty (or perhaps peculiarity would be better) disappears, and so accustomed is the pedestrian in Paris to the presence of the motor vehicle that he or she steps back to allow it to pass without apparently giving it a second thought. Public opinion is in favour of the automobile in Paris, and the advent of the exhibition is the psychological moment for this class of vehicle to cement its unmistakeable popularity. A number of these vehicles are electrically driven, and it is this pattern that will prove the survivor, although there is a comparative absence of smell from the petrel motors in use on the Paris autos that has led to the condemnation of those of this type seen in the streets of London and our chief provincial and seaside towns. The legal charge for the hire of either horse-drawn or electric two-seat vehicles is 1fr. 50c. for the ride anywhere within the Paris area, but a good rule where stoppages are contemplated or a call has to be made, is to hire the vehicle by the hour at 2fr. The hire of larger vehicles of each class are, of course, charged on a higher scale. In each case a pourboire of 25c. is demanded by the driver.

The electric tramway service in Paris is an excellent one. In fact, the means of getting about the city by means of tramways and omnibuses is very complete, except that the advisability for obtaining a numbered ticket before attempting to enter the cars is little understood by the average Britisher. It may be explained that, without this numbered ticket (obtainable at all the stopping places of the cars and omnibuses), the chance of securing a seat outside is nil, and a seat inside is only possible after the numbered tickets are exhausted—*i.e.*, if you have been waiting an hour without a ticket the last comer with a ticket takes precedence. As the Paris tramways and omnibuses are very crowded this point is worth attention by those who affect this excellent mode of "seeing Paris."

It remains to be mentioned that tickets for the exhibition can be had at any price from 55c. to 1fr., the ruling price being 65c., and this notwithstanding that these ticket are clearly marked "Une Franc." Strangers to Paris should obtain their entrance tickets from the shopkeepers who advertise them in their windows, rather than from the street hawkers, although, doubtless, all are genuine. It should be pointed out that admission is by ticket only, and that tickets cannot be obtained of the officials at the entrances. There are two officials stationed at each entry; one takes the ticket and perforates it, the second relieving you of your ticket altogether. The first issue of these tickets of admission is said to have been 65,000,000.

I have said nothing concerning the hotels—not because there is nothing to say, but because every person I have spoken to on the subject has a different (usually melancholy) story to tell. One word of warning, however—endeavour to obtain accommodation at the best, for the best is, as ever, the cheapest. Above all, avoid the tourist ticket.

Ibero-American Charity.—The tenth anniversary festival of the Ibero-American Benevolent Society was held at the Whitehall Rooms, London, on Monday evening, under the presidency of Sir Weetman D. Pearson, Bart., M.P. A large gathering of the chief Spanish and Spanish-American residents in this country were present, and a gratifying account of the assistance given to deserving candidates for the charity was rendered by His Excellency Don Arturo Baldasano, president of the society. Thanks to the indefatigable efforts of the stewards and the numerous other friends, the society is enabled to continue the good work inaugurated ten years ago. To these funds a large number of telegraph men have for many years contributed, thanks largely to the untiring work of Mr. Ch. Gerhardi, the respected manager of the Direct Spanish Telegraph Co., who on this occasion responded to the toast of "The Stewards." The toast of the evening, "Success to the Ibero-American Society," was given by Mr. E. M. Underdown, Q.C., chairman of the Direct United States Cable Co.

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MUNICIPAL, FOREIGN & GENERAL NOTES.

Alleged Theft.—At Clerkenwell (London) Police Court last week, a clerk named Frederick Purton, lately in the employ of the Jandus Arc Lamp and Electric Co, was charged with stealing letters, the property of his employers. Mr. Adrian Jones, manager of the company's works at Hartham-road, Holloway, N., gave evidence that for some time past he had been convinced that letters of a private nature and private particulars in connection with the works were being purloined, and, in particular, that the two letters, the subject of this charge, had been stolen. The matter having been placed in the hands of a detective, Mr. Jones' suspicions were verified. The *modus operandi* adopted by Purton was to obtain copies of the typewritten originals of letters, and upon being charged with this offence, he asserted that "the letters referred to a branch of the electrical business in which he took a great interest"! A large number of letters were found at his residence in Ruthven-road, Westcombe Park, W. After hearing the evidence the magistrate (Mr. Chapman) asked the grounds upon which the charge of larceny was to be established. Solicitor for the plaintiffs replied that the paper on which the letters were written belonged to the company, but that, of course, was a trifle compared with the stolen confidential correspondence, the betrayal of which to other firms in the same way of business might seriously affect the company. Mr. Chapman, however, held that the charge of stealing could not stand. The offence committed was a very grave one, but, so far as the evidence went, it did not amount to larceny, and prisoner must, therefore, be discharged.

Asylum Lighting.—The new asylum to be built for the Middlesex County Council at Napsbury, at an estimated cost of £360,000, is to be provided with electric lighting plant. The specification is being prepared by the Council's consulting engineer, Mr. W. H. Massey.

Ayr.—The committee recently appointed "to consider and report as to the merits of gas traction as compared with electric traction" submitted a report to the Council last week, recommending the construction of electric tramways on the overhead trolley system at an estimated cost of £57,000. This report has now been adopted by the Council, and the committee have been instructed to appoint an engineer for carrying out the scheme, and to have the necessary specifications prepared and tenders obtained. The line will be constructed to the standard gauge.

Bath.—The City Council have come to an arrangement with a private syndicate for the construction of electric tramways in Bath and the neighbourhood. The syndicate include Sir James Sivewright and Mr. Leopold Hirsch, and they have agreed to reimburse the authority the expenses of their recent application for electric tramway powers. They undertake to lay down a complete system of electric tramways without any liability on the part of the authority, who will exercise their statutory powers to purchase the undertaking of the existing horse tramways, the promoters paying the purchase price to the Corporation. For the first four years the syndicate agree to pay as wayleave to the Corporation £400 a year, for the second four years £450, and subsequently £500 a year. The Corporation reserve the right to repurchase the undertaking at stated periods, and the syndicate agree to repair the track or to pay the authority an agreed sum for carrying out the work. A separate generating station will be erected, and current will not be taken from the Corporation mains.

Bury (Lancs.).—The Tramways committee recommend the adoption of the overhead trolley system on the local tramways which will be reconstructed to the standard gauge.

Cardiff.—The question of erecting a separate generating station for the proposed municipal electric tramways has been discussed and agreed to. It has been further decided to engage an electric tramway engineer, at a salary of £500 per annum. The appointment is advertised in another column.

Cheltenham.—Application has been made to the Local Government Board for sanction to borrow £3,185 for extensions of the electric lighting plant.

Chester.—The Lighting committee have been authorised to substitute incandescent electric lamps for 21 gas lamps in Newtown at a cost of over £400.

Chesterfield.—An inquiry was held on Wednesday into the application of the Corporation to borrow £25,000 for establishing electricity works. Councillor Robinson said a provisional order was obtained in 1894. The General Power Distribution Co.'s bill had brought electric lighting matters to the front, and as they had also received a memorial from tradesmen on the question of supplying electric current, they had decided to establish a municipal scheme which was estimated to prove financially successful in the first year. There was no opposition.

Dock Lighting.—The Leith Dock Commission have authorised their works committee to engage a consulting engineer in connection with their proposed electricity scheme.

Dublin.—The Lord Mayor (Sir Thomas Pile, Bart.) announced at the Corporation meeting on Wednesday that the Local Government Board had sanctioned the loan of £250,000 for electric lighting. There was no truth in the statement circulated that this loan had been refused: as a matter of fact the Board expressed an opinion that the scheme was one of great merit, and was well within the compass of the Corporation to carry out.

Edinburgh.—The Electric Lighting committee recommend the Corporation to increase the charge for electric current for private lighting from 3½d. to 3¾d. per unit, and to reduce the charge on public lamps from £14 to £13 per annum.

Evesham.—The Council are making inquiries into the advisability of establishing electricity supply.

Fire.—Early yesterday morning a fire broke out in the subway belonging to the Central London Railway at the Bank, London, caused by the explosion of a paraffin lamp. Considerable damage was done to the subway works, but no loss of life occurred.

Hanley.—As the accounts of the electricity department for the past year show a deficiency of £1,200 a special committee has been appointed to investigate the cause of so large a deficiency.

Hastings.—An inquiry was held last week into the application of the Council to borrow, among other sums, £1,584 for electric lighting extensions. There was no opposition.

Hindley.—A sub-committee is to report upon the advisability of establishing electricity works.

Hyde.—The Council have approved the joint scheme for connecting Hyde, Stalybridge, Dukinfield and Mossley by a system of electric tramways. It is proposed that the capital for the joint scheme should be contributed by each of the four corporations in equal shares, the profits or losses to be received or borne in equal proportions; that the tramway and equipment be laid and provided by a joint committee, who would also maintain the lines on the county main roads; that each corporation should maintain the track on all the roads within their respective districts; and that the installation and distribution of electric energy both for lighting and power should be under the control of the joint committee. The Hyde Council have further decided to join with the Dukinfield Corporation in applying to the Light Railway Commissioners for an order to construct and work such portions of the tramways in the proposed joint scheme as would be situate within the two boroughs, and the borough surveyor has been instructed to prepare the necessary plans and estimates. The capital is to be contributed by the two corporations in equal shares; the profits and losses are to be received and borne by the two corporations equally, and the undertaking will be worked by a joint committee, one-half to be appointed by each corporation.

The application of the Oldham, Ashton and Hyde Tramways (Ltd.) to the Board of Trade for a transfer of the tramways from the British Electric Traction Co. is to be opposed by the council.

Heckmondwike.—At the meeting of the District Council on Monday, the Electric Lighting committee recommended the acceptance of certain tenders for electric lighting plant. The tenders (which amounted to an aggregate of £14,842, an increase on the original estimate of the consulting engineer, Mr. W. C. C. Hawtayne, of about £1 500) were adopted. Mr. Hawtayne's original estimate was submitted over 12 months ago.

Infirmary Lighting.—The Marylebone (London) Guardians have decided to light their infirmary electrically. Independent generating plant, estimated to cost £5,500 (annual maintenance £903), is to be erected.

Inverness.—Last week the Electric Lighting committee recommended the Council to accept the tender of the Brush Co. for the supply and etection of electricity generating plant. An amendment was moved that the tenders be let out in sections, as it was contended there would be a saving of between £3,000 and £4,000 by this method. Ultimately an amendment for further inquiry was adopted.

Kingston-on-Thames.—The sixth report of the electricity department, covering the 15 months ended March, was presented to the Council on Tuesday evening. The total capital expenditure amounted to £50,674 out of £58,426 sanctioned. The works cost came to 2·608d. per unit, against 3·036d. in 1898; management expenses (£910) and interest and sinking fund instalment (£2,785) amounted to £3,695, so that the total cost per unit was 4·967d., compared with 5·984d. in 1899. The receipts for the 15 months amounted to £7,511 and the expenditure to £7,559, leaving a deficit of £47. 18s. 11d. against £1,112 in the previous year. At the date of the report there were 311 customers, representing an equivalent of 16,130 8 c.p. lamps connected, compared with 211 and 11,856 in 1898. 364,000 units of current were supplied to private consumers, and 99,845 for street lighting. A 200 kw. steam alternator is being put down to meet next winter's load, and will permit of 10,000 8 c.p. lamps additional being connected. Experiments are being made in lighting the side streets by incandescent electric lamps. The report was adopted, and application is made for £15,000 for extensions.

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Kircaldy.—The Council has decided to proceed with their electric lighting and traction scheme, and the Tramways and Lighting committee has been empowered to engage a consulting engineer and to make arrangements for carrying out the project.

Leeds.—The Lighting committee decided on Tuesday to recommend the Council to apply for sanction to a further loan of £28,000 for electric lighting plant.

Light Railways.—The Colne and Trawden, Nelson, and Barrowford light railway orders have been submitted to the Board of Trade for confirmation. Objections to the two former must be lodged by June 6 and to the latter by June 1. The Spen Valley (Ravensthorp to Cleckheaton) and the Barnsley and District Light Railway orders have also been submitted to the Board for confirmation. Objections by June 9.

The Swansea Corporation decided on Wednesday to apply for powers to construct light electric railways in the district.

London Chamber of Commerce.—The annual meeting of this Chamber was held yesterday. The report, which was adopted, stated that 15 meetings of the electrical trades section had been held during the year, and a special committee had been appointed to consider and report upon the threatened municipalisation of electrical undertakings, and arising out of that a municipal trading committee was formed. The Council of the Chamber had addressed a communication to the Board of Trade objecting to the proposals in a number of provisional orders to insert clauses authorising municipalities to manufacture and deal in electrical fittings, &c., in competition with private firms. These provisions have since been withdrawn from the bills. Generally the action of the Chamber in this direction had been successful.

London County Council.—At Tuesday's meeting the Highways committee recommended that powers should be sought by the Council in one of the bills to be promoted in Parliament next Session to double the existing tramways in Battersea Park-road, Bermondsey New-road, York-road, Albert Embankment, and Wandsworth-road. The total length of the proposed tramways was 1 mile 1 furlong 118 yards, and the estimated cost of reconstructing them for an underground system of electric traction was £43,200. Also for power to construct a double line of tramways along the new street from Bermondsey New-road to Tooley-street. The length of this line was 3 furlongs 154 yards, and the estimated cost of construction on the underground system £14,000. It was also recommended that the Council should not appeal to the Board of Trade against the decision of the Light Railway Commissioners with regard to the Council's orders for (*a*) the Deptford, Shooter's-hill, and Woolwich light railway; (*b*) the New-cross, Lewisham, and Eltham light railway; and (*c*) the Clapham, Wandsworth, and Kingston-road light railway. A further recommendation was that the Council should appeal to the High Court against the decision of the magistrate at Southwark Police Court in the proceedings taken by the Council against the London Electric Supply Corporation in respect of its default in not having maintained a constant supply of electrical energy in the district included in the Corporation's Electric Lighting (Metropolitan) Order, 1890. The consideration of these recommendations was postponed.

The estimates were submitted for the year 1900-1. Amongst the items the Fire Brigade Committee estimated that the expenses of the electric light installation at the head office would be £435, and other electric work, £750; telephones and fire alarms, £9,000. The estimate of expenses of the Council acting otherwise than as local authority under the Electric Lighting Acts and Orders, and of receipts for fees for inspecting and testing meters, &c., were:—Expenditure—Salaries and wages, £850; gas and electric current, £95; stores and instruments, £350, and incidentals, £100; total, £1,395. The receipts for inspecting and testing electricity meters and of testing electric pressure were estimated to be £400. The expenses under the London Overhead Wires Act were estimated to be £100, and of expenses in connection with the preparation of schemes under the Light Railways Act, £500. The estimate for professional fees, &c., in connection with inquiries as to mechanical traction, was £500.

Luton.—An enquiry was recently held into the application to borrow £26,000 for electric lighting purposes. The town clerk appeared in support of the application, and the consulting engineer (Mr. Albion T. Snell) gave technical details of the scheme. There was no opposition.

Manchester.—The revised estimates of the Electricity committee, submitted to the Corporation on Wednesday, provide for £4,000 being handed over for the relief of rates. An amendment was moved by Mr. Lambert that the original estimate be adhered to. He said it was proposed to pay the £4,000 out of reserve. The reserve fund had been drawn upon to the extent of £21,000 during the year, leaving £12,000, and it was now proposed to take a further £4,000, leaving a ridiculously inadequate sum for such a department. Ultimately the revised estimates were approved, after an acrimonious discussion.

Melton Mowbray.—Tenders for street lighting from the Melton Mowbray Electric Lighting Co. and the local gas company have been referred to the Lighting committee for analysis and report. The electric lighting company offer to do the lighting for five years at £370 per annum, and to give illumination equal to 7,500 c.p. The gas company's tender amounted to £340. 11s. for 6,000 c.p. Last year's gas bill was £383, and the company only gave 2,140 c.p. There is consequently a disposition to favour the electric lighting tender.

Nottingham.—In consequence of the increase in the price of coal, the electricity department have decided to increase the price of current from June 30th. For lighting, 5d. per unit for the equivalent of 100 hours per quarter, and 2d. per unit beyond; for power, 1½d. per unit.

Overhead Telephone Wires.—At Bow-street (London) Police Court on Friday, the National Telephone Co. were summoned by the Strand District Board of Works, under the Overhead Wires Act, 1891, for failing to report the fixing of fresh overhead wires to the local authority. Inspector Gregory, of the Strand Board of Works, deposed that 180 wires had been erected by defendants between 34 and 35, Gerrard-street and 79, Wardour-street, W, since June, 1898, and, with one exception, no report had been made to the local authority of the fixing of those wires. Mr. Allsopp, for the defendants, contended that as the wires were not new there was no need to report. The wires had simply been diverted by the removal of a third standard which used to exist between these two. Sir Franklin Lushington held that a report was required, and imposed a fine of £5, and £2. 2s. costs. A second summons was dismissed on the ground that the wire was a renewal of one which had already existed.

At Bow-street Police Court, on Tuesday, Mr. Robert Williams, manager of Messrs. C. J. Grist and Co., electrical engineers, was summoned before Mr. de Rutzen, under the Overhead Wires Act, 1891, for failing to comply with the London County Council bye-laws as to the distance allowed between supports to such wires. Mr. F. Robinson, for the Strand Board of Works, said defendant's firm had fixed a private telephone wire between York-street and Tavistock-street with a span of 165 yards, the limit under the bye-laws being 115 yards. Inspector Gregory, of the Board of Works, said the span had since been reduced by 20 yards, and an attempt had been made to reduce it to 90 yards; but the insulator was not properly fixed, and rendered the wire more dangerous than before. A fine of 40s. and costs was imposed. On a second summons for failing to report the fixing of the wire, defendant was ordered to pay the costs. On a third summons charging him with failing to affix a distinctive mark to the supports, that the local authority might be able to distinguish them from those of other companies, a fine of 40s. and costs was imposed, the magistrate pointing out that firms such as defendant's must acquaint themselves with the bye-laws and comply with their provisions. [Contractors are advised that these and other bye-laws of municipal bodies are set out in "The Electrician" Electrical Trades' Directory and Handbook.—Ed. *E.*]

Partick.—Glasgow Corporation have agreed to supply current to Partick for lighting until the town's installation now being organised is completed. The supply is not to commence till Oct. 1, and the amount of current demanded is not to exceed 250 amperes at 500 volts for private lighting only. The price to be charged per unit is 3½d., and the period of supply 12 months. The Partick mains are to be laid by the Burgh Commissioners and the Glasgow Corporation is not to be responsible for any unavoidable failure in supply.

Plymouth.—The accounts of the Tramways committee for the past year were submitted to the Corporation on Wednesday. Mr. Page explained that there was an increase of expenditure of £1,689, of which £425 was due to the supply of electric current to the Prince Rock route. On the other hand, the receipts increased by £2,411, or 18 per cent. Of the total increase £1,855 came from the Prince Rock electric line and £850 from the Hyde Park and Compton section. He estimated the increased receipts arising from the use of electric traction at £435, and the extra expenditure involved in substituting electric for horse traction at £424, leaving only £21 as the net gain from the use of electric power on the Prince Rock line. There would be a greater advantage in the use of electricity on the Compton section. He estimated that the adoption of electric power for the Compton section to involve an expenditure of about £5,400 a year. Against that they would save by doing away with the horses and stables, £3,800, leaving £1,600 as the net extra cost of electricity.

Ripley.—The Ripley Co-operative Society are establishing electricity works.

St. Pancras (London).—On the recommendation of the Electricity committee the Vestry decided on Wednesday to lower the charge for electric current to places of worship and certain public hospitals in the district from 5d. to 4d. per unit.

Southampton.—The Corporation have received sanction to borrow £50,655 (out of £55,000 recently applied) to carry out electric lighting extensions. In the communication conveying consent the Local Government Board state that they have excluded from the

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amount of the loan the sum entered for contingencies with the exception of 10 per cent. upon the estimated cost of the new battery. The Board have also excluded £230. 17s. 6d., interest on stock previous to receipt of loan, as they consider that this cannot properly be paid out of borrowed money. The works for which the previous loan was sanctioned had cost £7,069 in excess of estimate, and £34,088 further had been expended upon extensions in anticipation of the Board's sanction. The Board, therefore, regard the action of the Council in this matter as most unsatisfactory.

The estimates of the Electricity committee for the year ending March 31, 1901, were submitted to the Corporation last week and approved. The income is estimated at £18,233, and the expenditure at £17,277. There was a deficit on last year's working of nearly £300, caused mainly by the increased price of coal.

Stockport.—An inquiry was held last week into the application of the Corporation to borrow £23,468 for electric lighting extensions. The loan is chiefly required for new feeders. There was no opposition.

Sudbury.—An inquiry into the application of the Council to borrow £650 for the electric lighting of the Wents estate was held on Wednesday. The consulting engineer (Mr. W. C. C. Hawtayne) said that the bill confirming the Council's provisional order had already passed through the House of Commons. The scheme really formed portion of a larger scheme for electric lighting. The cost of lighting would be a shade under 2d. per unit; the total annual cost would be about £47; 2d. per unit would be equivalent to 1s. a thousand for gas. Opposition was offered by the local gas company.

Sunderland.—An inquiry was held on Tuesday into the application of the Corporation to borrow £4,500 for the purchase of land for erecting a new generating station. The town clerk (Mr. F. M. Bowey) and the borough electrical engineer (Mr. John F. C. Snell) explained that in consequence of the present station in Dunning-street being taxed to its utmost capacity, and as the demand for current continued to increase, it had been decided to erect a new station in Hylton-road. There was no opposition.

Sydney (N.S.W.).—The City Council have adopted an electric lighting scheme prepared by Major P. Cardew (Messrs. Preece and Cardew) and estimated to cost about £138,000. In his report Major Cardew states that an immense amount of money has been wasted in England by starting electric supply on an insufficient basis owing to the desire to keep down initial capital expenditure. The private supply at Sydney would probably be equal to 600,000 units per annum for the city alone, and after five years the public and private supply should reach 4,000,000 units a year. The cost is estimated as under:—Mains and street work, £60,000; generating plant, £50,000; buildings, &c., £25,000; wiring and fitting markets, &c., £3,000. Allowing for contingencies the expenditure necessary will be about £150,000. Major Cardew anticipates that after the second year the undertaking will become profit-earning. After the fifth year the profit will be considerable, even with a reduction of the price to 3½d. per unit. Messrs. Preece and Cardew have been instructed by the Council to prepare plans and specifications and invite tenders for carrying out the work.

Wolverhampton.—The Corporation have received sanction to borrow £1,730 for electric lighting extensions.

Workhouse Lighting.—The Holborn (London) Guardians on Wednesday adopted the report of their consulting engineer, Mr. James Enright, recommending the installation of the requisite plant and machinery for the electric lighting of the City-road Workhouse, at an estimated total capital outlay of £6,930. Mr. Enright was instructed to prepare plans and specification for the carrying out of the work at a total cost of £7,623. It was stated the cost of maintenance, repayment of loan, &c., would be about £1,000 a year, and the present gas bill amounted to nearly this sum.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Durban (Natal) Corporation invite tenders for (*a*) the supply, delivery and erection of the overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, &c.; (*b*) the supply, delivery and erection of 22 double-deck motor cars complete; (*c*) the supply and erection of electricity generating plant, including three 250 kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, &c. Further particulars are set out in an advertisement, and specifications may be obtained from the agents to the Corporation (Messrs. Webster, Steel and Co.), 5, East India-avenue, Leadenhall-street, London, E.C., after 29th inst. Tenders in duplicate must be delivered to the agents by June 29, or to the town clerk of Durban by mail delivery on or about Monday, July 23.

The Provost, Magistrates, and Commissioners of the burgh of *Partick* invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught furnaces. Specification, &c., can be obtained on and after Tuesday next, at the offices of Mr. Jas. Donaldson, town clerk, 97, West Regent-street, Glasgow, and a copy of the specification can be inspected at (but not obtained from) the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. An advertisement elsewhere gives further particulars, and tenders must be sent in to Mr. Donaldson by noon of Friday, June 8.

Leeds Lighting committee invite tenders for two or three 630 kw. two-phase generators and one or two sets of surface condensing plant Tenders to town clerk (Mr. W. J. Jeeves) by 10 a.m. of 28th inst.

Great Grimsby Corporation invite tenders for the supply and delivery of arc lamp posts and brackets. Specifications may be obtained from the town clerk (Mr. W. Grange), St. Mary's Gate, Grimsby. Specifications can also be seen at (but not obtained from) the office of the consulting engineer (Prof. Alex. B. W. Kennedy), 17, Victoria-street, London, S.W. An advertisement contains additional particulars. Tenders must be delivered at Mr. Grange's office by June 1.

Great Grimsby Corporation also invite tenders for the supply and delivery of electricity meters. Further particulars are set out in an advertisement, and tenders must be delivered at the offices of the town clerk (Mr. W. Grange) by June 1.

South London Electric Supply Corporation invite tenders for a complete installation of 3,000 lights on the premises of 500 consumers in any part of the company's area of supply, and also for the installation of two arc lights on the premises of any consumer in the same area. Specifications may be obtained from the secretary (Mr. H. H. Boyer), 54, Bengeworth-road, Loughborough Junction, London, S.E., and tenders must be in by Saturday, June 2. See advertisement.

Newcastle-upon-Tyne Tramways committee invite tenders for switchboards, underground feeders, and pumping apparatus. An advertisement contains additional particulars, and tenders for switchboards and feeders must be sent to the town clerk (Mr. Hill Motum) by 25th inst., and for the pumping apparatus by June 1. Specification and forms of tender can be obtained after 16th inst. from the consulting engineer, Mr. Chas. Hopkinson (Messrs. Hopkinson and Talbot), 26, Victoria-street, London, S.W.

Bradford Corporation invite tenders for the supply and delivery (for 12 months) of enclosed electric motors of 4½ H.P., 7 H.P., and 10 H.P. Specification, &c., may be obtained from the city electrical engineer (Mr. R. A. Chattock). Further particulars are given in an advertisement, and tenders must be sent to the town clerk (Mr. Frederick Stevens). Town Hall, Bradford on or before 24th inst.

Bradford Corporation also require tenders for the construction and delivery of two steam engines and two 1,000 kw. dynamos. Specifications may be obtained from the city electrical engineer (Mr. R. A. Chattock), and tenders must be delivered to the town clerk (Mr. Frederick Stevens), Town Hall, Bradford, on or before 24th inst. An advertisement gives further particulars.

Bradford Corporation require tenders for coal-conveying apparatus, hoppers and ash-conveying apparatus for their Valley-road electricity works. Specifications may be obtained from the city electrical engineer (Mr. R. A. Chattock). Tenders must be sent to the town clerk (Mr. Frederick Stevens) by 31st inst. See advertisement.

Fulham (London) Vestry require tenders for the wiring of their electric lighting works. Specifications, &c., can be obtained at the offices of Mr. F. Hastings Medhurst, B.Sc., 13, Victoria-street, London, S.W., and tenders must be sent to Mr. W. J. H. Denselow, Clerk to the Vestry, Town Hall, Walham Green, S.W., by Monday, June 4. An advertisement contains further particulars.

Sutton Coldfield Corporation invite tenders for the supply and erection of electricity generating plant, particulars of which are set out in an advertisement. Specification may be obtained (after 24th inst.) at the offices of the town clerk (Mr. Thos. V. Holbeche). The contracts will be carried out in accordance with the plans and specification of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained after 24th inst. Tenders must be delivered to Mr. Holbeche before noon of June 21.

London County Council's Asylums committee invite tenders for the installation of electric lighting and power (except generating plant) and the installation of telephones, tell-tale clocks, fire alarms and call bells at the Horton Asylum, near Epsom, Surrey. Further particulars are set out in an advertisement, and specification can be obtained from the clerk (Mr. R. W. Partridge) after 21st inst. Tenders must be delivered to the committee, 6, Waterloo-place, S.W., by 10 a.m., Saturday June 16.

Dundee Town Council require tenders for the overhead equipment of four electric tramway routes particulars of which are set out in an advertisement. Specifications, &c., may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), and tenders must be lodged with the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 31st inst.

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Dundee Town Council invite tenders for supply of copper bonds. Specifications, &c., may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders must be lodged with the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 22nd inst. An advertisement contains additional particulars.

Dundee Gas Commissioners invite tenders for small coal and electricity meters. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders must be delivered to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 31st inst. See advertisement.

Devonport Corporation require tenders for the supply, delivery and laying of electric light and traction feeders, distributors, boxes, &c., in connection with the scheme of electricity supply for Devonport and East Stonehouse. Specification may be obtained from the borough electrical engineer (Mr. Charles Furness), Technical School, Devonport, and further particulars are set out in an advertisement. Tenders must be sent to the town clerk (Mr. A. B. Pilling) by 5 p.m. of 25th inst.

Walthamstow District Council invite tenders for the supply and erection of arc lamp posts and accessories and glow lamps on posts and on existing gas standards. Tenders to clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m. 29th inst.

Walthamstow District Council also invite tenders for fire alarms, wire, &c. Tenders to clerk before 5 p m., 25th inst.

Southampton Corporation invite tenders for a water-tube boiler with steam and other pipes and sundry ironwork. Tenders to town clerk (Mr. R. R. Linthorne) by 28th inst.

Bridgwater Town Council invite tenders for the supply and erection of electricity generating plant. Tenders to town clerk (Mr. W. T. Baker) before 3 p.m. on June 7th.

Crewe Town Council seek tenders for the supply and laying of about 25,000 yards of three-core cable for street lighting extensions, and the supply of upwards of 500 lamp holders and reflectors for adopting the existing lamp-posts for electric light. Tender to Mr. F. Cooke, town clerk by May 26.

Glasgow Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders to town clerk (Sir J. D. Marwick) before10 a.m., June 12.

Farnworth District Council require tenders for the erection of electricity station buildings. Tenders by 30th inst.

Wolverhampton Tramways committee invite tenders for the construction of nearly two miles of tramway. Tenders by June 26.

Worksop District Council require tenders for electricity generating plant. Tenders to clerk by 23rd inst.

Corporation of *London* Streets committee invite tenders for the supply on hire of electrically-driven dust carts. Tenders to town clerk (Sir John B. Monckton), Guildhall, E.C., by June 1.

Tenders are invited for wiring the *Leeds* Central Fire Station. Tenders to town clerk by 28th inst.

Bradford Corporation invite tenders for castings, forgings and turned work required for slipper brakes for electric tramcars. Tenders to town clerk by 19th inst.

Vladivostock (Siberia) Municipal Council invite tenders for the concession for erecting electricity works and for constructing an electric tramway.

Tenders are invited for the concession (which has already been applied for) for the construction and equipment of an electric tramway from the Puerta de Hierra (*Madrid*) to Aravaco and Pozuelo. Tenderers are required to tender in the first instance on the basis of a reduction on passenger fares set out in a schedule to the specification. The contract will be awarded on July 7.

Norwegian State Railways Administration invite tenders until 23rd inst. for telegraph and telephone materials.

The Council of *St. Gilles-lez-Bruxelles* (Belgium) invite tenders for an electricity supply installation for part of its territory. Conditions (for 3fr.) from 14, Parois St. Gilles, St. Gilles, and tenders to Mayor, before 2 o'clock of Sept. 19.

TENDERS RECEIVED AND ACCEPTED.

The Shoreditch (London) Vestry have received the following tenders for the supply of electric cables :—

British Insulated Wire Co. (*accepted*)	£582 14 8	W. T. Henley's Co.	£634 0 0
Siemens Bros. and Co.	655 2 3	W. T. Glover and Co.	598 5 10

The following tenders have also been received by the Vestry for the supply of feeder panels for switchboard :—

Electric Construction Co. (*accepted*)	£455	Crompton and Co.	£555
Brush Co.	716	General Electric Co.	497
Nalder Bros. and Thompson	575	Evered and Co.	457
		Verity's (Ltd.)	456

Plymouth Corporation have accepted the tender of Messrs. R. W. Blackwell and Co. for the supply and erection of the overhead electric equipment of the Compton electric tramway route at £3,433. The British Insulated Wire Co.'s tender at £3,270 was recommended for acceptance by the Tramways committee, but an amendment by Mr. Radford that Messrs. Blackwell and Co.'s tender be accepted was carried at the Council meeting on Wednesday.

The tender of Messrs. Fisher and Allison has been accepted for the electric lighting of the Doncaster Corn Exchange.

The Durban (Natal) Corporation have accepted the tender of Messrs. J. Hubert Davies & Spain, Johannesburg and East London, for the supply of steel rails and laying 15 miles of tramway track for electric traction (exclusive of Australian hardwood stringers) at £30,286.

Cheltenham Council have accepted the tender of Messrs. Siemens Bros. and Co. for a continuous-current dynamo at £480, and that of Messrs. Witting Bros. and Co. for a traction dynamo at £420.

APPOINTMENTS VACANT AND FILLED.

An assistant lecturer and demonstrator in electrical engineering is required for the University College of North Wales, Bangor. Applications to the secretary and registrar (Mr. J. Lloyd, M.A.), not later than June 9. See advertisement.

The chief electrical engineer of the Redditch District Council has a vacancy for three pupils. Particulars from Mr. W. J. Ferguson. See advertisement.

Southport Corporation require a manager for their tramway Further particulars are given in an advertisement, and applications must be sent to the town clerk (Mr. J. Ernest Jarratt), Town Hall, Southport, by 28th inst.

Cardiff Corporation invite applications for the appointment of a tramways electrical engineer, at a commencing salary of £500 per annum. Application to town clerk (Mr. J. L. Wheatley), Town Hall, Cardiff, by June 1. An advertisement contains additional particulars.

There is a vacancy for an assistant superintendent in the telegraph department of the Government of India. Further particulars may be obtained on application to the India Office, and applications should be sent to the Secretary, Public Works Department, India Office, Whitehall, London, S.W., by June 30. See advertisement.

A head-master is required for the Industrial School, Lucknow, India. Some additional information is given in an advertisement. Forms of application and further particulars can be obtained from the Director-General of Stores, India Office, Whitehall, London, S.W.

A lecturer is to be appointed at Cambridge, in succession to Mr. W. N. Shaw, F.R.S., lecturer in experimental physics. Applications are to be sent to the Vice-Chancellor by May 19.

Mr. William Paul, of the engineer's office of the City and South London Railway, has been appointed mechanical draughtsman to the electricity department of the Islington Vestry.

BUSINESS NOTICES.

The registered offices of Marconi's Wireless Telegraph Co. (Ltd.) have been removed from 28, Mark-lane, E.C., to 18, Finch-lane, Threadneedle-street, London, E.C.

Messrs. A. W. Flowerdew and W. M. Hunt (trading as Flowerdew and Hunt), electricians, &c., 42, Bridlesmithgate, Nottingham, have dissolved partnership. Debts by Mr. Flowerdew.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 5s. 7d. is payable at the O.R.'s, 31, Silver-street, Lincoln, in the bankruptcy of W. H. Bowman, electrical engineer, &c., lately trading at Heaton-street, Gainsborough.

The Doe Portable Electric Light and Power Syndicate (Ltd.) is to be wound up voluntarily, with a view to reconstruction. Mr. J. E. Ward, 122, Cannon-street, London, E.C., is liquidator.

A meeting of the Phœbus Electric Solder and Electric Soldering Fluid Co. (Ltd.) will be held at 52, Ayton-road, Stockwell, London, S.W., on June 18, to receive an account of the winding-up. Mr. S. Shortman is liquidator.

A meeting of the Nalder and Harrison Construction Syndicate (Ltd) will be held at 19, Queen Victoria-street, London, E.C., on June 16, to receive an account of the winding-up. Messrs. J. A. McMullen and N. Frank Nalder are liquidators.

Claims against the Perfect Arc Lamp and Accessories Co. (Ltd.) are to be sent by June 11 to the liquidator, Mr. S. H. Lee, 85, Gracechurch-street, London, E.C.

Gordon Webber, electrical and mechanical engineer, trading as G. Webber and Co., 101, Mount-pleasant, Liverpool, and at Leigh, has executed a deed of arrangement. Liabilities £173. 4s. 8d., assets £92. 2s. 10d. Mr. S. Jude, 14, North John-street, Liverpool, is trustee.

Thomas T. Markham, electric light contractor, 7, Warwick-court, Holborn, W.C., and Grove road, South Tottenham, N. London, has executed a deed of arrangement. Liabilities £215. 8s. 9d., assets £130. 7s. 10d.

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Plant for Sale.—Messrs. Cornelius and Boulter, the Promenade, Cheltenham, announce in an advertisement the sale by auction on 22nd inst. at noon, of the contents (including electric lighting plant and machinery) of the Assembly Rooms, Cheltenham. Catalogues, &c., from the auctioneers.

Some electric lighting plant (including a Fielding and Platt's gas engine and dynamo, switchboard and instruments, &c.) is advertised for sale in another column. Further particulars from Mr. J. A. McMullen, M.I.E.E., 17, Gracechurch, London, E.C.

Leeds Corporation invite tenders for the purchase of electric tramways plant. Further particulars of the plant, which may be inspected on application to the engineer-in-charge, are set out in an advertisement. All further information may be obtained from the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W. Tenders to town clerk's office, by 23rd inst.

Mr. Robert Feather, Craven Bank Chambers, Market-street, Bradford, has received instructions from the representative of the late Mr. B. U. Moore, to sell by auction on Tuesday, 29th inst., the machinery and plant, at 197, Sunbridge-road, Bradford. An advertisement contains further particulars, and catalogues may be obtained from Mr. Feather.

Messrs. Firth and Wright will sell by auction on Monday next, at 12 noon prompt, a large quantity of electrical, mechanical, and chemical manufacturing plant, &c., at Upper Lane Mills, opposite Cleckheaton station. Catalogues can be had of Messrs. Butterfield and Hartman, accountants, 2, Darley-street, Bradford, and of the auctioneers, Cleckheaton and Heckmondwike.

Business for Sale.—An electrical engineering business is advertised for sale in another column. The works are conveniently situated within 10 minutes of London.

A Large Belt.—Messrs. Balderston and Co., 201, St. Vincent-street, Glasgow, have recently specially manufactured for Messrs. Crosses and Winkworth, Bolton, a Hoyt double leather belt 147ft. long and 45½in. wide, the nett weight being 1,209lb., or 17½oz. per sq. ft. of single surface. The belt required the exact centres of 70 butts in its manufacture. At the speed it is intended to run the belt will transmit 528 H.P.

E. P. S. Cells.—To illustrate the electrical Power Storage Co.'s exhibit at Paris (stand No. 506, Group V.) a pamphlet has been issued describing and illustrating different types of E. P. S. cells, and giving a brief history of the company which is the oldest and premier company devoted entirely to the manufacture of electric accumulators or storage batteries. The pamphlet will be found serviceable by non-technical visitors to the Exhibition, and the information regarding accumulators and their uses which is here given will be read with general interest. It is singular that in this pamphlet as in so many other places Lord Kelvin's surname is spelt with a "p." The cover of the pamphlet might with advantage be strengthened.

"Maxim" Incandescent Lamps.—A neat list of "Maxim" incandescent lamps is now ready and obtainable by the trade from the Hiram S. Maxim Electrical Corporation (Ltd.), 44, Gillingham-street, Victoria, London, S.W. High and low voltage lamps of from 3 c.p. to 500 c.p. are listed, and a variety of shapes and designs of lamps of this company's make are illustrated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 9 to May 15, with the ports of destination:—

Africa—Alexandria, £38; Cape Town, £45; Durban, £423 (including £101 telegraph material); East London, £82; Quilimane, £62; Zanzibar, £71. *Argentina*—Buenos Ayres, £549 (including £312 telegraph material). *Australasia*—Adelaide, £96; Auckland, £35; Freemantle, £56; Melbourne, £136; Otago, £70; Sydney, £2,404 (including £89 telegraph material); Wellington, £242. *Azores*—£1,151 (telegraph material). *Burma*—Rangoon, £352. *Ceylon*—Colombo, £152. *Chili*—Boca, £385 (including £155 telegraph material). *Denmark*—Copenhagen, £28 (telegraph wire). *France*—Boulogne, £36. *Germany*—Hamburg, £700 (including £400 telegraph material). *Holland*—Amsterdam, £275; Flushing, £9. *Hong Kong*, £16. *India*—Bombay, £223; Calcutta, £1,101 (including £355 telegraph wire); Karachi, £240. *Japan*—Kobe, £745 (telegraph cable); Yokohama, £585. *Malta*, £135. *Spain*—Barcelona, £128 (including £102 telegraph wire). *Sweden*—Stockholm, £88 (telegraph material). Total £10,662, against £15,197 in the corresponding week last year (May 10 to May 16).

CITY OF LONDON ELECTRIC LIGHTING CONTRACTS.—Mr. J. W. Martin, who has vigorously criticised the action of the City Corporation in repudiating the validity of its contracts with the Brush Co. and Messrs. Laing, Wharton and Down (subsequently taken over by the City of London Electric Lighting Co.), points out, in regard to Mr. Justice Farwell's judgment establishing the validity of the contracts, that had the decision been reversed, the value of City of London Corporation securities as a safe investment would have been jeopardised. Mr. Martin estimates that the Corporation will have to issue a new loan of £2,000,000 to cover its liabilities to the City of London Co.

COMPANIES' MEETINGS AND REPORTS.

New General Traction Co. (Ltd.).

The fourth annual general meeting was held on Wednesday, under the presidency of Capt. FRANCIS PAVY.

The CHAIRMAN stated that four years ago the undertaking was a very small one—certainly as regarded capital. It only had £50,000 of preference capital, and the ordinary capital, which they now saw in the balance-sheet under the item of goodwill. He was approached because the amount of work in hand required further funds, and, believing it to be extremely good business, he and some of his friends joined the company. During the period in which they had been connected with it they had been enabled to put in an additional £200,000, and someone, he thought, would be required to provide something more before the works were finished, and the full benefit was reaped of what they had been doing. He thought it might be said that they had done very well during the period in question He thought that the shareholders should be satisfied with the balance-sheet. After deducting £6,116 for general expenses, salaries, &c., chargeable against revenue, they were left with a balance of gross profits of £76,299, which was increased by the amount brought forward to £82,512. During the year the directors had raised £100,000 of additional preference capital, making it £250,000. The cost of raising this was £281, which had been written off, and thus they were left with a disposable balance of £82,20. A dividend on the 6 per cent. preference shares (absorbing £13,487) had been distributed, which the shareholders were now asked to confirm, and deducting this, a balance remained of £68,743. Of this they proposed to appropriate £10,769 to reserve against goodwill, this making, with a further £2,230 from profit and loss, the sum placed against goodwill account, £13,000. The directors had commenced a reserve fund, to which they had placed £20,000, and this left them with a balance of £37,030 to start the new year. These figures were all based on the price at which the shares of the tramway undertakings in which the company were interested were taken, and this was at par. They had about £100,000 in the Coventry Electric Tramways, £165,000 in the Norwich Electric Tramways, £21,000 in the Douglas Southern Electric Tramways, £1,973 in the Light Railways Syndicate, and £76,000 in the Philadelphia, Morton, and Swarthmore Street Railway. He concluded by moving the adoption of the report and accounts.

Baron EMILE B. D'ERLANGER seconded the resolution, which was carried.

The dividend on the preference shares was sanctioned, and the proceedings closed with a vote of thanks to the chairman and directors.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 11/16d. per oz. (May 17). Consols (2¾ per cent.) 101⅛—101⅜ for money, 101⅜—101½ for account; 2½ per cent. 98¼—98⅜ (May 17). Stock Exchange Settling Day: Consols, June 1; Stocks and Shares Continuation Days, May 29 and June 12; Ticket Days, May 30 and June 13; Pay Days, May 31 and June 14; Mining Share Carry-over Days, May 28 and June 11.

CHISLEHURST ELECTRIC LIGHTING CO. (LTD.)—The annual report states that the supply of current was commenced in Feb., 1899, with an equivalent of 806 8 c.p. lamps connected, and this number had increased at the end of the year to 4,017. The net profit (£83. 1s. 7d.) has been carried forward.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—With the view to partly meeting the expenditure necessary in connection with the new Australian cable to be laid by this company, the directors have decided to issue to the shareholders the unused balance of 50,000 ordinary shares of £10 each at a premium of £3 per share. For this purpose the share register is closed until May 19.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LTD.)—The report of the directors for the past year states that there is a credit balance on the general account of £6,864, of which £5,663 has been paid as interim dividend. The profit on the Ramsey section of £2,415 is insufficient to meet the debenture charges of £2,600. The auditors (Messrs. Aldred and Co.) point out that whereas the capital expenditure has been £518,000, only £366,000 has been raised by shares and debentures, the balance being accounts owing, bills payable and bank overdrafts. Messrs. Turquand, Young and Co. are to report on the position of the company.

JAMES HINKS AND SON.—The net profits for the year ended March 31 amounted to £10,991. 18s. 9d., and a final dividend of 10 per cent. per annum was declared.

KENSINGTON AND NOTTING HILL ELECTRIC LIGHTING.—Applications are invited for an issue of £100,000 4 per cent. debenture stock by the Kensington and Knightsbridge Electric Lighting Co. (Ltd.) and the Notting Hill Electric Lighting Co. (Ltd.), the money being required for the joint station of these companies, authorised under the Kensington and Notting Hill Electric Lighting Companies' Act of 1899. The list closes this day (Friday).

MIX AND GENEST, LTD. (BERLIN).—The general meeting of this company was held on Saturday. The directors' report stated that the gross profit was £30,090, which, after making provision for depreciation on plant, tools, and buildings (£11,800), left a net profit of £18,290, out of which a dividend at the rate of 12 per cent. has been declared. The progress of the company is attributed mainly to the large extension of the

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telephone system in Germany. The directors anticipate that the requirements of the German Government will be still larger in the future on account of the adoption of the metallic circuit system. A further impetus has been given to the telephone industry by the German General Post Office allowing subscribers' private installations to be connected to the Government telephone system, free of charge, the only stipulation being that the instruments used on such private installations should be equal in quality to those used by the Government.

MOTOR GESELLSCHAFT FUR ANGEWANDTE ELECTRICITAT.—This company which is closely allied to Messrs. Brown, Boveri and Co., ha declared a dividend of 7 per cent. for the past year.

STOCK EXCHANGE NOTICES.—Tuesday last was appointed a special settling day for £300,000 5 per cent. first mortgage debenture stock of the *British Aluminium Co.* (*Ltd.*), and the securities have been ordered to be quoted in the official list. Wednesday, 23rd inst., has been appointed a special settling day in the further issue of 7,532 £3 full-paid ordinary shares (Nos. 46,419 to 54,000) of *Crompton and Co.* (*Ltd.*), and 81,092 £5 (£3. 10s. paid) and 18,908 fully-paid ordinary shares (within Nos. 490,001 and 590,000) and fully and partly paid provisional certificates for £5.0,000 4 per cent. debenture stock of the *National Telephone Co.* (*Ltd.*). The Stock Exchange Committee has also been asked to appoint a special settling day in 25,000 vendor's 7 per cent. cumulative preference £1 (fully-paid) shares (Nos. 115,001 to 140,000) of the *Nernst Electric Light Co.* (*Ltd.*), and to allow the further issue of 12,500 6 per cent. cumulative preference £5 fully-paid shares (Nos. 27,501 to 40,000) of the *British Insulated Wire Co.* (*Ltd.*) to be quoted in the official list. Application has also been made to the Committee to appoint a special settling day in and to grant a quotation to 7,000 5 per cent. cumulative £10 fully-paid preference shares of the *Alliance Electrical Co.* (*Ltd.*), and to allow the further issue of 20,000 6 per cent. cumulative £5 fully-paid preference shares (Nos. 54,001 to 74,000) of the *New General Traction Co.* (*Ltd.*) to be quoted in the official list.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The profits of this company for the half-year ended Dec. 31, 1899, being insufficient to provide the preference dividends, the directors have decided to withdraw the sum required from reserve, and recommend on this occasion the payment of the usual dividends on the cumulative preference shares, and one shilling per share on the ordinary shares.

WYCOMBE ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual meeting was recently held at High Wycombe. At the end of the year the equivalent of 7,636 8 c.p. lamps (including about 130 H.P. in motors) were connected, and since the beginning of the current year 4,225 further lamps had been applied for. The net profit was £438. 18s. 4d. After paying a dividend of 2½ per cent. upon the ordinary shares, and applying £144. 13s. 9d. in paying Parliamentary expenses, the balance (£230. 13s. 4d.) was carried forward. At the end of the last quarter the connections were equivalent to 10,279, and about 2,170 more were awaiting connection. The report and accounts were adopted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	May 12	4,297	+ 133	18	77,559	+ 3,998
Blackpool Corporation...	„ 10	285	− 3	6	2,191	+ 467
Blackpool and Fleetwood	„ 12	331	− 31	19	4,584	− 138
Bradford Corporation...	„ 13	420	+ 115	6	2,689	+ 626
Brisbane Trams	Mar. 28	1,725	+ 418	26	52,595	+15,930
*Bristol Trams & Carriage	May 11	2,850	− 13	19	51,770	+ 1,903
*Buenos Ayres & Belgrano	Apl. 15	2,501	+ 239	15	34,413	+ 5,039
City & South London Ry.	May 13	1,380	+ 454	19	23,625	+ 3,392
Dover Corporation	„ 12	177	+ 23	6	1.151	+ 111
Dublin United	„ 11	3,507	+ 520	19	61,216	+12,668
Dublin Southern Dist....	„ 11	823	+ 4	19	14,892	
*Glasgow Corporation ...	„ 12	9,183	+ 154	...	...	...
*Liverpool Corporation...	„ 5	7,380	+ 513	18	124,341	+16,065
Liverpool Overhead Rly.	„ 13	1,416	+ 77	19	26,752	+ 1,124
*Sheffield Tramways	„ 13	2,097	+ 664	19	36,477	+12,262
*South Staffs. Trams.....	„ 11	630	+ 55	19	12,278	+ 558

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 9.		Price Wednesday, May 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 16. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 17 4	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	62	65	62	65	5 12 8	Feb., May, Aug., Nov.	...	...
£3,062,240	Stock	30/0	Do. Preferred	114	115	114	115	5 4 9	„ „	114⅜	114
£3,062,240	Stock	27/0	Do. Deferred	13⅜	14⅛	13⅛	14	9 12 10	...	13⅛	13⅛
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	102	104	3 17 0	...	...	...
16,000	10	6/0	Cuba Submarine Ordinary .....xd	9	10	8⅝	9½	7 7 4	„ „ February and August	9⅛	9½
6,000	10	10/0	Do. Preference 10 per Cent. .....xd	19	20	18½	19½	5 2 7	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅝	105⅝	101⅝	105⅝	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 16 8	Jan., Apr., July, Oct.	1⅞	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100	103	100	103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150	155	150	155	4 10 4	Jan., Apr., July, Oct.	153	150
£1,826,888	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	„ „	100	98½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	113	118	111	116	3 9 0	May and November ...	114	112
250,000	10	6/6	Eastern Extension	15⅞	16¼	15⅞	16¼	4 6 2	Jan., Apr., July, Oct.	16⅛	15⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	118	111	116	3 9 7	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb.,1900 (reg.) ...	100	103	100	103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100	103	100	103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	103⅞	103⅞	103⅞	103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11¼	11¾	11¼	11¾	4 9 4	Jan., Apr., July, Oct.	11⅞	1 1/16
180,042	10	3/0	Do. 6 per Cent. Preference	15	1 5/8	15	15⅝	3 17 5	„ „	1 5/8	15⅝
150,000	10	15/0	Great Northern of Copenhagen	32	34	32	34	3 13 6	January and July.....	...	...
286,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	100	103	100	103	4 8 0	...	...	...
17,000	25	37/6	Indo-European .....xd	54	58	53	53	4 9 0	May and November ...	55½	53
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105	108	105	103	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102	105	102	105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124	129	124	129	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97	100	97	100	5 0 4	March and September	99½	99¾
30,008	2½	...	West Coast of America	¼	1	¼	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 14 7	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	...	May and November ...	1⅛	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9¾	9¼	9¾	6 3 1	„ „	9⅝	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	102	105	3 17 4	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½	15	14½	15	4 13 4	Mar., June, Oct., Dec.	14⅝	14⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105	108	105	103	4 15 10	June and December ...	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2½	3½	2⅝	3½	4 5 9	August	...	..
72,680	1	2½%	Monte Video Telephone Ordinary	¾	⅞	¾	⅞	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
430,000	5	3/0	National	4⅝	5⅛	4⅝	5⅛	5 17 1	February and August	5	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13	15	13	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	11	14	11	13	4 12 4	„ „	12	11
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛	5⅜	5	5¼	4 15 3	„ „	5	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97	100	96	99	3 10 7	June and December ..	98½	97½
171,504	1	0/3	Oriental	¾	1	⅝	1⅛	4 14 1	April and October	1	...
58,000	5	2/6	United River Plate	4¾	5¼	4¾	5¼	7 2 10	July	...	...
16,689	5	1/4	Do. 5% Cumulative Preference	4¾	5¼	4¾	5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	103	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, May 9.		Price Wednesday, May 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 16.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	1	⅞	1	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7	7½	7	7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	8½	9½	8½	9½	4 14 9	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5½	6	3 15 0	" "	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6½	7½	6½	7½	4 0 0	March	7⅛	7
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108	111	108	111	4 2 2	June and December	110½	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	10	11	10	11	4 0 0	February and August	10½	10½
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 12 4	January and July	12½	12½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	3 16 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	13	12	13	4 12 4	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109	112	109	112	4 0 9	...	111	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7½	7	7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1½	2	1½	2	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½	4⅝	4	4½	6 13 4	...	4	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100	102	100	102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½	14½	13½	14½	3 9 0	April and October	14½	13½
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93	98	96	98	3 11 10	...	97½	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½	7	6½	7	3 11 5	"	...	...
300,000	1	8%	Rand Electric	⅝	¾	⅝	¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	...	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	170	190	170	190	4 4 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	14½	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2		2	2½	...	...	2	...
£50,000	Stock	...	Do. 4% Debentures	85	95	85	95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	4 5 10	March and September	15½	...
			ELECTRIC MANUFACTURING &c. COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	13/16	15/16	13/16	15/16	6 8 4	...	1	...
85,000	1	...	British Electric Works Co. Ordinary	⅞	1	⅞	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	13/16	15/16	13/16	15/16	...	...	...	...
[£50,000	100	4½%	Do. First Mortgage Debentures	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6	6½	6	6½	4 12 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅝	5½	4⅝	5½	...	...	4⅝	...
90,060	2	1/2⅝	Brush Electrical Engineering	1⅝	2	1⅝	2	4 0 0	September	...	...
90,900	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cum.	2	2½	2	2½	5 6 8	"	2	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103	113	103	113	3 19 8	February and August	...	...
£103,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103	105	103	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½	15½	14½	15½	4 16 9	" "	15½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112	116	113	116	3 18 5	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,093)	3½	4	3½	4	4 10 9	January and July	3⅝	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	102	100	103	4 19 0	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½	4½	3½	4½	6 13 4	" "	4½	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
28,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4½	5	4½	5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101	104	101	104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2	2⅛	5 6 8	January and July	2⅛	2⅛
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅝	3⅛	2⅝	3⅛	4 6 2	July	...	...
£82,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	105	103	103	3 16 2	January and July	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½	14½	13½	14½	3 15 10	February and August	14½	13½
30,000	5	1/6	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3	" "	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 18 11	" "	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	" "	21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	104	103	103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	35	39	34	38	4 11 6	March and July	38	38
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	10	11	10	11	3 3 7	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	11½	12½	11½	12½	4 16 0	April and October	13⅝	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 7	" "	7⅞	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures xd	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
12,000	10	10/0	Blackpool and Fleetwood Tramways	17	18	17	18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102	104	102	104	4 16 2	...	104	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½	23½	22½	23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£5 paid)	8½	8⅝	8½	8⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 8 5	...	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	9½	10½	9½	10½	4 17 7	...	9½	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15½	15⅞	15½	15⅞	3 12 9	...	...	...
15,000	10	...	Do. (Nos. 60,001 to 75,000)	15⅝	16⅛	15⅝	16⅛	...	...	15⅝	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12	13	12	13	4 12 4	...	12⅝	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	125	...
40,000	5	2/8⅛	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5	5½	5	5½	5 14 4	...	5	...
27,500	5	...	Do. "B"	4	4½	4	4½	...	...	4⅛	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 14 10	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk. Prov. Certs. (£57½% to be p.l.)	37	40	37	40	...	...	...	...
208,940	10	3/0	Central London Ordinary	10	10½	10	10½	2 17 2	June and December	10⅛	10
£355,000	Stock	1½%	City and South London Railway Con. Ordinary	61	64	61	64	2 13 7	January and July	...	...
37,500	10	1/5⅛	Do. (Nos. 22,501 to 60,000)	5½	6½	5½	6½	2 5 4	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1893)	132	137	132	137	3 13 8	...	...	...
£344,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	123	128	3 2 6	May and November	...	...
20,000	10	8⅛%	†Imperial Tramways Ordinary	22½	24½	22½	23⅝	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	¼	⅝	¼	⅝	19 4 0	...	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	⅛	⅜	⅛	⅜	13 14 4	...	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅜	10½	9⅜	10½	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅞	9	8⅞	9⅛	4 3 1	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½	13⅝	13½	13⅝	3 14 1	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	2 15 6	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5½	4½	5½	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜	10½	10⅜	10½	4 13 0	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½	12½	11½	12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9½	10½	4 15 3	...	...	...
£510,000	Stock	3%	Waterloo and City Ordinary	100	103	100	103	2 18 8	June and December	100	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,149. [No. 5. Vol. XLV.] FRIDAY, MAY 25, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents. or 80fr., or 70pf.

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NOTES.

SIR E. SASSOON, who in the House of Commons on Wednesday last moved that an inquiry should be held into the commercial and strategic defects of our Imperial telegraphic communication, showed a certain familiarity with the more obvious facts of the subject. He quite failed, however, to grasp the point that the growth of traffic with a given place must finally have a greater effect than even distance in determining the tariff. Although the population of India, for instance, enormously outnumbers that of Australasia, the telegraphic traffic of the former has been practically stationary or retrograde year by year, while that of the latter has continuously increased and has always responded to reductions of rate in a way that India has never done. In comparing internal with international tariffs he failed to perceive that there are sacrifices—to secure uniformity or for other reasons—which a State may make on telegrams within its own territory, but which are not legitimate or even possible where messages pass over the lines of several countries. Sir E. SASSOON raised a laugh by pointing out that States like Luxemburg which possess no cables at all, have an equal vote with Great Britain in international telegraphic conferences; but international messages transit land lines as well as cables, and he did not explain how Sovereign States could be induced to take part in such a congress on any other basis than that of equality, nor that the colonies of Great Britain possess votes. Of course, in practice, on these occasions votes, which are weighed as well as counted, have no binding effect until the resultant convention is accepted and confirmed by the high-contracting parties. Further, it may interest him to know that the companies which own the cables have no vote at all.

SIR C. DILKE, who seconded the resolution, confined his remarks to the strategic aspect of the question. He expressed the view held by those entitled to speak with some authority on the matter—the late Sir JAMES ANDERSON, for instance—that while many of the cables might be cut, were Great Britain at war with a Continental Power, it would be impossible in practice to interrupt all the alternative routes simultaneously. And, of course, for this purpose an alternative route is one, no matter how roundabout, by which communication can be effected. He instanced a message between the metropolis and Cornwall, viâ Malta. In another case communication was effected between Land's End and London, by way of New York. His point as to the importance of the deep-sea landing of cables is not so obvious. The difficulty of interrupting a cable midway in any ordinary depth is not much greater (but rather less, so far as prevention is concerned), than near the landing-place. It is no good to shut one's eyes to facts—cables every day are repaired with little trouble, and they can be broken with even less difficulty. For strategic purposes in war, the only remedies are multiplicity of routes, cables laid secretly, strict silence as to sections interrupted, and the probable discovery of methods of working across "breaks."

As to the State purchase of submarine lines, no one seems to have thought out the difficulty respecting the way in which our Government is to get permission to work cables landing on the coasts of foreign Powers. Sir JOHN PENDER used to say, "Cables have no politics." In private hands they are cosmopolitan and secrecy-preserving, but are foreign nations likely to believe they would continue to be so in the hands of the British Government? Continental jealousy of British-owned cables is very great. What it would be if they were worked by our Government no mortal can conceive. If the cable companies had not existed they would probably have had to be invented.

MR. HANBURY admittedly made an able speech in winding up the debate, and had little difficulty in replying to the arguments which had been advanced. He pointed out that cheap telegrams and strategic cables were inconsistent with

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each other, because the former depended upon tapping every source of traffic at foreign ports, while the latter must avoid non-British territory as well as all English stations which could not easily be defended. He showed that most of the existing cables followed the main routes of trade, being, therefore, more easily capable of protection by our fleet; and that if the matter were left in the hands of the Government they would endeavour to meet the views of those who wished for cheap telegrams as well as of those who urged the importance of strategic cables. There is much to be said for the Government decision in favour of a departmental as against a parliamentary enquiry. National enterprise and foresight have been allowed a long start in establishing a network of cables all over the world, and—there is such a thing as letting well alone.

ROYAL birthday honours this year are notably deficient in the recognition of science, doubtless because in war times the arts of peace may reasonably be expected to wait. With the exception of DAVID GILL, the eminent Astronomer-Royal at the Cape, who has received a K.C.B., and Prof. T. E. THORPE, who has received a C.B., the name of no distinguished scientist appears on the list of honours. The electrical profession, however, will join with his numerous other friends in congratulating Sir RICHARD WEBSTER on his elevation to the peerage. In the office of Attorney-General, Sir RICHARD has frequently taken a leading part in events fraught with much importance to that profession and its industries.

WHILE it must be admitted that the scheme for an express mono-rail between Liverpool and Manchester appeared to be defective in several important details, it is impossible not to regret that this novel system of traction has received so serious a check as is implied in the rejection of the scheme by the Select Committee on Tuesday. On the whole, however, the Committee was quite justified in refusing to sanction any of Her Majesty's subjects being carried through mid-air at over 100 miles an hour, until such time as the safety of this feat is better guaranteed. We suggest that the possibilities of this high-speed system of traction might first be tested by the construction of a line purely for light parcel and mail traffic. It would then very soon be seen whether the system is a safe one for passenger traffic.

DURING the last few weeks there have been several cases of serious disagreement between municipal electrical engineers and their committees. In some instances, the duties and powers of the municipal engineer do not seem to be fully defined, with the result that there have been cases of this official exceeding the proper limits of his office, and on the other hand examples of undue interference on the part of the electric lighting committee. It would be well within the province of the Municipal Electrical Association to express an opinion as to how far the control of a municipal electricity department should be vested in the engineer; for although a report dealing with such a matter could in no way be binding the electrical engineer or his employers, it might tend to promote a unanimity of ideas on certain matters of professional etiquette which would go far to improve the *status* of the municipal electrical engineer, and to prevent many disputes of the nature of those to which we have alluded.

THE annual report of the Comptroller-General of Patents is always an interesting document. Its mass of statistical information enables deductions to be drawn as to the relative inventiveness during the year and the directions in which this inventiveness has extended. The report for the year 1899 exhibits a peculiar phenomenon, viz., that the number of applications for patents has steadily diminished during the last two years, having reached its maximum (30,952) in 1897, and fallen in 1899 to only 25,786. In commenting on the report for 1897 we called attention to the fact that although an increase in the total number of patents applied for that year was apparent, the quantitative inventiveness of Great Britain and its colonies had slightly decreased, and it is apparent that this decrease has continued. A diminution is apparent not only in the number of patents applied for, but also in the number of complete patents sealed; while on the other hand, the value at which patents are held does not appear to have diminished, for there were more 13 and 14-year old patents last year than in previous years, showing that it has been found worth while to pay the fees to maintain more patents for their full life than hitherto.

DETAILED figures as to the number of inventions in the various classes each year up to 1898 are given, and show some curious results. An effect of the Workman's Compensation Act was to increase the number of inventions for guards for preventing accidents in working circular saws. The interest in penny-in-the-slot machines is reviving, and inventions continue to flow with greater frequency into the classes "Dynamo-Electric Generators," "Electric Lamps," and "Electric Telegraphs (including Telephones and Phonographs)," and "Steam Engines." "Galvanic Batteries," however, are being invented at a slower rate than heretofore. During 1899 the accidents to passengers on trolley cars have resulted in several applications for patents for safety arrangements, and in non-electrical matters it is interesting to note that recent legislation and threatened legislation has promoted invention in the matter of seats for shop assistants, and of automatic couplings.

WE are able to recall but few instances where the microscope, an instrument of importance in so-called "natural science" researches, has been used with effect in physical investigation. Indeed, except as an auxiliary instrument for measuring the bore of a tube or the diameter of a wire, we believe it rarely finds a place among physical instruments. That physical science is the loser by the neglect of the microscope as an active agent of research was made evident in the course of Prof. J. A. EWING's admirable and lucid discourse at the Royal Institution, on Friday evening last, on "The Structure of Metals." This was an account of a series of experiments carried out during the past two years in Prof. EWING's laboratory at Cambridge, in conjunction with Mr. W. ROSENHAIN, on the structure of metals as revealed by a close inspection of the surfaces of metals which had been polished and lightly

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etched, or subjected to other physical or mechanical processes, such as heating, tension or compression. The results obtained were presented to a large audience in a series of beautiful micro-photographs, some of which, as thrown on the screen, represented a magnification of 170,000 diameters, a striking testimony to the searching and penetrating nature of the camera, and to the great experimental skill exhibited by Mr. ROSENHAIN.

THE main portions of the lecture had already been communicated to the Royal Society, and were the subject of last year's Bakerian Lecture, a long abstract of which was given in *The Electrician* (Vol. XLIII., p. 239). It was there shown that every metal or alloy, either under normal or abnormal physical conditions revealed, when examined under the high power of a microscope, distinct granular, or even crystalline structure, which no subsequent treatment could eradicate permanently. However heterogeneous a body might appear to be, closer investigation revealed perfect homogeneity; there were found geometrical form and uniform design even in metals which, like lead, might have been carelessly assumed to have no form or definite structure at all. A metal might thus be compared to a platoon of infantry, which outwardly might have any form, or any kind of bounding line, yet internally and individually each member remained the same and resembled his fellow. The plasticity of metals, from which property its heterogeneity is generally assumed, was then explained by the slipping of the granular crystals more or less readily over each other. To carry the military illustration a step further, a battalion which was very mobile, the members of which were continually slipping by and in front of one another, might present the appearance of a disorganised rabble, yet a closer inspection would reveal that the individuality of the members was unimpaired.

THE entirely new features of Prof. EWING'S discourse lay principally in his account of the extension of their researches to the "growth" of these granular structures. If a metal, lead for example, be subjected to considerable compression, the surface revealed a somewhat irregular granular structure, the size of these granules being comparatively very small. In the course of a few months, weeks, or sometimes days, periods which are considerably diminished by the application of heat, these small granules gradually coalesce and increase considerably in size, and are then found to have again assumed the original crystalline structure of the untreated lead. The same effects were discovered in other metals. There is a suggestion of vitality about this growth which is not a little fascinating to the student, seeming to link more and more closely animate with inanimate matter. The explanation of this growth, which Prof. EWING attributed to his collaborator, Mr. ROSENHAIN, is not a little ingenious, and it must be admitted is, so far as it has yet been carried, borne out by the facts. Between the granules of any metal, however pure, is supposed to exist some amount of impurity; into this the small granules dissolve, forming with it a kind of "eutectic" alloy, from which they subsequently crystallise out again, increasing in size during the operation. Experimental confirmation of this hypothesis was found in the fact that across the surface of a cold-welded bar, whose contiguous surfaces had been very carefully cleaned, no such growth was possible, simply because the necessary impurity was not present. On spreading some impurity over these surfaces before they were brought into contact and welded together, the growth took place across the welded surface with perfect facility.

International Telephony.—Direct telephone communication has just been made available between Berlin and Basle.

Personal.—Prof. Ludwig Boltzmann, of Vienna, has been appointed to the chair of physics in the University of Leipzig.

Electrical Engineer (R. E.) Volunteers.—With the approval of the War Office the establishment of this corps is to be increased from four to seven companies.

The Identity of Argon.—In the last issue of the *Chemical News* Dr. T. L. Phipson describes some experiments which he has made on cyanogen gas after passing over red-hot iron nails in a glass tube. He concludes that the resulting gaseous body might be identical with argon, which would therefore be a *carbide of nitrogen* containing half the carbon contained in cyanogen.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Manila—Iloilo	April 9, 1900
San Thomé—Loanda	May 20, 1900

Search-lights on the Suez Canal.—The Suez Canal Co. has decided that every vessel, before it can pass through the Suez Canal, must satisfy the company's agents at Port Said or at Suez that it has on board (1) at least one electric search light of sufficient power to illuminate the channel 4,000ft. ahead, and constructed so as to admit of rapid splitting up of the beam of rays into two separate segments, with a dark sector in the middle; and (2) with electric lights capable of lighting up a circular area 700ft. in diameter.

The Institution of Junior Engineers.—At a meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel on May 18th, a Paper was read by Mr. Charles H. E. Rush and Mr. Basil H. Joy on "A Short Review of the Motor Car Industry, Past and Present." The authors confined themselves to a description of oil-driven vehicles, other systems being only briefly alluded to. At the conclusion of the meeting it was announced that the summer meeting of the Institution would be held at Newcastle-on-Tyne on August 18th.

Institution of Electrical Engineers (Irish Section).—The official nominations of the members to be elected as committee of the Irish Section of the Institution of Electrical Engineers were announced at the ordinary meeting held on April 26 last. Owing to the short time during which they had occupied this position, the committee decided to submit themselves *in toto* for re-election. There having been no further nominations, as specified by the articles of association, the committee is duly elected. A list of the members was given in *The Electrician*, Vol. XLIV., p. 495, but one name, that of Mr. C. A. Burge, is to be added.

Extension of Canadian Water-Power Company.—The Chambly Power Co. is, says the *Electrical World* of New York, about to build a second dam across the Richelieu River, Quebec, about two miles above the present dam. This will, it is expected, serve the double purpose of preventing the formation of anchor ice at the lower dam, and of providing an additional 10,000 H.P. for transmission to Montreal, where it is pressingly required. At present the maximum load quite utilises all the current transmitted to Montreal, and it is anticipated that the additional power will be nearly all used up by the Montreal Electric Street Railway.

Telephone Service in Tokio.—The demand for telephonic communication in Tokio, Japan, is very strong, and the

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supply is stated to be entirely inadequate to meet the demand. While there were at the end of February 5,645 subscribers, there were in addition 5,641 applicants waiting to be connected up. Extremely high prices are being paid to subscribers for a transfer of their instruments, and even for a transfer of an application made before June, 1897. The delay in receiving the necessary wire is responsible for this deadlock, but it is expected that 1,700 of these applicants will be connected up by June next.

Voltage and Current Recorder.—According to the *Electrical World* of New York, an interesting apparatus has been designed by Mr. F. W. Springer, of the University of Minnesota, for automatically recording current and voltage. It is a combination of a chronograph and Weston continuous-current instrument, and is stated to have given excellent results in a recent test on a 400 H.P. motor. The instrument records between 50 and 100 times per second, and uses up a strip of paper 90ft. long and 10in. wide per hour. It is expected that this instrument will be of considerable usefulness on street cars, enabling an accurate comparison of the power required in accelerating the cars under various conditions of track, loads, motors, speeds, &c., to be made. It will be useful also in supplying the variations of current and pressure on starting.

Glasgow International Exhibition, 1901.—Electricity is to be employed to a somewhat considerable extent in the International Exhibition to be opened at Glasgow next year. The buildings, which (including the permanent art gallery and museum) will cover an area of about 20 acres, will be lighted by Brockie-Pell arc lamps, decorative lighting, &c., being effected by means of incandescent lamps. In the handling of exhibits electric cranes will be used wherever necessary, and a special feature will be the driving of many of the exhibits by electric motors. We are requested to state that all applications for space must be lodged not later than the 30th inst. with the general manager (Mr. H. A. Hedley). To professional men the Glasgow Exhibition will be of special interest, inasmuch as many of the principal scientific bodies, including the British Association and the Institution of Mechanical Engineers, are to hold their annual meetings in connection with it.

Institution of Electrical Engineers.—As no other names have been proposed for the council for next session, the members nominated by the retiring council have been declared duly elected. The constitution of the new council is therefore that given in the list published in *The Electrician* of April 27, 1900, p. 3.

The Institution of Electrical Engineers (Manchester Section.—The incorporation of the Northern Society of Electrical Engineers with the Institution has already resulted in the addition of some 66 members to the roll of the Institution membership, and there are still about a dozen more names to be added. In mentioning this at the meeting of the Institution on May 17th, the President remarked that the hands of the Institution would thus be strengthened in and around the Manchester district, and a distinct debt of gratitude was owing to the Officers, Council, and Honorary Secretary of the Northern Society for the manner in which they had helped to smooth over difficulties which might have occurred in bringing to a conclusion these somewhat delicate negotiations. The names of the 66 new members were then read out by the Secretary.

The Vizzola Electric Power Works.—In view of the remarks made by Dr. S. P. Thompson at the conclusion of the discussion on Prof. George Forbes' Paper at the Institution of Electrical Engineers (*The Electrician*, May 18, p. 131), the following further particulars of the system are of interest. The "Società Lombardia per Distribuzione di Energia Elettrica" was formed in 1897 with a capital of £320,000, subsequently increased to £400,000, and obtained a concession from the Government on the River Ticino, at Vizzola, some miles below its issue from lake Maggiore. The works, as originally contemplated, were for the distribution of about 10,000 H.P., but since they were begun the sanction of the Government has been obtained to the construction of a movable dam across the river some distance higher up, which will enable the volume of water available to be increased and to be kept constant during all seasons of the year, so that the effective electrical horse-power would be increased to some 12,000 E.P. Although this dam has not been commenced, the works have been constructed on the basis of this larger power. Seven turbines have been erected, each coupled to a 1,650 kw. three-phase alternator, running at a pressure of 11,000 volts; and there are, in addition, two exciters driven by separate turbines, with a capacity of 145 kw. at 110 volts. The two smaller turbines, as well as five of the larger ones, have been made by the firm of Riva, Monneret and Co., of Milan. The other two are of German manufacture, as are also the dynamos and remainder of the electrical plant. It was originally intended to transmit this energy to Milan, which is 25 miles distant; but all has been disposed of, as Dr. Thompson has said, in several manufacturing towns closer to the works, viz., Gallarate, Busto, Arsizio, Legnano, and Sarsuno, which towns at present use some 10,000 H.P. of steam power. The average price at which the electrical power is to be supplied is £4. 4s. per kw. per annum for 12 hours' use per day, the price for 24 hours' use per day being only slightly greater.

The Institution of Electrical Engineers and the Paris Congress.—M. Mascart, the President of the Electrical Congress which is to be held in Paris in August, and to which the Institution is sending delegates, has addressed a letter to Dr. S. P. Thompson relating to contributions from English writers to be read at the Congress. Dr. Thompson read the following translation at the meeting of the Institution on May 18: "In order to facilitate discussions at the Electrical Congress we have thought that it might be useful to have a series of reports upon questions of present interest. Some of our colleagues have already promised us *résumés* on the following subjects: Recapitulation of Decisions of Previous Congresses; Electrical Units; Photometry; On the Coupling of Alternators; Electric Lamps; Methods of Taking Currents for Supplying Tramways; On Commutating Machines and Rectifiers; On the Employment of Condensers; On Non-Synchronous Generators and on the Compounding of Alternators; Electro-Deposition; On the Furnaces employed in the Production of Carbide of Calcium; Telegraphy without Wires. We shall distribute in a few days a more detailed programme of the Congress, giving, so far as they have come in, all the questions which would lend themselves to such communications, but this programme will not be exclusive. It would be interesting if we might, at the same time, along with the foregoing reports, print and distribute to the members of the Congress before the sessions, other reports prepared by English electricians on subjects chosen by them. These reports might be very short, from 8 to 12 pages, for instance, and we should have great pleasure in receiving them. We would undertake the translation and printing of them, and sending proofs to the authors. You might, perhaps, raise this question before the Institution of Electrical Engineers, and possibly recruit for us some contributors, each one of whom would treat a subject within his competence, and we reckon on receiving something, for example, from yourself." The Council had decided, Dr. Thompson said, to ask all members who respond to this invitation to submit their papers beforehand to the committee of the Council which was appointed some time ago for dealing with matters in connection with the Paris Congress.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, May 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House, W. Agenda: (1) Experiments illustrating the Aberration called Coma," by Prof. S. P. Thompson, F.R.S.; (2) "Notes on the Measurement of some Standard Resistances," by R. T. Glazebrook, F.R.S.; (3) "On the Strength of Ductile Materials under Combined Stresses," by J. J. Guest.

MONDAY, May 28th.

SOCIETY OF ARTS.

4.30 p.m. Meeting of the Foreign and Colonial Section, when a Paper on "Imperial Telegraphic Communication," will be read by Sir Edward Sassoon.

FRIDAY, June 1st. ROYAL INSTITUTION.

9 p.m. Evening Discourse by Sir Henry Roscoe, F.R.S., subject "Bunsen."

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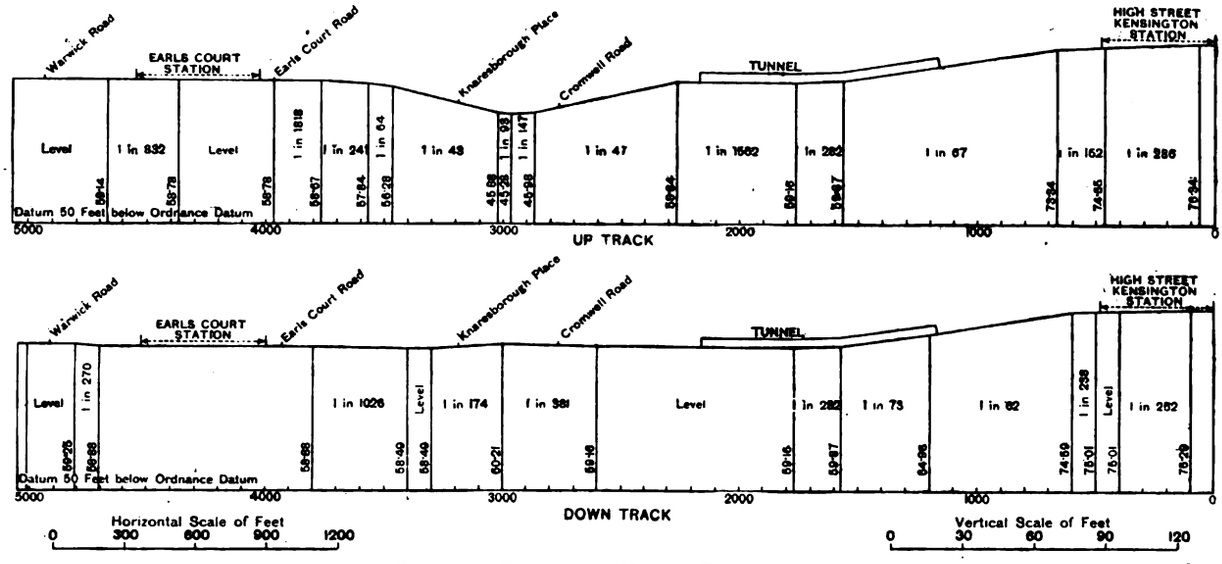
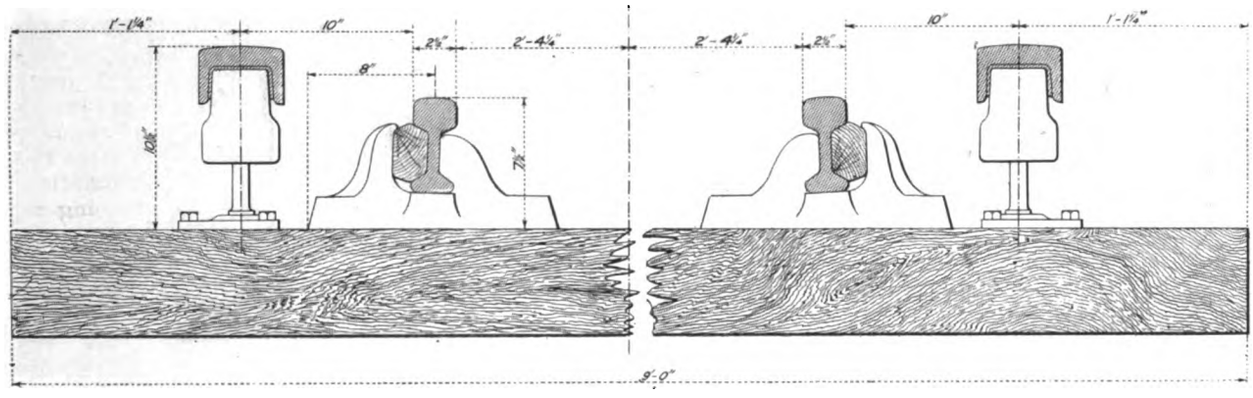
ELECTRIC TRACTION ON THE METROPOLITAN-DISTRICT RAILWAY.

On Monday last, the 21st inst., electric traction was for the first time used in working the public service on a short length of the Metropolitan-District Railway system. On that date the electric train designed by Sir John Wolfe Barry and Sir W. H. Preece was first put into operation on the regular time bill, although for some time past it has been working experimentally when the ordinary trains have not been running. An important stage, therefore, has been reached in the slow but inevitable conversion of the Inner Circle system of railways to electric traction. We deal with the historical and critical side of this development in our leading article this week. It will suffice, therefore, to give here a description of what has been actually accomplished on this experimental line. We may, however, state that in February, 1899, the sum of £20,000 was voted by the associated Metropolitan and District Railway Companies for this so-called experiment. The portion of the railway system selected for this experiment is about 5,000ft. in length, and is situated between Earl's Court and High-street, Kensington stations. It is composed throughout of double track with crossings, and a short length of side track upon which the train is shunted when not in use. Only a small portion of the route is in tunnel. The gradients of this route, as will be seen by reference to our gradients diagram, are in some places very severe, so that the section of line selected is well adapted to experimenting with electric traction on the class of train used on this railway.

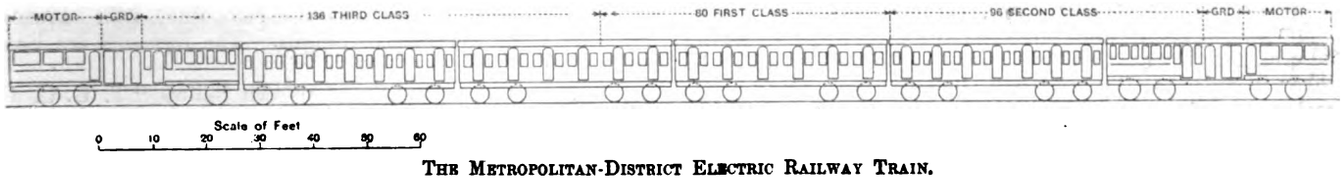


GRADIENTS DIAGRAM OF UP AND DOWN TRACKS.

This short electric line has so often been called "experimental" that some explanation of the use of this term in this connection is necessary. It required, of course, no experiment to prove that electricity was capable of running satisfactorily and safely trains similar to those on the underground railway and on quite as rapid and frequent a service. It was unnecessary to spend £20,000 to prove this. But the boards of the associated railway companies needed tangible proof that their railway system could be converted from steam to electric traction without the least interference, during the process, of their ordinary steam railway service. The engineers, Sir John Wolfe Barry and Sir W. H. Preece, were required to equip this line electrically without any interference with the permanent way, without any interference with the running of the ordinary train service, and without allowing



TRANSVERSE SECTION OF FOUR-RAIL TRACK.



THE METROPOLITAN-DISTRICT ELECTRIC RAILWAY TRAIN.

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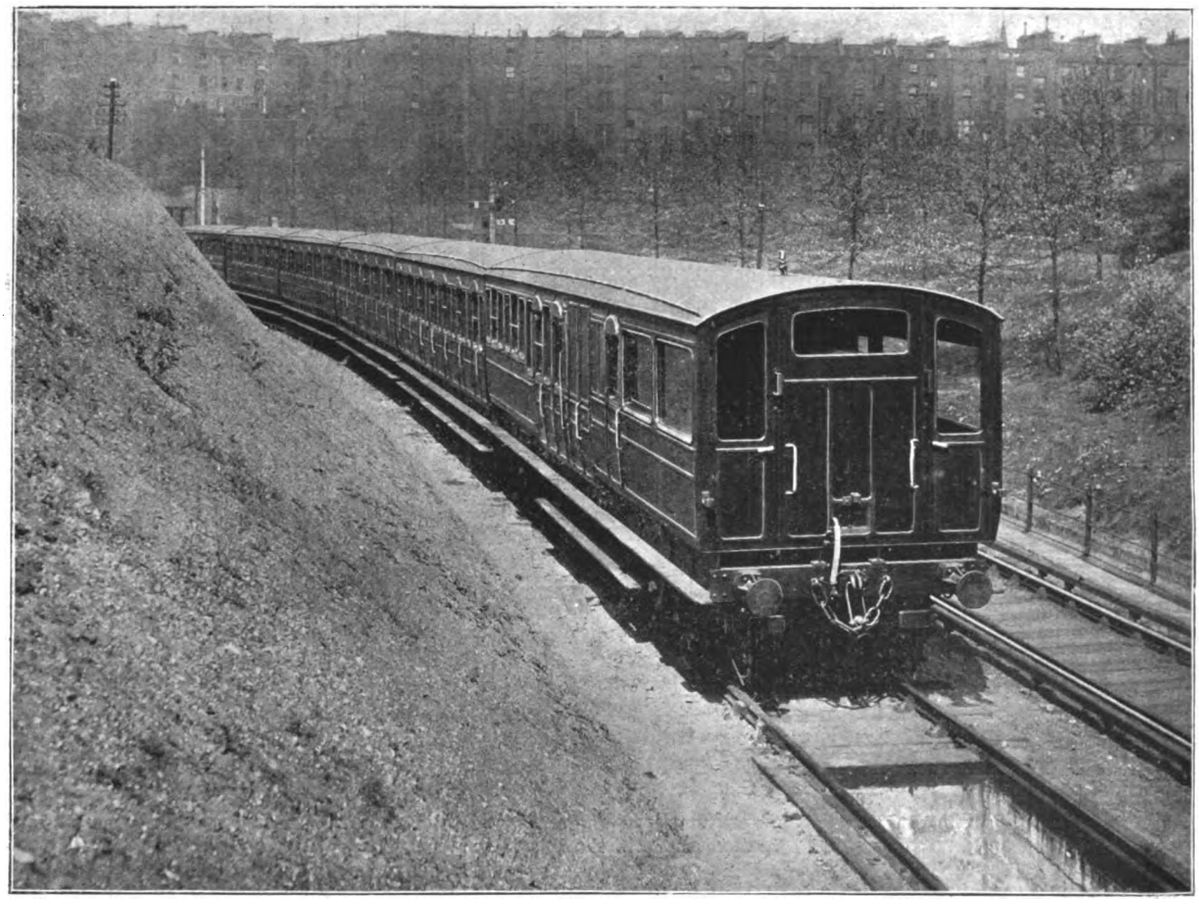
any electric current to pass through the permanent way or the subsoil lest such should interfere with the signalling arrangements of the line. In accordance with these stringent regulations, it became necessary to adopt an insulated system throughout, and to do the whole of the construction work in the few midnight hours when the trains were not running. The contract for the electrical equipment of the power station, line and train was placed in the hands of Messrs. Siemens Bros. and Co., and it was also arranged with them that they should work the entire electrical system for six months, with a further provision that they should carry on the work for a longer period in the event of the associated railway companies so deciding. The system may be termed a four-rail system. It includes the two ordinary track rails, which are not used for any electrical purpose whatever, and two electrical rail conductors placed on either side outside the track. These electrical conductors consist of inverted channel steel weighing 75lb. per yard, and are carried on double-petticoat porcelain insulators mounted on steel bolts. One of our illustrations shows a section of the track and indicates the relative position of the electrical rails and the ordinary track rails. Two of our photographic views also show the general appearance of the electric track, viz., at the Earl's Court station and at the western entrance to the tunnel. At points and crossings the continuity of the electrical rails had to be broken in order to allow of the working of the points or the passing of trains through the crossings. The gap, however, is in no case so wide that contact is not made in front of the train before it is broken in the rear, so that the train is always in contact with the conductor rails. The channel steel forming these rails is bonded by means of stout copper strip bonds, hydraulically riveted to the steel. These bonds carry all the current, an expansion gap being provided between the rail ends.

The system of conductor rails is fed from the temporary power station by means of eight short cables. This power house is situated about 250 yards west of Earl's Court station, and consists of an iron shed which has been erected near the track. From this power house there have been carried two positive and two negative feeders, each consisting of two cables in parallel. These are connected to the near end of the conductor rail system. Each of these cables has a copper section of 0·5 sq. in. and is lead covered and armoured. Thus there are provided a forward and a return copper section of 1 sq. in. to each track. The total length of this cable is 1,000 yards. The cross-over and interconnecting cables, where the conductor rails are broken at the crossings, &c., have the same section and are lead covered, but they are not armoured in the usual way. These cable are specially protected by iron plates or by being laid in conduits.

The power house is of an essentially temporary character. It is equipped with two direct-coupled Belliss-Siemens generators and two Babcock-Willcox boilers. The boilers work at 160lb. pressure, and each is capable of evaporating at the rate of 9,000lb. per hour for short intervals. It should be explained that as there is only one train running, and this only for about three minutes out of every 20 minutes or so, the boilers are called upon to generate steam only for a few minutes at rather long intervals. The boiler furnaces are fitted with forced draught, as the temporary iron chimney would provide insufficient draught. The furnaces are hand fired.



Electric Train for the Metropolitan-District Railway.

The generating sets consist of two Belliss "T. E. C. 4" engines direct coupled to two "H. B. 27 × 40" Siemens two-pole drum-wound railway generators. Each engine is capable of developing 360 I.H.P. overload, but is rated at 300 I.H.P. normal, running condensing. An ejector condenser is provided in order to get rid of the steam which otherwise might prove a nuisance to neighbours. The generators are similar in type and size to those supplied by Messrs. Siemens Bros. and Co. for the Waterloo and City Railway. They are compound-wound two-pole machines developing 385 amperes at 550 volts. The sets run at 380 revs. per min.

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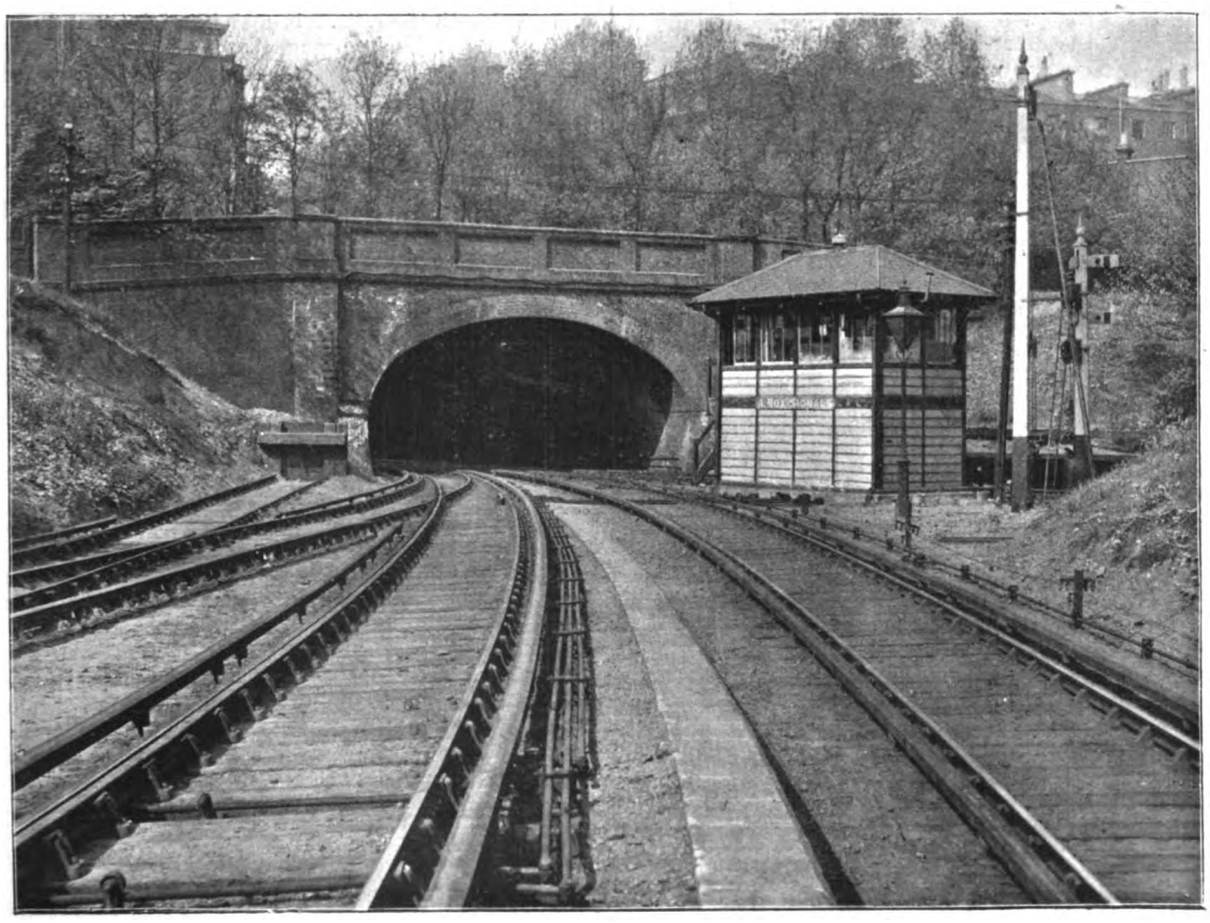
ELECTRIC TRACKS AT EARL'S COURT STATION.



ELECTRIC TRACKS AT WESTERN ENTRANCE TO TUNNEL.

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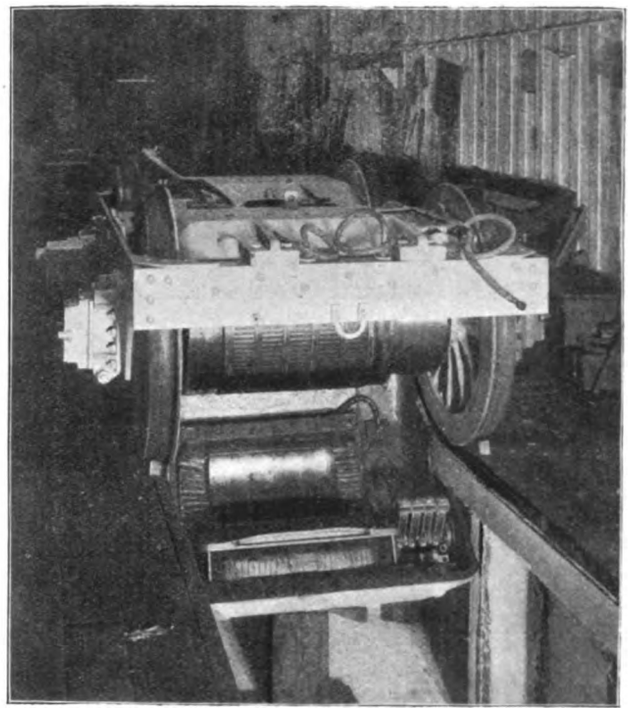
The switching arrangements at the power house are very simple in character, the chief items of interest being the large automatic cut-outs. There are four of these cut-outs, two for the feeders and one on each positive pole of the dynamos. The negative poles of the dynamos carry fuses. The feeder cut-outs are for the forward and return circuits.

A special type of train has been designed for this line, the design being such as to adapt it specially to the experimental conditions. There is no separate locomotive, the train being worked in block, and a motor carriage being placed at either end. Only one motor carriage, however, is used at a time—viz., that one in the front in the direction in which the train is moving. This arrangement, while duplicating the amount of electric motor plant, is convenient, as it obviates shunting the motor carriage. In the event of this type of train being adopted for the Inner Circle Railway, it would be necessary, of course, to have only one motor carriage as the trains on this line move in one direction continuously. The electric train consists of two motor carriages and four intermediate carriages, each being on two four-wheel bogeys. The carrying capacity of the train, as indicated in one of our illustrations, is 812 passengers, consisting of 80 first class, 96 second class, and 186 third class. The extremities of the trains consist of



Motor Truck showing Motor opened for Inspection.

the driver's cabins. Each motor carriage is equipped with four motors—viz., one on each axle of the two bogeys. The motors are of the four-pole "26 × 25" Siemens type, with the armatures built on to the axles of the driving wheels. Each motor develops a normal drawbar pull of 4,000lb. and a normal power of 110 B.H.P., the maximum power being 200 B.H.P. The motors are, of course, series wound. Within the driver's cabin, which is a spacious and entirely enclosed apartment with plenty of window look-out, the controller and other regulating arrangements are placed. The controller stands in the centre of the forepart of the cabin, and is a rather bulky contrivance, the handle resembling the steering wheel of a small yacht. It provides for 12 arrangements of the motors, as follows:

1, 2 and 3. All motors in series, and resistance in series.
4. All motors in series, without resistance.
5, 6 and 7. Two series of two motors in parallel, with resistance in series.
8. Two series of two motors in parallel, without resistance.
9, 10 and 11. All motors in parallel, with resistance in series.
12. All motors in parallel, without resistance.

Notches 4, 8 and 12 are, of course, the ordinary running notches, the others being intermediate notches for gradually getting up speed. There are no short circuit notches on the controller as it is not intended to use the motors for braking purposes. It is possible, however, to reverse the motors, while the train is running, by first bringing the controller to the zero point and then throwing over the interlocked reversing handle, afterwards throwing the motors against the train This arrangement, however, is not intended to be used in general practice, all the braking being done by means of a powerful "Standard" air brake. The air is pumped into the reservoir of this brake by means of a small electric motor and three-throw pump in the driver's cabin. The compressed air is also used to work the whistles of the train and the sanding gear. It should be observed that, in order that, the working of the trains may be carefully observed under test, an unusually large number of instruments have been erected in each cabin. Besides the main ammeter and main voltmeter, there is a separate ammeter on each motor. There is also an electric tachometer in each cabin. It is expected that the maximum current required in starting the train will be about 1,400 amperes, but the train is capable of taking a very much larger current without risk of injury. The total weight of the train, loaded, is 182 tons—viz., 72 tons for the four coaches empty, 90 tons for the two motor coaches empty, and 20 tons for the passengers.

Current is collected from the positive working conductors and returned to the negative working conductors by means of flexible cast-iron shoes suspended from the bogeys. There are 14 of these shoes on the train, seven on each side. All the positive shoes are interconnected and similarly all the negative. Each shoe is carefully insulated from the train or bogey truck by means of insulated suspension bolts. Each shoe is capable of a certain amount of vertical movement, also a very small amount of rocking movement, and the collecting surface is held against the working rail by means of spiral springs. The working conductors, we should add, are tapered at the gaps in order to provide for easy gliding of the shoe on to the conductor as these gaps are passed. As before mentioned, none of the gaps are of such a length that the train is ever in a position without a positive and negative shoe in contact with the rails. It may be of interest to add that the train is lighted throughout by means of glow lamps arranged in multiple series across the working conductors. Although no storage cells are used for this lighting, and notwithstanding that there is but one feeding point on the railway system, the lamps are but slightly affected by the starting and stopping, &c., of the train.

The Board of Trade inspection of this experimental line took place on April 3rd last, but some little delay has been occasioned on account of alterations in the signalling on this section of the line, these alterations being, however, in no way connected with the electric traction equipment. For some time past the train has been running during hours when the ordinary service of trains was suspended, and throughout last week the train was running frequently every day. On Monday last, as already stated, it was placed on the ordinary time schedule of the passenger service.

It is intended to carry out a serious of careful experiments on electric traction by means of this train, and for this purpose we understand a dynamometer car will sometimes be attached. Already certain experiments have been made. In his evidence before the Select Committee of the House of Commons considering the Manchester-Liverpool Express Railway, Sir William Preece recently stated that the train, fully loaded, had started on the very difficult gradient of 1 in 43—shown in our gradients diagram—a feat which an ordinary steam locomotive was unable to perform when hauling a similar load. Moreover, in a tug-of-war between the electric train and a steam locomotive, the electric train readily overcame the steam engine.

Our thanks are extended to Sir John Wolfe Barry and Sir William Preece for permission to publish this description of their novel electric railway and to take the photographs from which some of our illustrations were prepared. We are also indebted to Messrs. Siemens Bros. and Co. for much of the technical information contained in this article.

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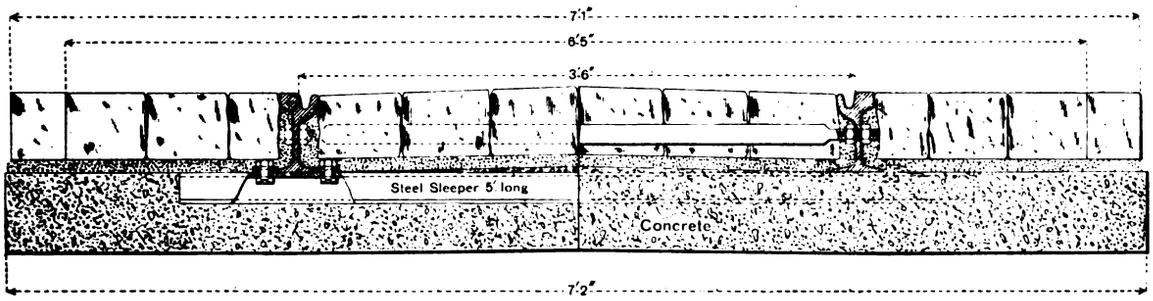
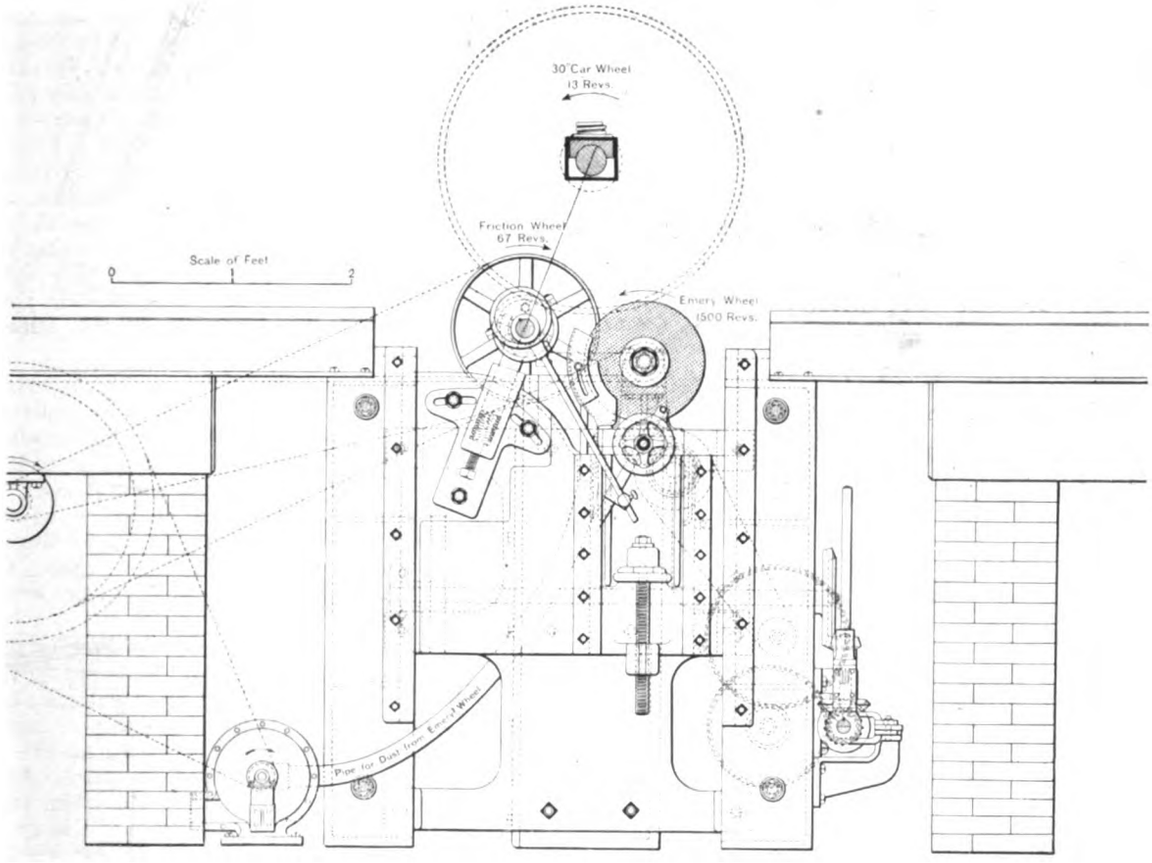
NORWICH ELECTRIC TRAMWAYS.

(*Concluded from page 127.*)

Power Station.—The power station is a substantial brick building situated near the centre of the tramway system, adjoining the river, and separated by only a narrow road from the site of the power house of the Norwich Electricity Co. Plans of the power station appeared in our issue last week. In the boiler house there are four Babcock-Wilcox boilers, each rated at 300 nominal horse-power. Each has a heating surface of 3,240 sq. ft., and works at a pressure of 160lb. The battery of boilers is fitted with Bennis mechanical stokers and a conveyer, and in the flues over the boiler a Green's economiser has been placed. The steam and other piping is in duplicate, a vertical main steam ring supplying steam to the engines and auxiliary plant. Within the spacious machinery room there is floor space for five railway generating sets, of which four only have at present been erected. These consist of Browett-Lindley tandem compound engines direct-coupled to Westinghouse railway generators. Each engine is rated at 320 H.P., and runs at 200 revs. per min. when working at 150lb. steam pressure, exhausting into the condenser. The cylinders are 16in. and 26in. diameter, and the stroke is 17in. The maximum horse-power each engine is capable of giving is 500 H.P. The flywheel carries a shaft governor of the Begtrup type, this controlling the piston valve of the high-pressure cylinder. The dynamos are of the Westinghouse multipolar railway type, each capable of developing 200 kw. at 550 volts. The machines are over-compounded for feeder drop. In addition to the railway generators, there is also a lighting set, consisting of a Westinghouse vertical steam engine direct-coupled to a 15 kw. Westinghouse dynamo, this set being used for lighting the works. The switchboard is of the usual Westinghouse railway panel type. It includes 10 continuous-current panels, one Board of Trade panel, and one lighting panel, with two spare panels.



TRANSVERSE SECTION ON TRACK.



ELECTRICALLY-DRIVEN WHEEL GRINDER.

Track Equipment.—The track is laid on a 3ft. 6in. gauge, and is of 65½lb. girder rail. The construction of the track is shown in an accompanying section. The rails are of 45ft. lengths, and are continuously cast-welded by the Falk process. As already stated, many parts of the track consist of difficult curves and gradients. Some examples of these are shown in four of our illustrations, the index numbers giving the positions of these examples of special work on the map we published

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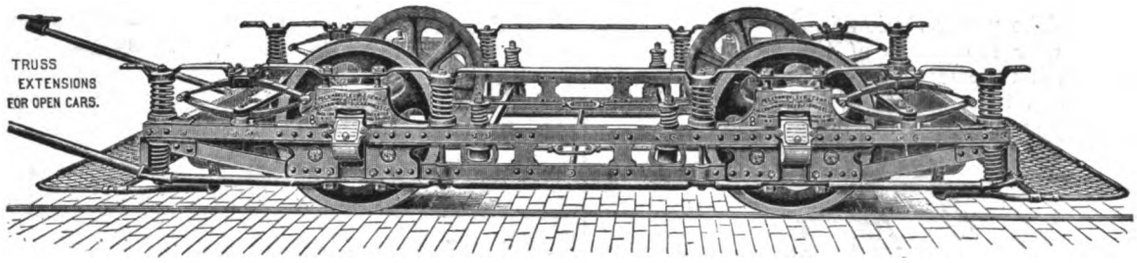
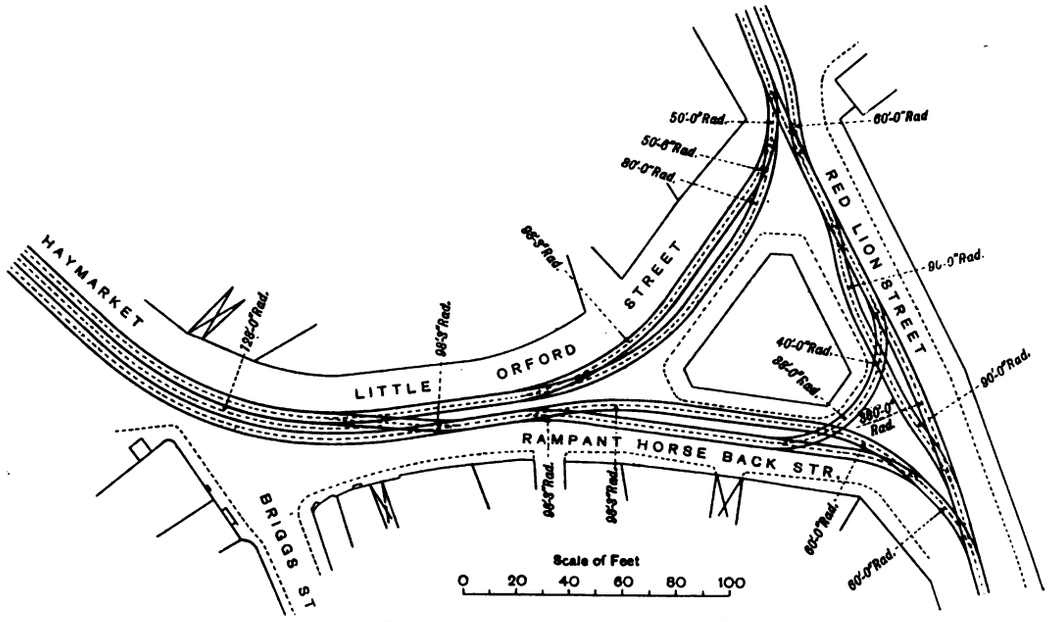
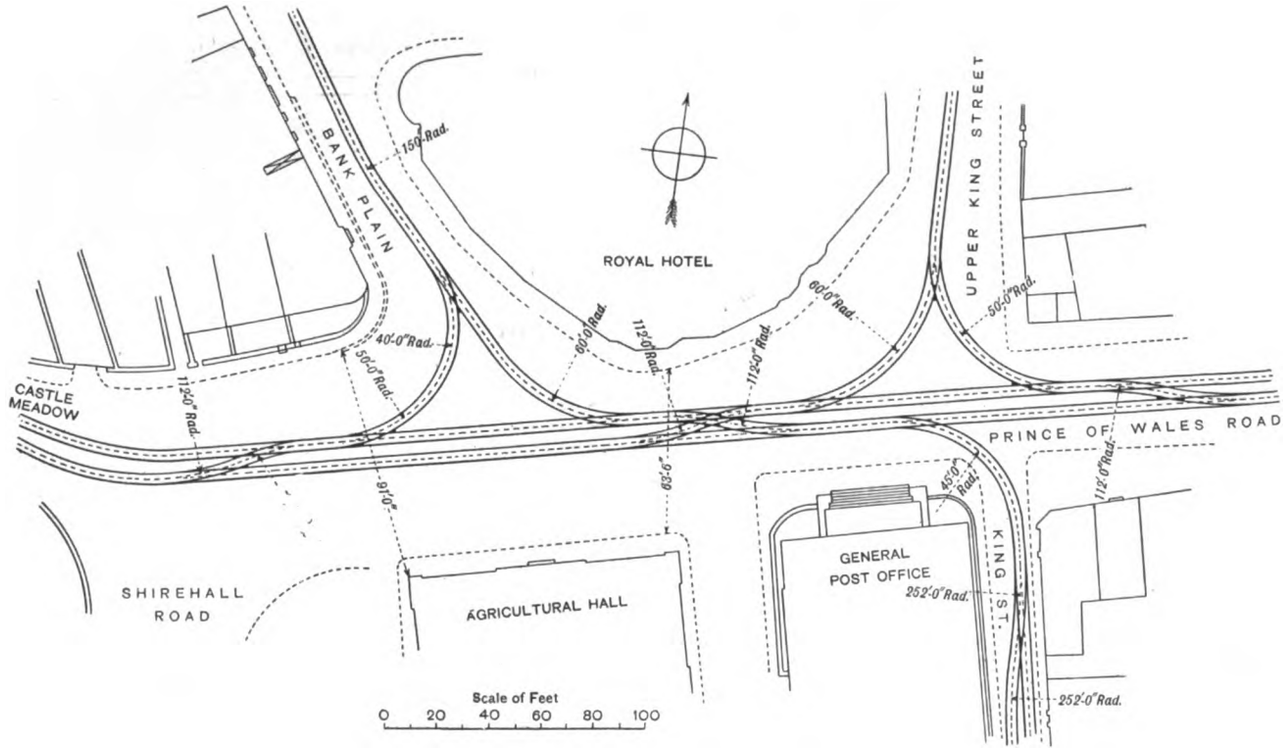
last week. Owing to the numerous gradients and curves it is expected that an unusually large number of flats will occur on the car wheels, and ample provision to remedy this has been provided for in the shape of an electrical wheel grinder, which has been erected in one of the car pits in the repairing shop at the car sheds. We give a scale drawing of this interesting machine. It consists principally of an electric motor driving an emery wheel at a rapid rate, together with a pair of friction wheels driving the car wheel at a slower rate. The wheel from which the friction wheels are run also drive a small centrifugal fan for collecting the dust from the emery wheel.



"Standard" Peckham Truck Used at Norwich.



"Special Work" at Point Marked "4" on Map.



"Special Work" at Point Marked "2" on Map.

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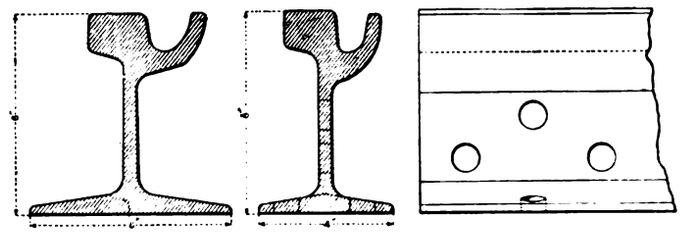
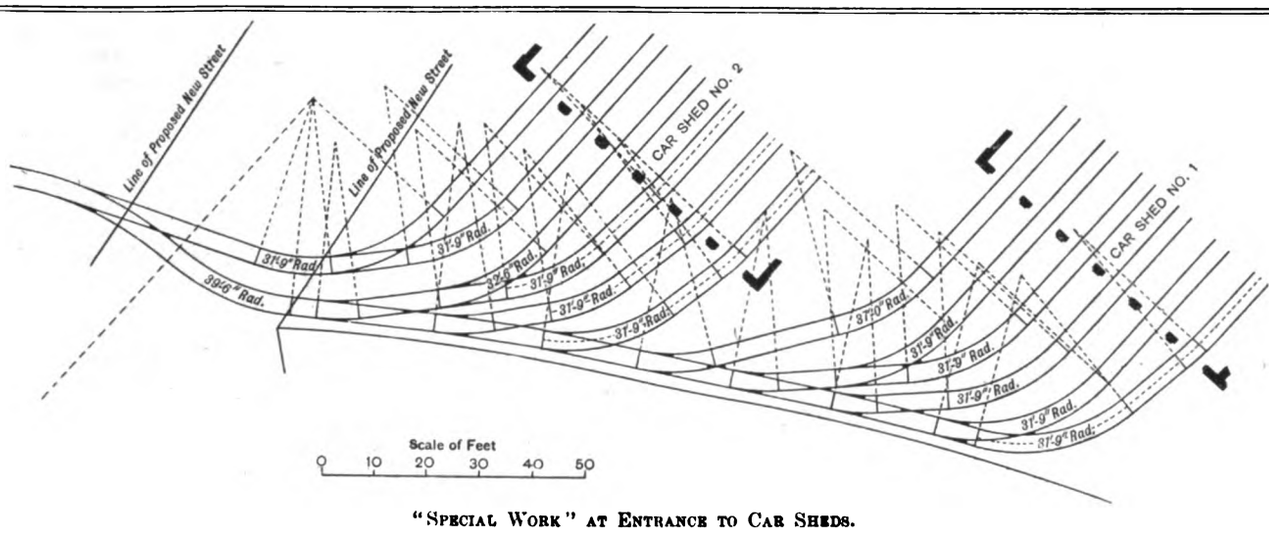
Cars.—The car equipment consists of 40 motor cars and 10 trailers, all of the double-deck type. The motor cars are equipped with Westinghouse motors and controllers carried on "Standard" Peckham trucks. An interesting feature of the car equipment is the Winslow trolley standard, a vertical section of which is shown in an accompanying drawing. The rotating head of this standard is carried on ball bearings at the top and bottom, as shown, and the tension springs are contained within the shaft. This standard gives a compact and efficient support for the trolley arm and provides for that degree of flexibility or side movement which is necessary for quick running on a trolley system in which the trolley wires are not exactly centred. It should be mentioned that the trolley head itself is not capable of moving on a vertical axis, as are many types of trolley head.

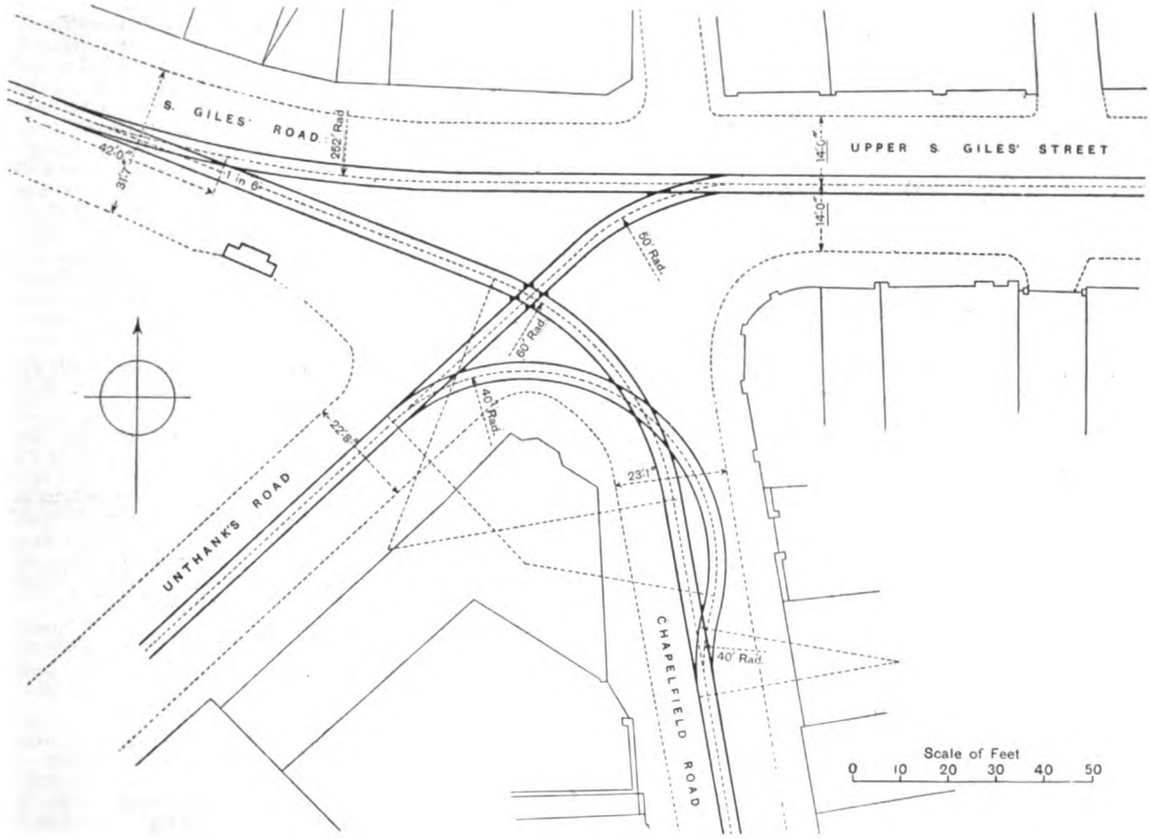
Section of a Cast Weld.



Guard and Track Rails.



"Special Work" at Entrance to Car Sheds.



"Special Work" at Point Marked "3" on Map.

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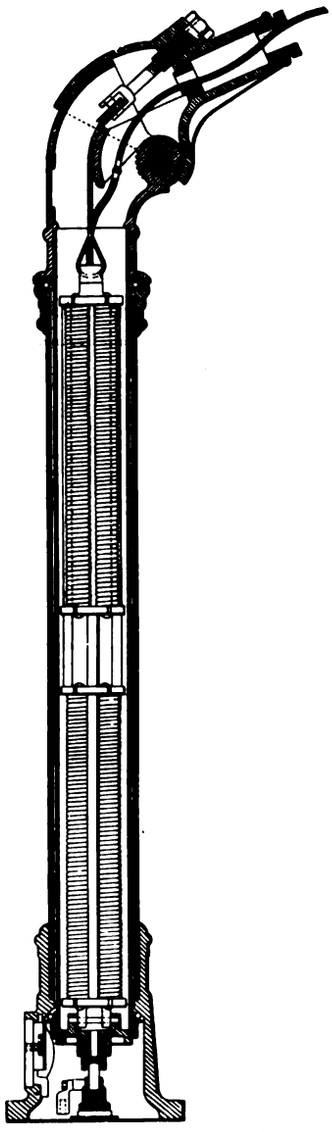
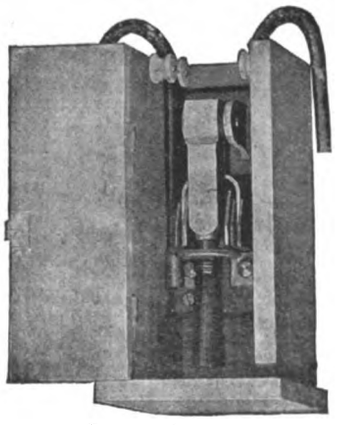
Conclusion.—Mr. I. E. Winslow, the chief engineer to the New General Traction Co. and to the Norwich Electric Tramways Co., is to be highly congratulated on the success with which he has carried out this extensive and difficult system



VERTICAL SECTION OF THE "WINSLOW" TROLLEY STANDARD.

of electric tramways. Our congratulations are also extended to Mr. Allan Bannister, who has ably assisted him as resident engineer during the construction work at Norwich. Our thanks are due to Mr. Winslow for the permission to repro-



SECTION SWITCHES.

duce the scale drawings accompanying this article, and also to Mr. Bannister for kindly showing us the power house and tramway system and placing at our disposal the information contained in this article.

LEGAL INTELLIGENCE.

Castner-Kellner Co. (Ltd.) v. Commercial Development Corporation (Ltd.).

The hearing of this appeal was commenced on Tuesday last week, and the case for the appellants, which was concluded on the following Thursday, was reported in our last issue.

Mr. TERRELL, Q.C., then addressed the House on behalf of the respondents. He dealt first with the smallness of the area of the invention which was said to be infringed, pointing out that he had pressed witnesses to say what it was that was said to be done by the Kellner patent which had not been done by other and previous patents. The most that any of them could say for it was that by its use a smaller quantity of mercury was required for the operation. There were three questions for their lordships' decision, which he submitted to the House in this way. The first was this: The respondents contended that the principle introduced in the final specification of the Kellner patent was not merely a departure from the provisional specification, but was absolutely a contradiction of it. Secondly, for that very reason, if the appellants were right in saying that the modification was not a contradiction of what was contained in their provisional, the respondents had not infringed the appellants' patent; thirdly, the respondents said that the appellants had failed to show that there was any subject-matter for this invention by their evidence according to the requirements of patent law. It was not enough to secure a patent, that an invention was claimed for a useful machine, if the invention was not capable of doing something that in itself was useful. He then described at some length Kellner's invention, and contrasted it with the Jensen, Sinding-Larsen, and other patents that had preceded it, and finally described in detail the apparatus of Rhodin, which consisted of a set of cells containing a solution of salt, in which were carbon electrodes. These cells, he explained, dipped into a circular pan of mercury, which acted as a cathode, filling up the intervals between the cells containing salt over which water was placed, and passing an electric current over the salt solution. Sodium was deposited on the mercury cathode forming an amalgam with the mercury, and as the cells were given continuous rotation, the amalgam so formed was brought into contact with the over-lying water and formed caustic soda by the action of the water and sodium. To ensure circulation of the mercury ribs were placed on the bottom of the pan causing the mercury to flow outwardly along its surface. It would thus be seen that the elements of Rhodin's apparatus consisted of a stationary vessel containing a layer of mercury, lying in the bottom whereof were a series of bells with their lower edges just dipping into the mercury containing the salt solution to be decomposed. The object of the ribs at the bottom of the vessel were, to arrest the flow of the mercury, and to make it flow relatively to the bells, whereas, if it were not for the ribs this result could not be obtained. Contrasting the respective specifications of Rhodin and Kellner, he maintained that, if the respondents infringed the latter, it was because there was disconformity in the appellants' specifications, and if there was no disconformity then the respondents did not infringe.

A model of Rhodin's apparatus was at this stage of the argument brought into the House and placed on the table before the Lord Chancellor. Mercury was poured into it by a gentleman representing the respondents' company, who proceeded to explain how the apparatus worked.

The LORD CHANCELLOR: When I turn the handle at the authorised speed of four turns to the minute, do I, in fact, turn the mercury in the vessel, or is it only an optical delusion?

Mr. TERRELL: The handle, in fact, turns the mercury about. That can be shown by placing on the surface of the mercury a scrap of paper. The machine in use would be some 4ft. in diameter, and turning its handle four times in the minute would produce the same amount of movement in the mercury as turning the handle of the model at the speed of 20 revolutions a minute. Resuming his argument, the learned counsel proceeded to deal with the distinctive features of the Rhodin process and to argue the question that it contained the subject matter for an invention. Subject matter of a patent, he said, involved utility.

The LORD CHANCELLOR: This word "utility" does not appear in the statute, and in no decision of the courts has the word been interpreted in the sense in which learned counsel used it. Of course a mere idea, which is incapable of being applied to any practicable use, cannot be the proper subject matter for a patent.

Mr. TERRELL agreed that in every valid patent there must be the element of "invention." There must be the exercise of an inventive faculty, and the invention must do something. It must accomplish some purpose. In this case the appellants to succeed must show that their patent accomplished something, and they could not show that it accomplished anything which the original method of using mercury did not equally well perform. He maintained that, reading Rhodin's specification and taking it, as he was entitled to do, as a description of what the respondents proposed to do, there was no evidence that the respondents using Rhodin's process must of necessity infringe the appellants' patent. He pointed out that the appellants had never worked Kellner's patent, and he went so far as to assert that it could not be worked

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because the Kellner apparatus in fact would not effect the objects or produce the results claimed—in short, that the patent was both worthless and void for want of utility. The appellants had been the owners of Kellner's patent since October, 1895, yet they had never attempted to work commercially or to lay down any plant or apparatus made in accordance with the specification, but had carried on business by means of an apparatus on Castner's principle. The apparatus the respondent's proposed to use had not been shown by the appellants to be in accordance with any apparatus or invention claimed in Kellner's specification, and therefore this appeal on the ground of an alleged infringement must fail.

In conclusion, he submitted that the appellants had failed to show that the decision of the majority of the Court of Appeal was erroneous.

Mr. ASTBURY, Q.C., followed: There were three grounds upon which he should submit that this appeal should be dismissed, and the judgment of the Court of Appeal affirmed. Briefly they were these: (1) Because the appellants' complete specification described, and in claim 3 claimed, an invention different from and larger than that described in the provisional specification. The patent sued on was also void (2) for want of subject matter, and (3) because of prior publications. At the trial various diagrams and models, including a working model of a machine constructed according to the specification of Rhodin's patent (No. 21,509 of 1896) and machines constructed according to the specifications relied upon as prior publications, were put in evidence. These showed that prior to the appellants' alleged patent the use of mercury as a cathode in electrolysis, and to form a seal between the cells of electrolytic apparatus, and the process of the electrolysis of alkaline salts with the aid of a mercury cathode were well known; and prior inventors had pointed out the difficulties and the means by which those difficulties could be surmounted. All that was left open, therefore, for any inventor dealing with this process was to devise a particular or suitable apparatus by which the desired object could be successfully secured. Carl Kellner, in his provisional specification, said that it had reference to an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode, in which the amalgam formed by electrolytic action had its location changed from the decomposing chamber in which it was produced to a combining chamber in which it was decomposed, and the cation combined with water, an acid or other body by the shifting of a partition, which was adapted to be moved to and fro in the mercury, and served to separate the two chambers from one another. This portion was made in the form of a bell, closed at its lower edge by a mercurial seal, and enclosing the decomposing chamber, so that the amalgam formed in the latter was caused by the shifting of the bell to have its location alternately on one side and on the other side of the bell, without itself changing or moving its position, and thus got into the combining chamber, while the mercury on the other side of the partition, which was previously situated in the combining chamber, effected the amalgamation of the metal that was being separated by the eletrolytic decomposition of the electrolyte. Kellner claimed that in this way a considerable output could be obtained from the apparatus with a small quantity of mercury, but at the trial evidence was given that his alleged invention really required the use of as much or more mercury to produce a given result than Rhodin's patent, and, therefore, the claim that his apparatus produced a saving was disproved. So, too, Kellner's statement that this economy was due to his method, by which both operations could take place at one and the same time and uninterruptedly, was only the statement of a fact that had already been noted and covered by other apparatus of prior date. Then Kellner's provisional specification went on thus: "In order that the mercury shall not become displaced by the lower end of the bell sliding over the bottom of the trough B. when the bell is being moved over slots or notches e or f^2 are provided in the lower edge of the bell, as in Figs. 1 and 4, or in the bottom of the trough, as in Fig. 5," and after describing the manner of working the apparatus the specification concluded as follows: "It will thus be seen that by the to-and-fro movement of the bells the transposition of the amalgam formed in the decomposing chambers to the combining chambers, and the practically continuous formation of caustic soda in the latter are caused to take place alternately on the one side and on the other side of the anodes, whilst the mercury cathode itself remains at rest."

The LORD CHANCELLOR: Do you say, Mr. Astbury, that the essential characteristics of Kellner's invention, as shown by his provisional specification, consists in devices for keeping the mercury cathode stationary and in the to-and-fro or alternating motion of the bells, alternately charging and discharging certain patches of the mercury surface with sodium?

Mr. ASTBURY: Certainly, my Lord; that was the evidence given at the trial also by the experts we called.

The LORD CHANCELLOR: And you contend from the specification of Rhodin's patent that in his process the mercury is agitated and churned up, and made to flow continuously from the centre to the sides of the vessel containing it and back again, and that this distinguishes it from the alternating method described by Kellner in his provisional specification?

Mr. ASTBURY: Yes, my Lord. In Rhodin the continuous flow from the centre to the circumference of the vessel containing it, and back again, gives this result, that a definite percentage or richness of sodium throughout the whole body of the mercury is maintained instead of Kellner's alternating method, as described in his provisional specification, the apparent feature of which was to charge and discharge certain patches of the mercury surface, and then, as a distinct operation, to discharge the same.

The LORD CHANCELLOR: How do you say that Kellner's provisional essentially differs from his complete specification?

Mr. ASTBURY: By describing an alleged modification which, in fact, is an absolutely different method of using the apparatus.

Lord MORRIS: Do you say that Castner's patent anticipated Kellner's complete specification?

Mr. ASTBURY replied that from the specification of that patent it would appear that the electrolytic operations in such process also took place simultaneously and uninterruptedly, and that no greater quantity of mercury was used in such apparatus than in Kellner's. The alleged modification introduced by Kellner in his complete specification consisted in this: that instead of being slid along rectilineally, the bell E or the vessel A, or the bottom of the latter, might have a rotary motion imparted to it. That alleged modification was an absolute departure from the essential feature of the invention as originally described, which said nothing about the alternating process of working with a stationary cathode, and reverted to the continuous process which had been described in Castner's by agitating and stirring up the cathode and by producing and maintaining a definite state of richness in sodium throughout the same, as distinct from charging and discharging definite patches of the mercury surface.

The LORD CHANCELLOR: Whether there is any practical difference between moving a bell through mercury and moving mercury under a bell,—a question over which experts differed at the trial—you say that any process by which the mercury is intentionally moved or disturbed otherwise than to the least possible extent by moving bells of salt water over it is outside, and cannot fairly come within, Kellner's real invention.

Mr. ASTBURY said that was the view of the Court of Appeal, and, he submitted, the right view, for Kellner's alleged modification was inconsistent with the original idea. It could not be successfully contended that an invention for an apparatus for keeping the mercury still was one for an invention for an apparatus for keeping the mercury moving. Claim No. 3 covered both inventions, and was such a departure from, and such an extension of, Kellner's real invention as to render the patent invalid. The learned counsel then addressed himself to the question of infringement. Describing the process as being one to transfer the mercury from one cell to another, he referred to Mr. Grindle's evidence, which showed the distinction between the appellants' and the respondents' machine in respect that the Rhodin apparatus of the respondents had ribs at the bottom of the vessel. The learned counsel explained in detail the differences between the apparatus and the appellants' and respondents' methods of distributing the electric current. Without the ribs, the Rhodin apparatus would not work. Mr. Astbury referred to the evidence of Mr. Dugald Clerk, who said that in Kellner's arrangement there must be one cell in the path of the other—the combining cell being in the path of the decomposing cell. In the respondents' case the combining chamber was out of the path of the decomposing cells altogether. Mr. G. A. Grindle had described Rhodin's apparatus as being efficient in consequence of the perfect circulation of the mercury, and said that Kellner's apparatus was not practical, and he had never heard of anybody working it. The appellants' patent was of a very limited character and very inefficient operation. It was only an apparatus for carrying out a perfectly familiar process. If there was any invention which could be patented it lay in the difference between the Kellner and the Castner specifications. In summing up, counsel said that Lord Justice Rigby was right in holding that there was no subject matter for the appellants' patent. With regard to disconformity Figs. 7 and 8 differed from Fig. 1, and went back to a former model, and the authorities showed in such a case that there was disconformity. Turning to the last question for decision, namely, that of infringement, the learned counsel said the plaintiffs, to succeed, had to show that their invention was a stationary cathode. If, in fact, there was any disconformity between Kellner's provisional and his complete specification, then Kellner had not invented a stationary cathode, and Kellner's patent was anticipated. Rhodin's apparatus did not infringe the plaintiffs' invention for several reasons. The defendants' apparatus made on Rhodin's specification had no stationary cathode, and there was no intermittent movement or its equivalent. Rhodin's apparatus discharged mercury in bulk and did not discharge in alternate patches; moreover, there was no water space between the mercury and the bells. Again, in Rhodin's there were no equally-sized charging and discharging cells following each other and together carrying the whole cathode; then the defendants' patent had a very much larger annulus—eight or nine times as large as Kellner's—which gave the opportunity of using a greatly increased current. Again, in the Rhodin patent the surface of the mercury outside the bells was revolving, and the radial ribs prevented it revolving underneath the pot and threw it outwards towards the periphery. This outward flow of mercury together with the large outside annulus were the superior points of Rhodin over Kellner. Indeed, if the mercury revolved underneath the pot itself, the whole thing would be a poor inefficient apparatus, very much the same as the Kellner one. In Kellner's provisional specification the whole thing consisted in moving the bells from a definite patch of mercury charged with sodium to a definite uncharged patch, the charged patch then coming into contact with water. But in his complete specification, in Figs. 7 and 8, Kellner was dealing with definite patches. Therefore the defendants contended that his Figs. 7 and 8 were inconsistent with a stationary mercury cathode, for the edge of the partition dividing the two chambers really acted as a stirrer. There was as much stirring in Kellner's Fig. 7 as there was in Castner's. To produce the flow of mercury by friction of the bottom of the containing vessel was the same thing as producing the flow by means of a paddle. The learned counsel again referred to the evidence given by the defendants' witnesses at the trial—especially that given by Mr. Dugald Clerk and Mr. G. A. Grindle—and submitted that the invention of Rhodin differed in every important detail from that of Kellner, and he was about to cite authorities in support of his contention, when—

The LORD CHANCELLOR said there was no principle of law in dispute between the parties. It was a dispute as to facts, and therefore authorities were quite unnecessary.

This closed the defendants' case.

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Mr. FLETCHER MOULTON, in reply, addressed himself principally to the question of infringement. He claimed that the plaintiffs held the patent by which for the first time in a satisfactory way an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode were produced, and he proceeded to show how the Kellner patent increased the usefulness and differed from the invention of Castner. Having explained at length the essentials of the two patents, he showed in what respects he considered that Rhodin's patent infringed, and then went at great length into each point of difference in the Rhodin and Kellner patents which Mr. Astbury had advanced. He submitted that the nature of the invention described in Kellner's specification must be considered in the light of the evidence given at the trial, and with that view he went into the evidence of Lord Kelvin and Mr. Swinburne, the plaintiffs' chief witnesses. He traversed Mr. Dugald Clerk's evidence to the effect that if the mercury were moved from one chamber to another it did not matter whether or not it moved in relation to the vessel which contained it. In Rhodin's there was a large annulus outside the bells in which most of the combining action went on. The ribs at the bottom tended to make the amalgam flow outwards of this annulus. Mr. Astbury had said it was impossible in Rhodin's to have alternate patches covered and uncovered; there was a constant stirring and not a stationary cathode. The mercury in Rhodin's apparatus was purposely kept at a high state of churning or agitation. These and other points Mr. Astbury asserted distinguished Rhodin's from that of the plaintiffs'. He (Mr. Moulton) submitted that the evidence of the plaintiffs' witnesses showed that was not the case. Lord Kelvin, in his evidence, said the advantage of Kellner's method was that there were no helical blades. Stirring was not wanted; in fact, the less the mercury was stirred the better. In Kellner's the mercury moved in relation to the fixed cells; the electrolyte and the water were included in the cells; they were stationary, whereas in Rhodin's the cells were moved in relation to the mercury, but in both of them Mr. Swinburne said there was just that agitation which would be caused by the edges of the cells dipping into the mercury. In conclusion, he submitted that none of the reasons Mr. Astbury had given why the delendants' invention did not infringe were well founded, and he invited the House to say that the claim for infringement had been proved, and that the plaintiffs were entitled to judgment.

This concluded the case, on Tuesday, and the Lord Chancellor announced that the House would take time to consider its judgment.

Legal Intelligence continued on p. 184.

ELECTRICITY WORKS ACCOUNTS.

Liverpool Corporation Tramways.

In our table subjoined we have attempted to summarise the more interesting figures of the working during 1899 of the extensive tramway system of Liverpool. The official report does not entirely separate the accounts of the electrical section from those of the horse-worked sections — such a separation is hardly possible. The working expenses are, however, separately available, and a comparison, even to this limited extent, between the two systems of working is, we think, possible and of course most interesting. In our analysis the small proportion of the "Road and Traffic Expenses," and of the "Horse-keeping and Maintenance" charges, which are chargeable to the working expenses of the electrical system, have been so charged; and, so far as we can see, the total working expenses (though, of course, not the elements which contribute to them, although of the same denomination), as set forth in our table, are directly comparable.

It will be seen that not only is the revenue per car mile on the electrical system higher than on the horse section, but that the working expenses on the electrical section are no more than about 6·0d. per car mile, as compared with 9·5d. on the horse-worked sections. These results are significantly similar in their indications to those we were able last year to record for Glasgow, and in both cases the figures in our analyses are eloquent of the unqualified success which has attended the introduction of electric traction in these towns.

The Brighton and Rottingdean Seashore Electric Tramroad Co.

In our remarks on the 1898 accounts of this interesting little line, we stated that it was expected that as a result of the purchase of power from the Corporation, and the reduction in the tariff for its supply, the "locomotive power" item in the accounts would be so reduced as to enable the concern to show improved financial results. Unfortunately, while a

LIVERPOOL CORPORATION TRAMWAYS.

Worked by	Liverpool Corporation.
Date of Commencement of Working	1898.
System	Overhead trolley at 500 volts.
Tramways Manager	C. R. Bellamy.
Engineers	A. Bromley Holmes and J. A. Brodie.

Year ended ..... December 31, 1899.

	Electrical section.		Horse section.		Whole tramway system.	
Quantities.						
Car mileage	*1,473,750*		*6,126,796*		*7,600,546*	
Passengers Carried	**15,853,160**		**47,918,290**		**63,771,450**	
Total Length of Track Worked	**20·6 miles**		**about 60 miles**		**about 80 miles**	
Rolling stock, No. of motor cars	103		—		—	
Ditto No. of trailers	15		—		—	
Total Capital Expended	—		—		**£1,161,279**[a]	
Revenue.	**Total.**	**Per electric car mile.**	**Total.**	**Per horse car mile.**	**Total.**	**Per total car mile.**
Total	—	—	—	—	**£365,860**	**11·560d.**
Electrical tramway cars	£77,663	12·64d.	—	—	77,663	2·452d.
Horse tramway cars	—	—	£230,411	9·025d.	230,411	7·285d.
Omnibuses	—	—	50,547	1·980d.	50,548	1·596d.
Advertising, &c.	—	—	—	—	7,237	0·229d.
Expenditure.						
Total	—	—	—	—	**£302,160**	**9·550d.**
Total Working Expenses	**£36,973**	**6·023d.**	**£242,391**	**9·500d.**	279,365	**8·830d.**
Maintenance and renewal of way	*1,252*	*0·201d.*	*4,853*	*0·190d.*	*6,085*	*0·192d.*
Maintenance and renewal of lines	961	0·156d.	—	—	—	—
" " of elec. equipm't	271	0·044d.	—	—	—	—
Power	*7,195*	*1·171d.*	*144,559*	*5·663d.*	*151,754*	*4·795d.*
Horse keeping and maintenance	—	—	144,559	5·663d.	—	—
Elec. energy for haul'g, light'g cars, &c.	7,195	1·171d.	—	—	—	—
Maintenance and renewal of cars	*6,477*	*1·054d.*	*12,895*	*0·505d.*	*19,372*	*0·612d.*
Salaries and wages	4,492	0·732d.	—	—	—	—
Materials, &c.	1,984	0·323d.	—	—	—	—
Road and traffic expenses	*19,697*	*3·209d.*	*73,775*	*2·890d.*	*93,472*	*2·959d.*
Salaries and wages	17,450	2·842d.	68,788	2·694d.	—	—
Printing and stationery	146	0·024d.	609	0·024d.	—	—
Other charges	—	—	—	—	—	—
Maintenance of buildings, &c.	*146*	*0·024d.*	*2,822*	*0·111d.*	*2,968*	*0·094d.*
Miscellaneous working expenses	*2,226*[b]	*0·363d.*	*3,487*	*0·137d.*	*5,713*	*0·180d.*
General charges	—	—	—	—	*22,794*	*0·720d.*
Advertising, printing and stationery	—	—	—	—	703	0·022d.
Rents, rates and taxes	—	—	—	—	10,956	0·346d.
Management and office expenses	—	—	—	—	2,541	0·080d.
Compensation and law	—	—	—	—	1,798	0·057d.
Other general charges	—	—	—	—	6,796	0·215d.
Financial Results.	**Total.**		**Total.**		**Total.**	**Per cent. to mean capital expended.**
Working Profit	—	—	—	—	**£63,700**	**6·07%**
Sum carried to depreciation fund	—	—	—	—	14,580	1·39%
Net interest on loans	—	—	—	—	28,193	2·69%
Sum carried to sinking funds	—	—	—	—	29,584	2·82%
Balance from last account	—	—	—	—	6,169	0·588%
Balance	—	—	—	—	nil[d]	—
Percentage of total expenditure to rev.	—	—	—	—	82·6%	—
Revenue per Mile of Track	—	—	—	—	**£4,573**	—
Expenditure per mile of track	—	—	—	—	£3,778	—
Revenue per Passenger from Fares	1·18d.	—	1·16d.	—	1·16d.	—
Total Revenue per Passenger	—	—	—	—	1·38d.	—

REMARKS.—*a* Includes "reconstruction and extension of tramway lines for electrical haulage, including paving, permanent way, overhead electrical equipment, &c.," £172,302; also "preliminary expenses incidental to the laying of the experimental electric line," £471, and "lands and buildings," £28,745. *b* Includes £395 alterations to cars and £1,703 preliminary expenses—viz., £23 electric energy and £1,680 wages of drivers and conductors while learning. *c* Being £13,915 to Tramways Undertaking Sinking Fund, £7,007 to Tramways Sinking Fund, £5,611 to Reconstruction, Extension and Equipment Sinking Fund, £170 to Mortgage Debt Sinking Fund and £2,881 to Cancellation of Debt Account. *d* After crediting account with £100 from War Office for registration of horses.

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very decided reduction in the costs per train mile has taken place in the working during last year—especially during the latter half—the receipts per train mile have dwindled very materially owing to the decrease in the passenger traffic. This falling off in the number of passengers carried during the year amounted to about 11 per cent., and is significantly shown by a comparison of the receipts per train mile during the latter halves or the best portion of the two years. It will be seen that the total has dropped from 13·2s. in 1898 to 8·5s. in 1899, or 36 per cent. On the other hand—and this is a most hopeful sign—the costs in the same periods show a diminution of nearly 46 per cent., while the ratio of the expenditure to revenue fell from 70·3 to 59·6 per cent.

The following is a list of electric railway and tramway works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Blackpool & Fleetwood (Co.)	Mar. 30, 1900	Glasgow Corporation (Mun.)	Aug. 11, 1899
Brighton & Rottingdean Seashore (Co.)	April 7, 1899	Isle of Man (Co.)	May 27, 1898
Bristol Tram & Carriage (Co.)	Feb. 17, ,,	Leeds City (Mun.)	June 2, 1899
Br'mpt'n & Pico'dilly Cir. (Co.)	July 8, 1898	Liverpool Overhead (Co.)	Mar. 30, 1900
City & South London (Co.)	Mar. 30, 1900	New General Traction (Co.)	May 27, 1898
Douglas Southern (Co.)	May 27, 1898	Oldham, Ashton & Hyde (Co.)	Mar. 30, 1900
		Waterloo & City (Co.)	Feb. 17, 1899

BRIGHTON & ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD.

Worked by	Brighton and Rottingdean Seashore Electric Tramroad Co.
Date of Commencement of Working	November, 1896.
System	Overhead trolley at 550 volts.
Chief Engineer	Magnus Volk.

Half-year ended	June 30, 1898.	June 30, 1899.	December 31, 1898.	December 31, 1899.
Quantities.				
Train mileage	*2,508*	*1,930*	*2,539*	*3,826*
Passengers Carried	45,106	33,239	67,422	66,842
Length of railway authorised	3 ml.	3 ml.	3 ml.	3 ml.
Length of railway constructed	3 ml.	3 ml.	3 ml.	3 ml.
Length of Railway Worked	3 ml.	3 ml.	3 ml.	3 ml.
Length of railway under construction	nil	nil	nil	nil
Rolling stock, number of cars	1[a]	1[a]	1[a]	1[a]
,, number of locos.				
Capital.				
Authorised (Total)	£35,000	£35,000	£35,000	£35,000
Authorised (share)	28,000	28,000	28,000	28,000
Authorised (loan)	7,000	7,000	7,000	7,000
Received (Total)	28,139	29,140	29,140	29,140
Received (share)	23,139	24,140	24,140	24,140
Received (loan)	5,000	5,000	5,000	5,000

	Total.	Per mile of working railway.	Total.	Per mile of working railway.	Total.	Per mile of working railway.	Total.	Per mile of working railway.
Expended (Total)	£34,933	£11,644	£35,824	£11,941	£35,792	£11,931	£35,711	£11,904
On line open for traffic	—	—	—	—	—	—	—	—
On line in course of construction	—	—	—	—	—	—	—	—
On working stock, including power station	—	—	—	—	—	—	—	—
Balance of Capital Account	-6,794[b]	-2,265	-6,684[b]	-2,228	-6,652[b]	-2,217	-6,571	-2,190
Revenue.								
Total	£1,092	8·710s.	£803	8·318s.	£1,679	13·230s.	£1,617	8·460s.
Passenger traffic	1,083	8·670s.	794	8·227s.	1,664	13·100s.	1,602	8·375s.
Parcels, rents, transfer fees, &c.	4	0·032s.	9	0·093s.	16	0·126s.	15	0·078s.
Expenditure.								
Total	£1,006	8·015s.	£890	9·223s.	£1,180	9·300s.	£964	5·041s.
Maintenance of way, works, & stations (less *depreciation*)	*113*	*0·900s.*	*181*	*1·876s.*	*114*	*0·898s.*	*136*	*0·711s.*
Maintenance of way	113	0·900s.	181[f]	1·876s.	114	0·898s.	136[m]	0·711s.
Repairs of structure, stations, &c.								
Locomotive power	*309*	*2·460s.*	*179*	*1·855s.*	*437*[j]	*3·440s.*	*266*	*1·391s.*
Coal and cake	129	1·023s.	127[g]	1·316s.	142	*1·120s.*	197[g]	1·030s.
Wages at power station	165	1·314s.	42	0·435s.	78	0·614s.	50	0·261s.
Oil and stores	15[c]	0·120s.	9	0·093s.	10	0·079s.	19	0·099s.
Repairs and renewals								
Repairs and renewals of cars	*36*	*0·287s.*	*76*	*0·788s.*	*176*[k]	*1·390s.*	*86*[n]	*0·450s.*
Traffic expenses	*181*	*1·440s.*	*104*	*1·078s.*	*128*	*1·010s.*	*146*	*0·764s.*
Salaries and wages	140	1·120s.	99	1·026s.	110	0·866s.	116	0·606s.
Other charges	41	0·327s.	5	0·052s.	18	0·142s.	30	0·157s.
General charges	*277*	*2·210s.*	*234*	*2·426s.*	*231*	*1·740s.*	*260*	*1·360s.*
Directors	100	0·797s.	100	1·036s.	100	0·788s.	100	0·523s.
Salaries of Secretary, General Manager, and Clerks	177	1·410s.	134	1·389s.	121	0·953s.	160	0·837s.
Other charges								
Rents, rates, taxes, &c.	*41*	*0·327s.*	*58*	*0·601s.*	*36*	*0·284s.*	*52*	*0·272s.*
Miscellaneous items	*49*[d]	*0·391s.*	*58*[h]	*0·601s.*	*69*[l]	*0·544s.*	*18*	*0·094s.*

	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
Financial Results.								
Working Profit for Half-year	£86	0·250%	-£87[i]	-0·243%	£499	1·410%	£353	1·82%
Sum carried to depreciation fund	—	—	—	—	—	—	—	—
Net interest on loans	223	0·648%	300	0·833%	361	1·02%	318	0·888%
Balance from last half-year's account	-41	-0·119%	-46	-0·128%	-178	-0·505%	-433	-1·21%
Balance Available for Dividend	-178[e]	-0·517%	-433[i]	-1·21%	-39[i]	-0·110%	-93[i]	-0·278%
Ordinary Dividend paid at per cent. per annum	nil.	—	nil	—	nil	—	nil	—
Percentage of total expenditure to revenue	92%	—	111%	—	70·3%	—	59·6%	—
Revenue per Mile of Working Railway	£361	—	£268	—	£560	—	£539	—
Expenditure per mile of working railway	£335	—	£296	—	£393	—	£321	—
Revenue per Passenger	5·81d.	—	5·80d.	—	5·98d.	—	5·81d.	—

REMARKS—*a* One motor car only. *b* Over-expended. *c* Includes oil £4, and miscellaneous £11. *d* Includes £43 to insurance and £6 to auditing. *e* Being defici's. *f* Includes wages £106, and material £73. *g* Paid for electricity used, supplied by the Brighton Corporation. *h* Being insurances. *i* Deficit. *j* Includes £207 for electricity used. *k* Includes £140 to materials and £36 wages. *l* Includes £63 to insurance and £6 to auditing. *m* Includes £100 wages and £36 to materials. *n* Of which £12 is wages and £73 material.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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ELECTRIC TRACTION ON THE "UNDERGROUND" RAILWAY.

Monday, May 21, 1900, is a date to set down in the annals of electric traction, for on that day an electric train was first put on the public passenger service on the Metropolitan-District Railway. The event, important though it undoubtedly must be in any circumstances, was, however, deprived of some of its glamour, owing to the fact that London is already familiar with electric traction on underground railways. The opportunity has been missed by the directorial Boards of the Metropolitan and District Railway Companies of being first in the field; and, despite its significance, the event of Monday last falls flat. Everyone is asking, Why was not this thing done five or ten years ago? Instead of being an event in the vanguard of railway engineering, it is but an inevitable capitulation to the force of circumstances on the part of the two associated railway companies, who have striven to set their faces against it as long as possible. Nor can we discover, in this so-called "experiment" in electric traction, anything more than an attempt to put off the day when the entire Inner Circle system must be electrically equipped, or cease to enjoy any measure of public patronage.

It will be remembered, doubtless, by our readers that in February, 1897, a committee was appointed by the Board of Trade "to inquire into the [then] existing system of ventilation of tunnels on the Metropolitan Railway, and report whether any, and, if so, what steps could be taken to add to its efficiency in the interests of the public." This reference is more closely related to electric traction than may appear at first sight; for, in October, 1897, the Committee made its report, the sum and substance of which was that "by far the most satisfactory mode of dealing with the ventilation of the metropolitan tunnels would be by the adoption of electric traction." We gave the full text of the recommendations in our leading article of October 15, 1897 (*The Electrician*, Vol. XXXIX., p. 820); and on that occasion we observed that "in the face of such unmistakable conclusions on the part of a strong and competent departmental committee, and with the pronounced success of electric power as a means of propulsion on railways confronting it, it is to be hoped the Metropolitan Railway Co. will no longer hesitate to adopt electric traction." As regards

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the actual ventilation to be adopted, we quote again the fifth and final recommendation of the Committee :—

5. Therefore, as a temporary measure, the Committee are prepared to recommend that the construction of the proposed additional openings, which would be found useful even when the line is worked electrically, should be allowed, but only upon the condition that, unless electric traction be adopted, or some satisfactory artificial ventilation be introduced within three years after the passing of the Act authorising these openings, it shall be made incumbent upon the company to close them if called upon to do so by some competent authority to be named by Parliament.

The three years have nearly expired, but what has been done to carry out these recommendations? For answer, we see only the "experimental" line between Earl's Court and High-street, Kensington—scarcely any of it in tunnel—and the bill which has been quite recently promoted by the associated companies, to obtain powers to erect a power station and work their lines electrically. Emphatically this is a policy of dawdle and delay. Of "experimental" line there was no real necessity whatever; and the bill should have been promoted as soon after the report of the Board of Trade Committee as it could be properly drafted. Note what happened instead. For nearly a year the railway companies appear to have done nothing; but in the early summer of 1898 they awoke from their lethargy to the extent of appointing two eminent engineers, a renowned bridge builder and a leading telegraph expert—to wit, Sir John Wolfe Barry and Sir William Preece—to report to them about the possibilities of electric traction. What these engineers told the directors we do not know; but they had plenty of material at hand to enable them to make out a clear case in favour of the immediate adoption of electric traction on the Inner Circle. Incredulous as the directors seem to have been at the outset, it might reasonably have been supposed that they would be convinced by the successes already achieved with heavy electric traction elsewhere. But no: not easier than other mortals can directors be convinced against their will. So they met in solemn conclave and voted £20,000 between them, for the purpose of presenting their two expert engineers with a pretty little problem, which would keep things quiet for a couple of years or so. Now, there happened to be a short length of railway over which but few trains passed daily; it lay between Earl's Court and High-street, Kensington. "Go," said the directors to their experts, "erect your electrical apparatus on that little bit of our line, without in the least disturbing our precious permanent way, or our trains, or our signals; spend £20,000 in doing this thing, and afterwards we will come and see if it will work." In spite of the stringent conditions the electrical equipment was successfully put in place; nothing in the permanent way was disturbed, not a single train was interfered with, and an insulated return conductor was provided, so that there should be no disturbance from earth currents. Then came the directors to view the "experiment"; and, doubtless to their amazement, the whole thing worked successfully—worked as any electrical engineer three years ago would have predicted it would do.

It is difficult to perceive what the associated railway companies, or anyone else for that matter, are going to learn from the experiment at Earl's Court. Doubtless the expert engineers and their friends will take advantage of the electric train to make useful measurements and tests; we hope they will do so, and that the results will be communicated to the Institution of Electrical Engineers. But it is hardly likely that the directors have voted £20,000 to enable electric traction engineers to make technical experiments for themselves. Yet the purpose of the line is by no means evident. For, the particular system and the mode of working adopted are certainly not designed to show that electric traction is cheaper than steam locomotives; the experiment is to be carried out without regard to economy of working. Neither can it be claimed that the particular type of train or system of track-work are such as the engineers would recommend for a permanent equipment of the underground railway system. Indeed, it appears to be certain already that, in the event of such extensions, quite different arrangements would be made. In the Inner Circle, for example, it would be far better to place the working conductor or conductors near to the top of the tunnel, where there would be less risk of their giving shocks to platelayers or becoming earthed by being accidentally connected to the track rails by means of, say, a crowbar. At present, the temptation to a tired platelayer to sit down on the flat top of the 500-volt working conductor, and put his feet on the track rail, may only be overcome after saddening experience. Not that we anticipate serious mishaps on this short length of scarcely-used track; the system adopted is suitable enough for the purposes of the "experiment." In fact, the directors have now had it demonstrated to them that electric traction *can* be provided on their lines on the conditions they have stipulated; and we trust that they are satisfied thereby, and that they will proceed without further delay to look at the matter in the light its seriousness demands. No more time should be lost in electrically equipping the entire Inner Circle system.

A CENTURY OF CHEMISTRY AT THE ROYAL INSTITUTION.

(*Concluded from page 136.*)

Lecture IV.

At the Royal Institution on Thursday afternoon, May 17th, Prof. J. Dewar, F.R.S., delivered the fourth and concluding lecture of this course. Resuming his remarks on Faraday's experiments on the liquefaction of gases, the lecturer pointed out that Thilorier's discovery of the manufacture of solid carbonic acid led to a resumption of Faraday's experiments, which had been temporarily suspended. He soon arrived at the conclusion that both low temperatures and considerable pressures were necessary for the liquefaction of every gas, and that there invariably existed a Cagniard-de-la-Tour state for every gas. The use of solid CO_2 by Faraday is analogous to the use of liquid air at the present time. Faraday next investigated the solubilities of some of his liquefied gases, finding that liquid CO_2 was a feeble, and liquid NH_3 a very powerful solvent. He examined also the nature and properties of india-rubber, which he proved to be a hydro-carbon, losing all traces of its elasticity when cooled to a very low temperature. After referring briefly and rapidly to the remaining chemical and electro-chemical investigations of Faraday, Prof. Dewar turned to Sir Edward Frankland, who continued the investigations of Faraday in the domain of organic chemistry, considerably extending that science by original investigations and successful speculations which made him second to none as an experimenter of the modern type. Frankland was the first to conceive the idea of "atomicity," or "valency" as we now prefer to call it, in chemical action, and one of the first also to examine the nature of flame. The principal technical work with which Frankland was notably connected was (1) the analysis of the water supplies of the metropolis and Great Britain, and (2) the enrichment of coal gas.

In conclusion, Prof. Dewar made references to two other chemists connected with the Institution. First, to Dr. Odling, who made himself principally remarkable for his clear and philosophical grasp of the whole field of chemical theory; and second, to Dr. John Hall Gladstone, whose name would be chiefly remembered by future chemists and physicists for his notable work leading to the formulation of the well-known Gladstone's law of refractive powers of solutions, and who was still amongst us, actively occupying himself in chemical investigations.

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PHYSICAL SOCIETY.

At an ordinary meeting, held May 11, 1900, Prof. O. J. Lodge, F.R.S., President, in the chair, a discussion of Prof. Lodge's Paper,

"On the Controversy Concerning Volta's Contact Force,"

was commenced by Prof. Armstrong.

Prof. ARMSTRONG expressed his indebtedness to the President for stating clearly what we are trying to understand, and said that it was hardly time for chemists to enter the discussion so long as physicists themselves differed. There had apparently been a change of front since the effect was supposed to be due to (1) chemical action between metals, or (2) oxidation. Prof. Lodge's view is intermediate but approximate to the second. Prof. Armstrong said that, from a practical point of view, the existence of the effect was unknown, because sufficient precautions had never been taken to prevent chemical action. He urged the continuance of experiments similar to those carried out by Mr. Spiers, and stated that modern ideas of chemistry were favourable to the view which Prof. Lodge had taken up with regard to the Volta effect.

Mr. R. T. GLAZEBROOK made some remarks upon the meaning of the term E, which occurs in the expression for the Peltier effect at the junction of two metals. If we confine our attention to an infinitesimal cycle at the junction of two metals at slightly different temperatures, we get the equation for the Peltier effect, in which E is the potential difference at the point considered. If, then, assuming reversibility, we sum up all the infinitesimal cycles round a circuit, and get a finite cycle, the E.M.F. of the circuit is a function of the two temperatures between which it is working. Differentiating with respect to temperature the total E.M.F. of the circuit, we get an equation which applies to the circuit as a whole, and in which E is the total E.M.F. round the circuit.

Mr. PRICE asked if any critical experiment could be suggested to settle the question.

Dr. LEHFELDT called attention to some experiments which had been performed to measure the potential difference between an electrolyte and a gas. The electrolytes considered were chiefly aqueous solutions, and the potential differences observed varied largely. The surface tensions of the liquids were measured, and it was shown that the variations in the potential difference were very similar to those in surface tension. This suggests, in the case of electrolytes, true physical surface effects and not chemical action.

The CHAIRMAN remarked that Dr. Lehfeldt evidently looked upon the metal-ether boundary as being the effective one. The experimental evidence was not sufficient to say exactly which was the effective contact, but it seemed to show that the metal-ether effect was of the same order of magnitude as the oxygen-layer effect. According to Helmholtz, they ought to be related, and so they were.

The CHAIRMAN then read a Paper, by Mr. J. B. TAYLER, on

"The Heat of Formation of Alloys."

Experiments have been made upon alloys of lead with tin, bismuth, and zinc, and of zinc with tin and mercury. The method employed consisted in dissolving (1) the alloy, and (2) the corresponding mixture of metals in mercury and measuring the heat of solution in each case. On the assumption that the solutions obtained are identical, the difference between the heat of solution of the mixture and that of the alloy is the heat of formation of the latter. The calorimeter was a thin glass tube, silvered on the outside, and supported by a stouter tube, silvered on the inside. Suitable arrangements were adopted for the introduction of the metals or alloys, which were used in the form of filings. Solution was often complete in less than a minute, and rarely took more than two minutes and a half. The alloys first experimented upon contained their constituents in equivalent proportions, and the heats of formation were found to be small in comparison with those found for brass by Galt and Baker. It was thought that only a small percentage of the atoms present had entered into definite chemical combination, and that more reliable results would be obtained by dissolving a small quantity of one metal in an excess of the other, and calculating from the experimental results the heat of formation of the gramme-molecular weight of compound upon the supposition that the whole of the small quantity of metal had entered into chemical combination by the exercise of its normal valency. Using these numbers so obtained to find by Kelvin's theory the potential difference which should exist between the metals concerned when put in contact, results were arrived at which agreed neither with the Volta effect nor the Peltier effect, but which were considerably nearer the former than the latter.

A Paper on

"The Want of Uniformity in the Action of Copper-Zinc Alloys on Nitric Acid"

was read by Dr. J. H. GLADSTONE. Experiments have been made by dissolving copper-zinc alloys in nitric acid, following the method of Dr. Galt, and adopting the precautions mentioned by him. The reaction between nitric acid and these metals or alloys is very complicated, and there is a difference between the products in the case of an alloy and in the case of the equivalent mixed metals. The gases evolved being small in the experiments performed, attention was directed to the determination of the substances remaining in solution, *i.e.*, the nitrous acid and ammonia. The alloys gave much more nitrous acid and less ammonia; in fact, two of the alloys employed produced no ammonia. Discrepancies in results may be due to the fact that the zinc and copper in contact form a zinc-copper couple which in the presence of acid sets up a vigorous action, and produces a different evolution of heat. Difficulties arise in the investigation because the alloys used may not be definite chemical compounds, but mixtures of two or more alloys with uncombined zinc and copper. The alloy with 38·38 per cent. of copper appears to be fairly uniform. Different observers disagree as to the amount of heat produced by any reaction, but the excess of calorics in a zinc reaction over those in a copper reaction appears to be fairly constant. Starting with 640 calories, the value, according to Galt, when copper is dissolved in nitric acid of specific gravity 1·360, we should have 1,357 calories when zinc is dissolved, provided the chemical action is the same in each case. All the calorimetrical results from the different specimens of alloys would theoretically lie upon the straight line drawn between 604 and 1,357. This is practically so from pure copper to the copper 70 per cent. alloy, but beyond that there is less heat produced than that indicated by the straight line law, the maximum deviation being at about copper 37 per cent. The specimen containing 38·38 per cent. copper, which is not far from the alloy $CuZn_2$ shows a loss of 32 calories. The only way in which this deficit can be accounted for is by supposing that the action of this alloy on nitric acid produces a larger quantity of nitric oxide than in the case of pure copper. But allowing full force to this argument it cannot account for as much as 10 calories of the deficit. There is, therefore, a residual deficit as yet unaccounted for on chemical grounds. The author states that it is desirable that experiments should be conducted on the zinc-copper alloys with solvents which give a simpler chemical action than that produced by nitric acid.

The CHAIRMAN pointed out that the results obtained by Galt for an alloy, which appeared to be a chemical compound, were in close agreement with what would be expected from the existence of the Volta contact force.

Prof. ARMSTRONG said that the action of nitric acid on brass or zinc and copper was a function of the quantity of acid present, its strength, the temperature, and the pressure, and that therefore it was unsatisfactory to conduct experiments using nitric acid as a solvent. He suggested the use of a solution of bromine, in which finely-powdered zinc, copper, and brass are easily soluble with a simple chemical reaction.

Mr. TOMLINSON pointed out that it was impossible to use the ordinary formula for the calculation of the Volta effect from the heat of formation of alloys, unless we know exactly the chemical composition of the alloy which is produced.

Mr. W. R. COOPER, referring to Mr. Tayler's Paper, said it was difficult to see that anything could be proved by the application of the Kelvin theory to a metallic contact unless there is ground for believing that some particular alloy of fixed composition is always formed. There is also a further difficulty in converting heat of formation into E.M.F. in cases where the metals have different valencies, for there is no reason why one valency should be selected rather than the other. Referring to Dr. Gladstone's Paper, Mr. Cooper said that it was possible that the difference in the reducing powers of mixtures and alloys might be due to local action, which would be more pronounced in the case of alloys. More hydrogen would be evolved and the reduction would be more complete.

Prof. S. P. THOMPSON then showed an

"Electromagnetic Experiment."

A circular coil, capable of carrying a strong current, was placed with its axis horizontal in a tank of water. Into the tank were also placed some small magnets in sealed glass tubes so adjusted as to have a density approximately equal to that of water. The magnets just floated or just sank. On running a current through the coil it was possible to "fish" for the magnets, which, acted upon by the magnetic field, immediately made their way to the coil. When the current was carefully reversed, upon the approach of a magnet repulsion took place instead of attraction, and the magnet retreated. In general, however, reversal of the current produced reversed polarity in the magnet, and attraction still persisted.

The Society then adjourned until May 25th.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"L'Electricité à l'Exposition de 1900." By M. M. E. Hospitalier and J. A. Montpellier. No. 1. (Paris: C. Dunod.)

"Dynamometers and the Measurement of Power." By J. J. Flather. Second Edition. (London: Chapman and Hall.) 12s. 6d.

"Æther and Matter: A Development of the Dynamical Relations of the Æther to Material Systems on the basis of the Atomic Constitution of Matter." By Joseph Larmor, F.R.S. An Adams Prize Essay, in the University of Cambridge. (London: C. J. Clay and Sons). 10s. net.

"The Official Gazette of the United States Patent Office." No. 5, Vol. XCI. (Washington: Government Printing Office.)

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THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

BY C. E. GROVE.

(*Continued from page 129*).

Boat-hoisting Engines.—A British battleship carries two sets, one on either side, of such power that each set can lift by means of tackle a boat weighing 18 tons at not less than 20ft. per minute. This is a favourable case for electric driving, and in the latest British ships electric motors are specified for the work. The actual net horse-power for the lift is approximately 24, and as the motors have to drive through a worm gear and a wire-rope tackle, the maximum input may be taken at about 50 B.H.P. The motors are specified to run at not more than 750 revs. per min., to be watertight, and to be fitted with reversing switches and automatic brakes. The rating of the motors is determined by the temperature limit of 80°F. rise after one hour's run at full load; which enables the weight of the total equipment to be about the same as that of the steam hoist An electric compound deck-winch, as fitted in the United States battleships "Kearsage" and "Kentucky," is illustrated in Fig. 31.

Coal Hoists.—These machines (of which two sets are carried) are of the same class at the boat hoists, but work at a quicker rate. The latest British specifications define their work to be the lifting of 1 ton at 250ft. per minute, but on test they have to lift 1½ tons at this rate. On the test load they have to exert 25 actual H.P., and though the efficiency may be a little higher in this case than in that of the boat hoists, the total input will be 40 E.H.P. to 50 E.H.P. The motors, therefore, may well be of the same size; they are governed by the same specification as to temperature limit, control, &c. The weight of the motors and gears will probably be a few hundredweights more than that of corresponding steam hoists.

Ash Hoists.—One of these is usually fitted to each boiler-room; the "Albion" carries five. Their work is not definitely specified, but may be described as lifting with wire-rope tackle a bucket of ash weighing, when full, about 1½ cwt., at from 200ft. to 250ft. per

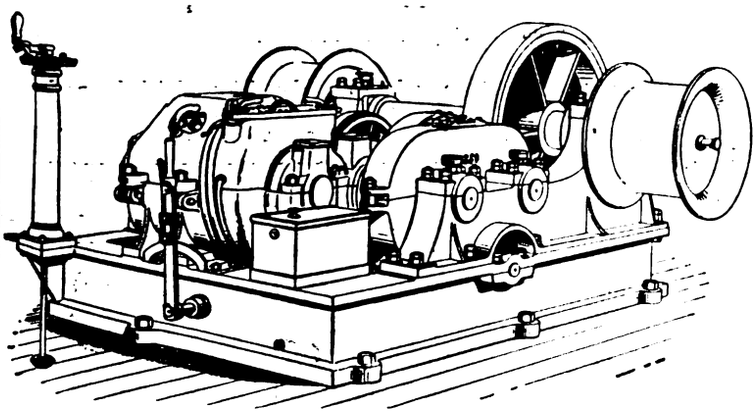

FIG. 31.—Electric Deck-winch, U.S.S. "Kearsarge" and "Kentucky" (General Electric Co., U.S.A.).

minute = 1½ actual H.P., the maximum I.H.P. of the steam engines being about five on a weight of 14cwt. Being placed on the boat deck, machines of this class may well be electric, and as the motors will run at higher speed than steam engines no increase of weight need be involved.

Ventilating Fans.—These are employed for ventilating all compartments below the protective deck and some of the compartments above that deck, such as mess and living spaces. The general practice up to 1898 was to provide six 5ft. 6in. double-breasted steam fans on lower deck, three at each end of ship, driven at a maximum speed of about 400 revs. per min., and connected together to main ventilating trunks, besides an auxiliary system of ventilation with one 4ft. 6in. fan at each end of the ship. The electric driving of ventilating fans is now common in most navies. Fig. 32 shows a Sturtevant fan with open-type motor as used in the United States navy. In a few recent ships, electric fans of from 3ft. to 4ft. diameter have been fitted taking about 7 H.P. at 600 to 700 revs. per min., the same number (8) being employed and connected to the same system of trunks as designed for steam fans. Figs. 33, 34, and 35 show a 3ft. 9in. electric fan of this sort designed by the author and fitted in the I.J.B. "Shikishima." These fans have been adjusted to deliver 7,500 cubic ft. of air per minute, each at 2in. pressure at 480 revs. per min., at which output they consume 5 E.H.P. apiece, but their speed and output can be increased if desired. Experience has shown that the matter of ventilation has been somewhat overdone in recent years, such powerful fans being seldom worked at their full speeds and powers. Accordingly, in the latest British ships—*i.e.*, all designed since 1898, a larger number of smaller fans with shorter and simpler trunks are employed. The "Duncans," for example, will each carry 14 fans not exceeding 24in. in diameter, with motors of about 2 B.H.P., delivering 1,500 cubic ft. of air per minute at 2in. pressure.

Air Compressors for Torpedo Work.—A modern first class battleship carries usually four sets, each capable of delivering 30ft. of air compressed to 1,700lb. per sq. in. in 70min. This involves an average B.H.P. of about 50 to 60 per set of pumps on a little less than three tons weight. Electric compressors would involve quite a different design, but would result in much quieter and smoother working. The weight would remain approximately the same.

Workshop Engine.—This is a small engine of about 5 H.P., driving one or two short lines of shafting actuating half-a-dozen machine tools in the engineers' workshop. It is an obvious case in which electric driving is handier than anything else.

Gun-working Mechanism.—A modern battleship, mounting two pairs of large guns *en barbette*, carries quite a nest of machinery for

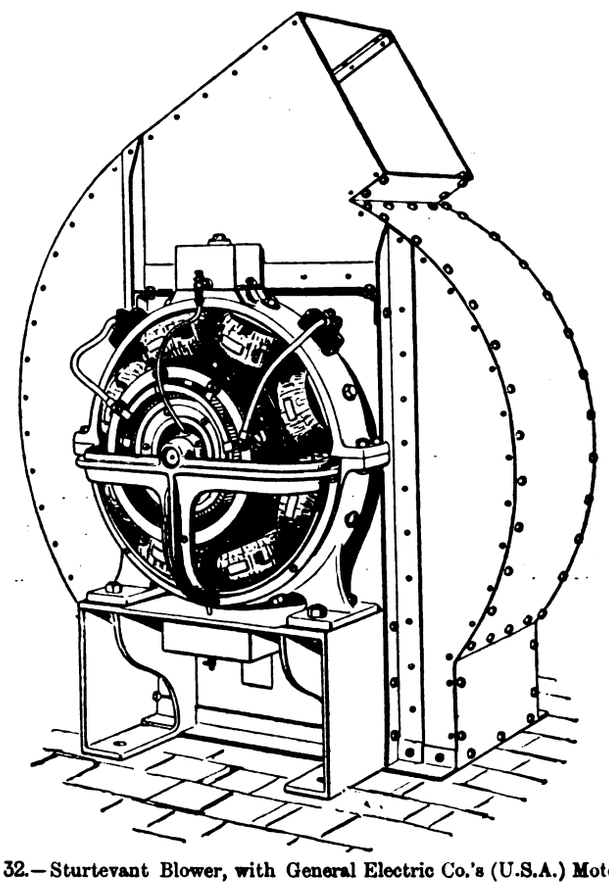

FIG. 32.—Sturtevant Blower, with General Electric Co.'s (U.S.A.) Motor.

working the guns. There are engines for training the turret, independent engines for each gun for elevating and depressing and for running in and out, rammers for loading, hoists for bringing up powder and shell from the magazines below, besides lifting and traversing gear for transporting shot and shell from the bins in the shell-rooms to the handing-up cage. Some of the machines are duplicated and some triplicated, and there are always in conjunction hand-gears for continuing the work if the mechanism fails.* In a ship carrying hydraulic mountings the power is supplied by a steam-hydraulic pumping engine of about 250 I.H.P. situated below and adjacent to the barbette. A pump in the barbette itself is used for circulating the water in the pipes under pressure for use over and over again if the pumping engine below is out of use. The hydraulic supply to each barbette is interconnected with that to the other, pipes running fore and aft along the ammunition passages below the water-line. Hydraulic power has been almost universally used in our navy for the last 20 years. Steam is used a good deal in the United States Navy, possibly because their ships have to operate in latitudes where extremes of temperature are common, and where, therefore, hydraulic appliances are liable to be disabled by freezing. But steam has great disadvantages for the purpose. The working being intermittent, there is great difficulty in starting owing to condensation, and there is further the serious liability to injury to the steam-pipes in action, with possibly disastrous results to the gunners.

* Paper read before the Institution of Electrical Engineers, April 26th.

* Illustrated descriptions of the turrets and gun-mountings of several British and foreign ships are given in a Paper entitled "The Rise and Progress of Rifled Naval Artillery," by Sir Andrew Noble, K.C.B., F.R.S. (*Proc.* Inst. Naval Architects, 1899).

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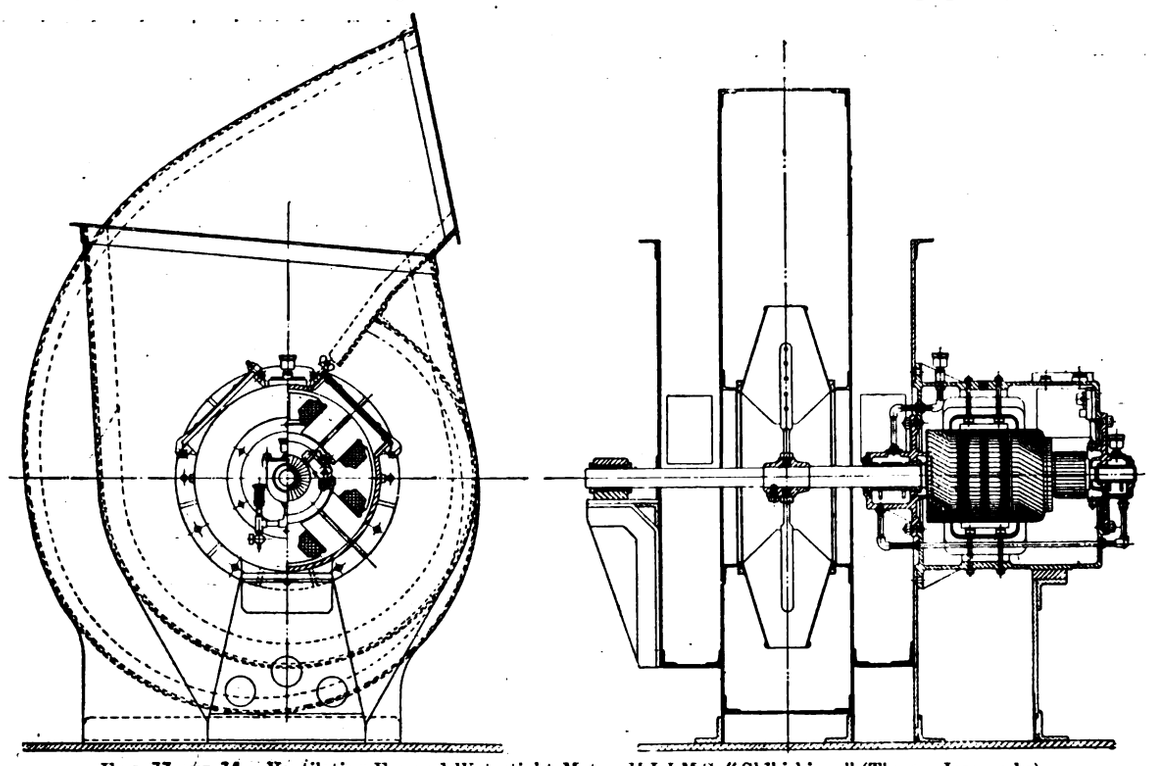
Electricity has come to the front in recent years as a rival to the older hydraulic system. By the English Admiralty it has scarcely been used at all. In the "Majestic" class of battleships electric motors have been put in as an auxiliary for training the turrets, but



FIGS. 33 AND 34.—Ventilating Fan and Watertight Motor, H.I.J.M.S. "Shikishima" (Thames Ironworks).

these are small-powered machines intended only as a help to the hand-gear, the primary installation being hydraulic. A beginning was also made in cruisers by applying electromotors to the 9·2in. guns of H.M.S. "Terrible." In the Japanese battleships fitted with Elswick armament an auxiliary electric training gear is carried, but the motor is about 15 H.P. capacity, and is able to train the turret at the rate of about 2deg. per second. The pump referred to above is also electrically driven. In the United States Navy electricity has been more largely used, and, as compared with steam, earned in the late war good reports in respect of quickness of action and precision of control. The "Brooklyn," which carries two 8in. turrets superposed on two 13in. turrets, had two turrets trained by steam and two by electricity, which favoured a direct comparison. The electric turrets are said to have been started and stopped 37 times in a minute and to have been capable of very small motions at a time. The success of the electric motors in the first ships led to their extended use in later ships, and in the "Kearsage" and "Kentucky," not merely are the turrets trained, but the guns are elevated and the ammunition hoists and rammers worked by electric motors. At the present time there seems to be a

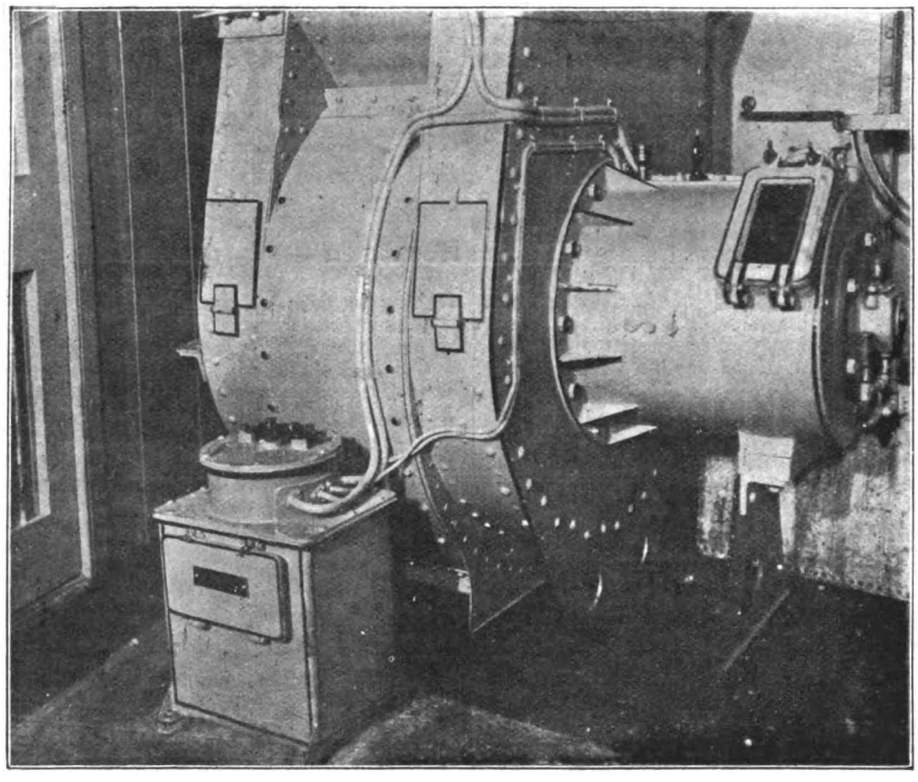


FIG. 35.—General View of Motor Fan and Controller, H.I.J.M.S. "Shikishima."

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revulsion of feeling against electric installations. Lieut. Norton (speaking apparently on behalf of the American constructors) said * that in the new large triple screw ships being designed for the United States Navy it has been decided not to use electrical power in the turrets except for the hoist, for the reason that "you can tell what is the matter with a steam or hydraulic engine instantly; but you may chase for hours to find a broken circuit, and by that time the action is over and you are out of the deal." To understand this remark the difference in the character of American and English installations must be borne in mind.

For controlling turrets the Americans use an ingenious method devised by Mr. Ward Leonard, which may be fittingly mentioned here. In the turret is a motor (or a pair of motors in parallel) separately excited at constant voltage; its armature is directly connected with that of a generator in the dynamo room, which is steam-driven at constant speed in a field of which the excitation can be varied from maximum to zero, reversed and increased to a negative maximum. The voltage of the generator accordingly varies as its field varies, and the motor armature receiving this varying voltage while its field remains constant, its speed will vary in a corresponding manner. The regulation of the generator field is effected from a controller under the sighting-hood in the turret. The control is said to be extremely sensitive and precise. Retardation is effected with smoothness and rapidity by dropping the excitation of the generator to a point which gives a voltage below that corresponding to the speed at which the motor is at the instant moving; the latter immediately begins to generate current, and therefore quickly absorbs the kinetic energy of the turret. In the latest ships the current so generated is taken up on a braking resistance.

Most nations are now employing electricity to greater or less extent in turrets. Even Sweden is building cruisers in which the working of the turrets and guns is entirely electric. Among the best examples of electric turrets are those designed by M. Canet,† and built in France for many Governments. The essential feature of M. Canet's design is that the turret is, as a whole, primarily designed for electric working. He arranges that the centre of gravity of the moving mass should as nearly as possible lie in the axis of rotation. This ensures moving with minimum power. In the Chilian "Capitan Prat," for example, a 9in. turret, weighing 87 tons complete, was rotated by a 15 H.P. motor at two thirds power, and could be turned by four men through 270deg. in 107sec. It could be moved through one-fifteenth of a degree at a time. If electric power is to render its best services in connection with ordnance work, it seems pretty clear that the turret must be designed throughout for electric working To tack electric motors on to an unbalanced turret designed for hydraulic working is not the way to success. If the turret be fairly balanced, a great saving in power, weight and complexity might be effected by employing electrical gears. Of course a large margin of power and strength are needed to ensure the successful operation of the turret when the ship takes a list in a rough sea or while turning; but, allowing for this, it would seem that the aggregate power, if everything were electrical, might be of the order of 100 B.H.P. normal to 150 B.H.P. maximum under worst conditions. Allowing 250 B.H.P. maximum in motor capacity to provide for duplication where possible, the motors with their gears, switches, and connections would certainly show a saving of 5 tons to 10 tons per turret on the aggregate weights of the hydraulic cylinders and gears, while the weight of the main hydraulic engines and transmission pipes (about 25 tons) would be a set-off against the weight of the electric generators.

(To be concluded.)

THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.‡

BY H. M. SAYERS.

The design of electrical distributing systems in this kingdom has been practised hitherto almost exclusively for electric lighting purposes. The short daily duration of the heavy load and small annual load factor obtained in most cases induce economy in capital expenditure, and the current density at times of full load is restricted by considerations of pressure variation, rather than by losses in the conductors. The conditions of working electric tramway systems are so different that calculations of another order come in, and very materially affect the design of the conductors when highest total economy has to be studied. The principal special conditions are as follows:—

1. The high load factor—due to the fact that a large output is called for throughout the whole of the working hours, which are usually from 15 to 18 per day in the United Kingdom. There are daily "peaks" and seasonal peaks but the hills and valleys are of much less extreme character than those observed on a lighting system.

2. The permissible variation of pressure is much greater. So far as the working of the line is concerned, the only limitation is that sufficient pressure be given at every point to enable the cars to keep schedule time. At the speeds allowed in this country, and with the motors usually fitted, a variation of 10 per cent. of the normal pressure causes no inconvenience.

3. The unsymmetrical arrangement of the two conductors, as between the outgoing or insulated positive conductor, and the return earthed negative conductor. In the great majority of cases, the rails forming the negative or return conductors are of such large section that no other conductors are needed on that side of the system whether for economical or pressure regulating purposes—so far as the working of the line is concerned. But for the protection of other property, the extreme potential difference allowed to exist between different points on the rails is limited by the Board of Trade to 7 volts, and the proportion of current allowed to return through the general mass of the earth to an earth plate at the generating station must not exceed 5 per cent. of the average load or 2 amperes per mile of line. Hence, on a tramway or railway using the rails as return conductor, while the positive conductor should be designed with regard to ordinary considerations of economy and efficiency (including the fact that practically the whole of the pressure drop will occur on that side of the system); the negative conductor designed primarily to satisfy mechanical conditions in most cases accidentally happens to afford much better conductivity than the positive conductor, and yet its conductivity has in many cases to be supplemented in order to satisfy the regulations imposed by a benevolent Board of Trade. It will be seen below that the determination of these auxiliary return conductors can be arrived at by calculations similar to those controlling the choice of the positive conductors, but that some of the factors have different values, and their load has to be estimated in a different way.

One effect of these special conditions is that the use of conductors designed for lowest total working cost is practicable in many electric traction systems. The well-known consideration that the total working cost of a conductor during any given time is the sum of two items, one being the value of the power wasted in it, and the other a percentage of its original cost at some annual rate, indicates at once that for a higher load factor a conductor should be worked at a lower rate of loss, or in other words at a lower current density. To determine the most economical current density in a given case, values are required for the following factors:—1. The money cost of the cable to be employed expressed in terms of the amount of copper in the cable, say the price in pounds of a ton of copper, insulated, sheathed and laid $=p$. 2. The percentage of the cost of the cable which must be annually set aside to provide for interest, maintenance and depreciation $=$ R. 3. The average number of hours per day taken throughout a year that the cable will be under load $=h$. 4. The load factor of the cable during the time it will be under load. If the load will be steady, the value of this will be unity. If the load will vary in a known way, the load factor will be the mean square value of such variable load referred to a steady load of its maximum value as unity, and can be calculated from a prophetic load diagram, and in the case of such variable load the most economical current density given by the calculations will correspond to the square root of the mean square value of the current. In what follows, this load factor will be taken as unity. 5. The cost of a Board of Trade unit generated and delivered to the conductor in pence $=n$.

From 3, 4, and 5 the cost per annum of a watt wasted in the conductor can be calculated, or inversely, what number w of watts wasted in the cable will cost, say, £1 per annum, and the two quantities representing the total cost per annum reduced to a common measure. In Perry's "Calculus for Engineers,' page 55, the question of economy in electric conductors is used as an example in maxima and minima, and I have found the method there indicated convenient for practical use. Prof. Perry there shows that the waste in watts or ohmic loss, and the constant loss or interest loss, can both be simply expressed as functions of the resistance of a conductor, assuming a certain current and certain length, and that their value may be written: $y = \mathrm{C}^2 r + \frac{t^2}{r} + b$. Where $\mathrm{C}^2 r$ is ohmic loss, $\frac{t^2}{r}$ is the interest item—expressed in watts, and b is a constant which depends upon factors not affected by the size of the cable laid.

In Appendix No. 1 Prof. Perry's expression is worked out at length, and the result shown that the most economical current density $\frac{\mathrm{C}}{\mathrm{A}} = \sqrt{\frac{\mathrm{R}wpm \cdot 045}{100}}$, where C = amperes, a = cross-section of cable in square inches (so that $\frac{\mathrm{C}}{a}$ = amperes per square inch) and m = tons of copper in a mile length of one square inch

* Discussion on Admiral Melville's Paper, "The Logical Arrangement of the Motive Power of Warships," Inst. N. A., March, 1899.

† See detailed descriptions in *Engineering*, Vols. 59 and 60, 1895.

‡ Paper read before the Institution of Electrical Engineers, May 3rd.

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section, R = annual rate per cent. for interest, &c.; w = the number of watts wasted continuously during working hours, which will cost £1 in a year's working, and p = the price in pounds of a ton of copper in the form of cable. ·045 is resistance in ohms of a mile of copper of one square inch cross-section, the weight m of which is 9·1 tons. In Appendix No. 2 an example is worked out numerically and tables are shown giving values obtained by taking figures within probable practical limits. The method of calculation here used is, of course, perfectly general, and applies equally to low-tension, high-tension, continuous and alternating currents, however fed to the conductors. The cost per ton of copper in cabled form will, of course, vary widely with the way the cable is to be used, the working pressure, and other conditions; for example, a triple twisted cable for three-phase currents will be much more costly per ton of copper than a concentric cable for continuous currents, working pressure and material being equal. It has also to be carefully noted that the value of the Board of Trade unit to be used is that of the unit delivered to the conductor system under consideration, and if the energy has to be transmitted or transformed before such delivery, the cost of generating the unit has to be "loaded" with the cost of such transmission or transformation, including the interest, maintenance, and depreciation cost of transmitting or transforming system. For example, the most economical density in a low-tension system fed from transformers is lower than in a low-tension system fed direct, assuming that the generating stations in the two cases supply energy at equal costs. It must also be recognised that power wasted (or used) in distribution costs as much as power used in the motors. For cables of a given construction and for use under given conditions, it will generally be found that the average price per ton of copper taken from makers' prices through such narrow ranges of size as are usually employed on a given system is sufficiently accurate. Where a very wide range of size is called for it may be worth while to calculate separately for the larger and the smaller cables.

The question of systems of laying cables and the cost thereof is not considered here, as the choice of the methods to be used depends much upon various local conditions, and the cost per mile is very little affected by the size of the conductor laid. It may be worth while to suggest, however, that the cost per ton of copper of a cable armoured for laying direct in the ground is higher than that of a similar cable sheathed for drawing into pipes or conduits, and as the allowance for depreciation and maintenance of pipes and conduits is a good deal lower than that for cable, economy may frequently be best studied by the use of a "drawing-in" system. The facilities for renewal and repairs and for replacing cables by others of larger size if required, are advantages not to be lightly ignored, and the conditions on electric traction systems enable these advantages to be utilised to a degree that does not obtain in some other services. The calculation of best sizes for track feeders is exactly that above described, but in most cases a higher value has to be taken for the wasted energy, *i.e.*, w in the equations is smaller. This leads to the use of a lower density in such cables or to a larger provision of copper for the current to be carried. The reason is that in most cases a "negative booster" has to be employed in connection with such a feeder, and the energy wasted has to be loaded with the loss in transforming, and the capital charges on the apparatus. The booster may be considered a part of the feeder, and as its size and the losses in it are proportional to its output, they are properly brought into the calculation by charging a higher price per unit delivered to the cable. Appendix No. 3 gives some examples of such calculations, and is also applicable to trolly feeders in which "boosters" are employed to keep up the voltage at the distant end. Considering the figures given in the tables, it will be seen that the limiting distance due to loss of pressure in feeders designed on economical principles is reached at from two to three miles from the generating station. The density of the traffic does not affect this limit. The cost of energy does affect it, and in such a way that the lower this cost, the shorter is the range of economical distribution because the economical density being higher, the limiting drop of voltage is the sooner reached. But it may be worth while in any particular case to use heavier conductors and so extend the working radius of a station, because the cheaper generation of power at that particular place more than compensates for the increased distribution costs. It may happen also that the use of heavier mains for the more distant parts of the system may prove to be cheaper than any other means of keeping the pressure up on those parts. It is a useful feature of the methods of calculation herein described that they indicate in a facile way the results of any departure from the theoretically best conductor sections, and so provide at least part of the data for determining the best system to adopt.

When the distribution radius much exceeds the distances above named, it will be obvious that the single station supplying direct to the feeder system becomes impracticable, and it is under these circumstances that an engineer is called upon to thoroughly investigate the alternatives, and estimate the total annual cost of working the lines by means of each of such alternatives. Only certain systems in practical use in the United Kingdom can be mentioned. They are—1. The multiplication of generating stations retaining the direct-current low-tension system of generation. (2) The use of battery sub-stations charged from a single generating station. (3) The use of a single generating station, generating polyphase currents at high pressure, and transforming sub-stations placed at suitable points on the line, supplying low-tension direct current to the line feeders. The direct current for the lines near the station may or may not be generated by special direct-current sets: when it is, separate consideration has to be given to such contiguous area, in calculating conductors and costs.

The second system above mentioned has but few examples, and reliable data are somewhat difficult to obtain. Its application would seem to be limited to cases where an infrequent service is given on distant lines; hence the feeders having to carry but a small average current, their size may be kept down, and the battery provides for the larger current needed by the cars. It will be obvious that the arrangements require to be carefully thought out in order to ensure the battery being properly charged, and always available during service hours. A very good example is that designed by the late Dr. John Hopkinson for the Leeds tramway, and described in Prof. Ernest Wilson's "Electrical Traction." It will be found that some complication is involved. Considering the present limited application and the many questions of detail involved in calculating the working cost of such arrangement, the system cannot be discussed now, and is mentioned as a practical means of meeting the demand which may be sometimes made for working a long branch, the traffic on which only calls for a sparse service, or on which the traffic is relatively heavy for only a small portion of the working hours. The discussion will be narrowed down then to a comparison of the first and third alternative systems, involving a statement of the data which affect the choice and the calculations by which the working cost of each may be estimated with an exactness dependent upon the accuracy of the figures adopted. As some of these figures must themselves be estimated, the judgment and experience of the engineer are here very important factors.

It is quite clear that there are two broad questions to be decided, firstly, What will be the total cost of producing a unit at the station or stations? and secondly, What will be the total cost of getting a unit to the car? in each case. The first question involves the charges on the capital cost of the station plant in addition to the working expenses, and the second question involves the efficiency of the distributing system as well as the capital charges upon it, as the cost of delivering a unit includes the energy wasted in its distribution. "Used in distribution" seems a more rational expression than "Wasted in distribution," but the latter phrase is so widely adopted that confusion might result from an attempt to reform. It is obvious that by the multiplication of directly feeding generating stations *ad lib.* the loss in distribution as above defined may be reduced to any desired extent. On the other hand, with a system involving transformation there is some minimum loss which cannot be reduced, and which corresponds to the attainable efficiency of the transforming devices. Clearly, then, this minimum loss constitutes a handicap upon the multiphase high-tension system which must be overbalanced by other advantages in order to justify its adoption. The reduction in the cost of generation of energy due to the employment of large units in one large station as against smaller units in a number of stations can only be estimated in advance by a complete study of local conditions guided by experience and judgment. Cases arise, of course, where it is clear that a station at a particular place enjoys such a great advantage as regards cost of fuel, abundant available condensing water, and freedom from neighbours who may object to noise and vibration, that direct and indirect costs must be much lower than in any other available site. The greater economy in staff and in total value of plant and buildings to be obtained by generating at one station instead of several can be estimated very fairly. A more difficult item to estimate is the relative value of the land.

Whilst every case requires special study to determine what advantage in generating costs is attainable by the adoption of the single large station, a study of the distribution costs can be made on general principles, which will indicate what that saving must be in order to give the single station a balance of advantage.

The limit of direct-current supply has been assumed to be the distance at which the drop in the trolley wire is 50 volts, *i.e.*, 10 per cent. of the energy given to the cars. Assuming a uniform distribution of the cars, this means an average drop of 5 per cent. over the whole system. (Notice that if the system is one radiating from a large town, so that the cars are more dense near its centre, the average drop will be less. It can be calculated as closely as the service can be predicted.) The loss in track feeders will be less; probably 2½ per cent. will cover it in most cases.

This total loss of power in distribution, amounting to 7½ per cent. of that delivered to the cars, can be attained with generating stations spaced from four to six miles apart, *i.e.*, delivering power, each for a radius of from two to three miles. As the interest item of distributing cost equals in value that of the loss of power item,

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it follows that distribution costs in such a system = 15 per cent. of the value of the power delivered to the car, and the total cost of 100 B.T.U. at the cars = that of generating 115 B.T.U. The plant has to be proportioned to produce 107½ per cent. of the energy delivered to the cars, as its normal full load. In a multiphase transforming system, the overall efficiency cannot at present be taken at more than 80 per cent. Mr. Parshall has given figures from Dublin experience showing somewhat lower rates, but 80 per cent. seems attainable. Then the generating stations will have to supply 125 units per 100 units delivered to the cars. The interest and operating costs of the distributing system cannot be calculated so simply in this case as in the former, as moving transforming devices calling for human attention are involved ; but if the prices of those devices are known, and a proper rate of interest calculated to cover depreciation, the cost of attendance and sites can be got at pretty closely, and a price worked out per unit delivered to the mains which can be expressed as a percentage rate of loss of the energy delivered. If this is called N, we have the following expression showing at what proportionate cost the high-tension station must generate energy to counterbalance the larger distribution losses. $\frac{b}{a}=\frac{115}{125+N}$, where b equals cost of production at the single high-tension and a = cost of production at the multiple low-tension stations. Unless $\frac{b}{a}<\frac{115}{125+N}$, the low-tension multiple station system will give the lower working cost. For this calculation to be of any practical value, it is evident that the cost of production must be properly debited with all charges in each case. To make such an estimate for prospective stations with a near approach to accuracy is a task much more difficult than calculating conductors, but an incorrect decision as to the system to be preferred in a given case is not probable if experience and judgment are brought to bear on a careful investigation of the local conditions. The value, N, above taken includes the interest item on both the high and low-tension conductors. This value can be found as in the other case, and will, as in that case, be equal to the ohmic loss in each ; but it must be noted that the cost of a watt is greater in the low-tension conductors owing to the transforming loss. The best density in the high-tension conductors is found exactly as in the case of direct supply, but the cost per ton of copper will be considerably higher in the case of the three-core high-tension cable, and hence the best density will be higher. The interest and operating costs of the transformers must be carefully considered, proper allowance being made for the necessary spare plant and margin of power necessary.

If these costs come to d pence per unit, the condition of advantage for the high-tension system is

$$\frac{b+d}{a}<\frac{115}{125+p},$$

where p is the percentage value of the losses in the high-tension conductors. This will usually be small, not over 5 per cent., and taking this value we get

$$\frac{b+d}{a}<\frac{115}{130};$$

so that for equal costs under the two systems

$$b=0\ 885\ a-d\ ;$$

or in words, the cost of generation at the single high-tension station must be less than 88½ per cent. of the cost at the low-tension stations by the cost per unit of interest, attention, and stores due to the transformers. If $b<0{\cdot}885\,a-d$, the difference is the saving per unit to be made by the high-tension system ; if $b>0{\cdot}885\,a-d$, the difference is the advantage for the low-tension system. Using correct data to suit the case, a very good judgment can be arrived at as to the most economical system to be adopted, and it is suggested with much confidence that such calculation is a safer guide than a general statement that for a traction station of over so many thousand horse-power this or that system is the only commercial one. It seems to be overlooked sometimes that the cost per unit at the car, and not at the switchboard, is the commercial criterion, and that to attain a lower figure at the car the cost of the unit at the switchboard must be very considerably lower in the case of any system using moving transformers than in alternative arrangements.

The choice of a site for a generating station may greatly affect the generation costs, and as these materially influence the design of the distributing system, the importance of careful choice of site or sites is very great, and in any contemplated electric traction system this should be one of the earliest matters submitted to and decided by the engineer. Whenever possible, eligible sites for compulsory purchase should be scheduled in the order authorising the line. The points affecting the choice are foreign to the subject now discussed and a certain cost per unit at the switchboard will be herein assumed, the sole subject considered being the delivery of the power to the cars at minimum cost under the conditions imposed. The economical use of the power on the cars is also foreign to this discussion, but it cannot be seriously contended that waste on the car excuses avoidable waste in the distributing plant. The consideration of a particular case will best illustrate the application of the foregoing principles. Diagram A is a scale plan of a tramway system, all single lines with turnouts. The proposed service results in a distribution of cars as marked in figures along each section of the line. The total number of cars is 57. The average current taken by each car is reckoned at 15 amperes. Hence the average power demanded at the cars will be

$$\frac{57\times15\times500}{1{,}000}=427{\cdot}5\text{ kw.}$$

At T is a site available for a power-house. The extremes as regards distance from T are A 7·1 miles west, H 5·2 miles east, and L 7 miles south-west of T. There is, however, a shorter route from T to J than by the tramway, and this route being available for a feeder cable reduces the distance TL to about 4·35 miles, and facilitates feeding at J, which it will be seen is an important centre. In natural order one should first consider the use of T as sole generating station for the whole system, find the most economical current density, and see whether the drop permits of low-tension generation and direct feeding (Diagram B).

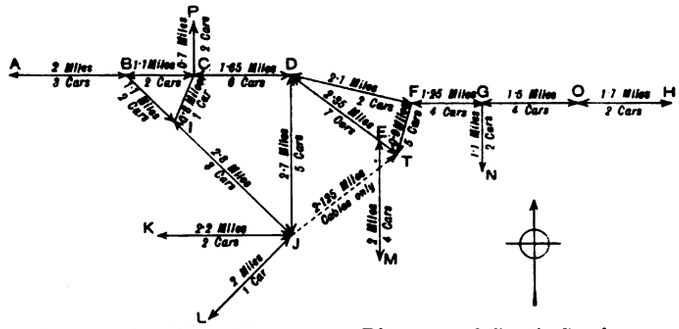


DIAGRAM A.—Plan of Tramways. Distance and Cars in Service.

For the purpose of this example the following figures are used :—

Annual charges on cost of cable for interest and depreciation, 7 per cent. or R = 7.

Annual hours of use, say 15 × 365 = 5,474.

Cost of energy per B.O.T. unit at switchboard n = 75d.

Tons of copper per mile run of 1 sq. in. cross-section = m = 9·1.

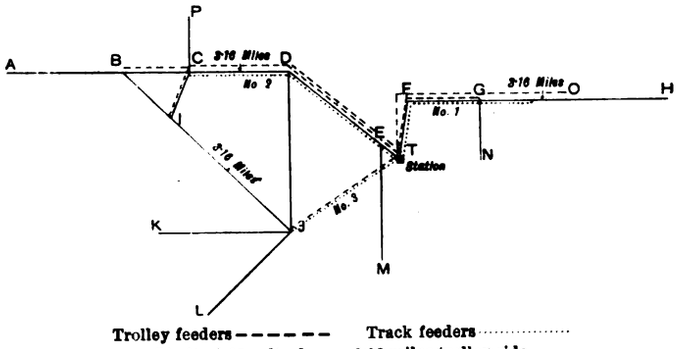
Cost of insulated cable per ton of copper p = £151.

Watts continuously lost worth £1 per ann. $=w=\frac{240}{5{\cdot}475}\times0{\cdot}75=58{\cdot}45.$

Then, by formula given in Appendix No. 1, we have

$$t^2=\frac{\text{R}.w.p.m.0{\cdot}045}{100}=\frac{7\times58{\cdot}45\times0{\cdot}045\times9{\cdot}1}{100}=251,\text{ or } t=15{\cdot}8\ ;$$

say $\frac{t}{0{\cdot}045}=352$ amperes per sq. in. is thus the most economical density in this case. The voltage drop per mile is 15·8. Hence the drop from T to A would be 15·8 × 7·1 = 112 volts, and from T to H



Trolley feeders - - - - - - Track feeders .....

Limit of 50 volts drop = 3·16 miles trolley side.
Limit of drop in rails, 5 volts = 173 amp. miles.

DIAGRAM B.—Low Tension, Single Station.

15·8 × 5·2 = 82 volts. These are too great for good working, and, taking 50 volts as the limit, the distance limit is $\frac{50}{15{\cdot}8}=3{\cdot}16$ miles.

Beyond this limit there are 15 cars west and three cars east of T, so that two-thirds of the load comes inside the permissible drop, and should be supplied by directly-fed cables. The remainder should be fed by "boosted" cables. No allowance is made for the conductivity of the trolley wires excepting where they suffice without cables in parallel, and there two No. 0 wires of 0·162 sq. in. combined section are reckoned on. It is found in practice that in a tramway system calling for several feeders it is better to work the trolley wire in separate sections, each being fed by a distinct feeder. This results in the rapid localisation of short circuits of all kinds and

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minimises disturbance to traffic. It also facilitates the proper loading of the individual feeders and gives valuable information to the power-house staff as to the distribution of the load.

The losses in the feeders to the directly-fed portions of the sample system will be approximately as follows:—The cable TJ has to carry 98 amperes 2·125 miles ; the average length on the branches beyond J over which the power will be distributed is, say, one mile total from T 3·125 miles. The branches JD and JI will only be fed viâ J to points equidistant from T by the other routes, and on all these branches the trolley wires suffice without cable. The remainder of the current from T within the area is supplied by cables accompanying the line, and for the purposes of this approximate calculation it may be taken that the load is symmetrical along them, so that the average load may be taken as half the total and the loss as that due to half the current carried the extreme distance. (Obviously the loss may be calculated much more minutely than this for any given distribution of cars, gradients, &c.) The current being 532 amperes, half of it is 266 amperes. Then we get total loss in watts—

For current supplied to J $98 \times 3{\cdot}125 \times 15\ 8 = 4{,}820$
And the balance $266 \times 3{\cdot}16 \times 15{\cdot}8 = 13{,}300$

18·12 kw.

As 58·45 watts cost £1 in a year's working, the money cost of this loss will be $\frac{18\ 120}{58{\cdot}45} = £310$ in round figures, and as the interest cost of the cables should equal the total cost of distribution (strictly speaking that portion of the cost affected by system adopted) to the trolley wire, the total cost under these heads for the lines considered would amount to £620 per annum. But the use of the trolley wire where practicable will reduce the cable cost and interest item below this theoretical amount, and a table follows giving the actual feeder cost. Inspecting the plan, it is clear that the junction I is about the centre of gravity of the load beyond the 3·16 miles on the western sections. This is five miles from T, and the load to be delivered is that for 15 cars = 45 amperes. The energy lost in these boosted feeders is more costly, having been transformed by the boosters, whose efficiency is rarely over 75 per cent. The value of the boosted unit must therefore be taken at $0{\cdot}75 \times 1{\cdot}33 = 1$d., the value of w becomes 44 instead of 58·45, and $t^2 = \frac{251 \times 44}{58{\cdot}45} = 189$ nearly, or $t = 13{\cdot}75$ and $\frac{13{\cdot}75}{045} = 306$ amperes per sq. in. as best density.

Drop per mile is 13·75 volts. The boosters would only be necessary to make up the drop in the lengths beyond the 50-volt drop limit, so that this lower density should, strictly speaking, apply only to the excess of cable length beyond 3·16 miles. It will be better, obviously, to use a conductor of uniform section to give the same drop. In the case of the western section then the drop will be $50 + (13{\cdot}75 \times 1{\cdot}84) = 75{\cdot}3$ or 15·06 volts per mile, showing that the refinement makes little difference in this case. On the eastern section the drop will be $50 + (13{\cdot}75 \times 1{\cdot}16) = 65\ 95$, say 66 volts, or 15·3 per mile. The losses will thus be :—

Western 75 $3 \times 225 = 16{,}942$ watts.
Eastern 66 $\times\ 45 = 2{,}970$ „

19,912

(say 20 kw.)

Of this 20 kw , $270 \times 50 = 13{,}500$, the unboosted cost £1 per 58·45 and 6,500 cost £1 per 44, so that the total annual cost of the loss in these feeders will be :—

$\frac{13{\cdot}500}{58{\cdot}45} = £231$ nearly
$\frac{6{\cdot}500}{44} = £148$ „
£379 „

The interest on the mains will be somewhat less, owing to the use of trolley wire on the more lightly loaded branches. To this has to be added an annual charge representing interest, maintenance and running cost of "boosters" to give an output of 6·5 kw. With spare plant 10 kw. might be provided, and would probably cost £20 per kw., say £200. Fifteen per cent. per annum is a proper charge for interest and running expenses on such plant, so that this item would be £30 per annum. The following is a schedule of feeders on the trolley side, wherever needed to supplement the trolley wires :—

Direct Feeders.

Line.	Length, miles.	Amperes.	Section cu. sq. in.	Tons, cu.	Value.
TJ	2·125	98	0·277	5·37	£817
TE	0·35	247	0·700	2·23	337
ED	2·00	165 mean	0·470	8·55	1,290
TF	0·9	187 „	0·531	4·35	655
FG	1·25	120 „	0·342	3·56	538
	6 625			24·06	£3,637

Boosted Feeders.

Line.	Length, miles.	Amperes.	Section cu. sq. in.	Tons, cu.	Value.
TC	4·1	225	0·672	25·00	£3,775
CI	0·9	60	0·179	0·15	23
CB	1·1	75	0·224	0·22	33
TO	3·8	45	0·134	4·63	699
	9·9			30·00	£4,530

Total, £8,167.

The cost of distribution on the trolley side is thus :—

Loss in direct feeders, 18·12 kw., worth annually	£310
Interest on cables in ditto, 7 per cent. £3,637	255
Lost in boosted feeders { 13·5 kw., worth £231 ; 6·5 „ „ £148 }	379
Interest on cables in ditto, 7 per cent., £4,530	317
Annual charges on boosters	30
	£1,291

This works out per unit delivered to the cars :—

$$\frac{1{,}291 \times 240}{427{\cdot}5 \times 5{,}475} = \frac{309{\cdot}840}{2{,}340{,}000} = 0{\cdot}133\text{d. ;}$$

making total cost 0·883d., disregarding losses in the return conductors. But the regulation as to P.D. in rails forbids such disregard, and their effect must now be considered. Assume that the track is single and laid with 90lb. rails, or 180lb. rail per yard of track. Assuming the resistance of the rail to be 11 times that of copper of equal section, and that joints add 5 per cent. to that resistance, a mile of bonded track will have a resistance of 0·0289 w. The interesting Paper read by Mr. Parshall before the Institution on April 28, 1898, will be familiar to all interested in this question, as it shows by examples how the chemical composition of rails, kind of bonding, and number of joints per mile has to be taken into account. Naturally the mechanical use of the rails takes precedence of their electrical functions, and hence the electrical engineer has to be thankful for what he can get. The resistance of the return as laid is usually lower than that of the rails alone, some conduction being afforded by the earth. The amount of this varies very much. Mr. Parshall has found an instance in which only two-thirds of the current returned by the rails. Weather affects it. In one case within the writer's knowledge wet weather reduces the voltage drop, and also the stray current, evidently increasing the conductivity of the non-metallic parts of the track. But as this earth shunting of the rails cannot be foretold, the safe course is to take the resistance of the uninsulated return as that of the rails alone. To allow for possible increase of service, abnormally busy days, and bunching of cars, the limit calculated on should be, say, 5 volts, not the whole 7 volts allowed in the Board of Trade regulations. The integrated product of amperes into mile to give this drop will thus be $\frac{5}{0{\cdot}0289} = 173$ ampere miles. Mr. Trotter's Paper of April, 1898, gives a neat and simple graphic method of showing the drop under given conditions. It can be easily applied along any section of line with a uniform service. For such a case as that under consideration, with varying services along different sections and junctions, an arithmetical process seems a little simpler. The arithmetical process is as follows :— Starting from the station, sum the product of amperes into miles until this product equals the constant corresponding to the limiting drop—*e.g.*, 173 for the case here assumed. It is at once clear that all all current from cars beyond this point has to return by track feeders.

From this point start the integration afresh, and go on until the constant is again reached. At this second point the rails should be at earth potential. Recommence the summation from this second point and go on again to the constant. Then all the current due to cars between the first and third points should return to the station by a track feeder connected at the second point, and so on in succession, the even points marking feeder connections kept at earth potential, the odd points marking points of maximum D.P. above earth in the rail. This calculation applies equally to feeding points in transforming systems, so far as such points depend upon the drop in the return. It will be clear that the direction of the current must be from odd points to even points. When the terminus of a route does not correspond with an odd-numbered point, integrate the ampere miles from the last odd point forwards, and from the terminus backwards, and the point on the line where these sums are equal is the last feeding point, the potential of which may be above that of the earth by the amount corresponding to the defect in the ampere miles from the constant. This means, of course, a little lighter feeder, but the difference is usually insignificant as regards economy.

(To be continued.)

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LEGAL INTELLIGENCE.

(*Continued from page 172.*)

Chamberlain and Hookham v. Bradford Corporation.

Judgment in this action is to be given to-day (Friday) by Mr. Justice Farwell.

Cuba Submarine Telegraph Co. (Ltd.) v. West India and Panama Telegraph Co. (Ltd.).

This case, which came before Mr. Justice Farwell on Saturday and Monday in the Chancery Division, raised questions as to the construction of an agreement dated Jan. 31, 1870, entered into between the two companies. Plaintiffs own submarine telegraph cables laid along the south coast of the Island of Cuba and a land line across the western extremity of the Island of Havana, the cables thus connecting Havana with Santiago. From Havana submarine cables, owned by the International Ocean Co., run northwards to Florida, which is connected by a land line with New York. Defendants are the owners of submarine telegraph cables running from Santiago to Jamaica and to nearly all the other islands of the West Indies, and to Georgetown and to Colon on the Isthmus of Panama. By the agreement of Jan. 31, 1870, between the plaintiffs and a company of the same name as defendant company (being the predecessor of the defendant company), it was provided that :—

(1) "The Cuba Co. will hand over to and forward by the West India Co. all telegraphic messages received by or sent through the lines of the Cuba Co. for any other part or parts of the world with which the West India Co. may be in telegraphic communication. (3) The West India Co. will hand over to and forward by the Cuba Co. all telegraphic messages received by or sent through the West India Co. for such places as the Cuba Co. may be in telegraphic communication with. (4) Each company party hereto will forward the traffic and messages received from the other company with all possible expedition, and in case of breakdown of line will repair the same as speedily as practicable, and generally will assist by every means in their power to develop the traffic and business of the other company. (5) Neither company party hereto will enter into any agreement or traffic arrangement with any other company or persons, or be connected with, or interested in, any telegraphic line whatsoever which may be prejudicial to the interests of the other company party hereto without the assent in writing under the seal of such company being had and obtained. But either company shall be at liberty to send messages over their lines at the written request of the sender of such messages, without solicitation or suggestion by any competing lines, provided that in such case the other company party hereto shall share in the amount accruing in respect of such messages in proportion to the amount each company would have received had the messages gone over the lines of both companies. (7) The West India Co. are to be at liberty to place all their wires and cables at Santiago de Cuba in connection with the wires and cables of the Cuba Co., and they are also to be at liberty by their own officers and servants to work all through traffic from any part of the West India system to any place or places beyond Havana without any interruption or interference by the Cuba Co., and the through traffic of the West India Co. is to take precedence and have priority over all the local traffic of the Cuba Co., except as otherwise provided by the terms of the said concession. (8) The West India Co. are to find, supply and maintain the necessary staff at Santiago de Cuba for working not only their own lines but also the Cuba lines, charging the Cuba Co. a fair proportion of the cost of staff at Santiago de Cuba, and the whole cost of staff at the intermediate station or stations, and an addition of 25 per cent. on such cost, their share of the expenses of general management and superintendence."

Plaintiffs alleged that by means of defendants' cables plaintiffs are in telegraphic communication with all places directly served by defendants' cables, and with places beyond with which defendants are in telegraphic communication, and further, that by means of the cables from Havana to Florida, and of the land lines to New York, and of submarine cables from New York across the Atlantic, all places directly served by defendants' cables and places beyond with which defendants are in telegraphic communication with North America and with London and other places in Europe. A new cable has recently been laid between Bermuda and Jamaica by the Direct West India Cable Co., and by such means, and the cables of companies allied with the Direct Co., plaintiffs alleged that competition with the business of plaintiffs and defendants was threatened. The plaintiffs charged that any such arrangement as defendants threatened and intended to make with the Direct Co., whereby messages handed in by the Direct Co. at Jamaica would be transmitted by defendants' lines to places south and east of Jamaica at a rate lower than that charged locally from Jamaica to such places would be an agreement or traffic arrangement prejudicial to the interests of plaintiffs, and that any such arrangement would constitute a breach of clause 5 of the agreement. Plaintiffs claimed an injunction restraining defendants from entering into an agreement or traffic arrangement with any company or persons which might be prejudicial to the interests of plaintiffs without their assent in writing under seal; also an injunction restraining defendants from forwarding any telegraphic messages received by defendants at Jamaica from the Direct West India Cable Co. for transmission to the east or south of Jamaica under an agreement or traffic arrangement which was or might be prejudicial to the interests of plaintiffs, and for consequential relief and damages.

Defendants contended they had never threatened or intended, and did not now threaten or intend, to arrange with the Direct Co. to transmit messages from London handed by the Direct Co. at Jamaica to defendants for transmission to places south and east of Jamaica at a lower rate than the local rate to such places from Jamaica, or to arrange terms with the Direct Co. which should enable the message handed by the Direct Co. to defendants at a rate greater than the through rate which had been fixed with respect of messages from London to places south and east of Jamaica viâ New York and Havana. Defendants had fixed the rate payable for messages transmitted over their lines so that the through rate from London viâ the Direct Co., to a place to the south or east of Jamaica was for the present the same as the present through rate to the same place from London viâ New York and Havana, but they had not done so under or by virtue of any arrangement or agreement with the Direct Co. They alleged that plaintiffs claimed to do, and had for many years done, and were still doing the very thing which they now claimed defendants were not entitled to do. In 1889 a French company, La Société Francaise des Telegraphie Sous Marine, opened for public traffic a system of cables between Santiago de Cuba, Porto Palala, San Dominique, Curaçoa, and Venezuela, and in 1890 they opened cables between Martinique and Paramaribo. In 1891 they also laid a system of cables between Paramaribo, Cayenne, and Vizen, and between Porto Plata and Martinique, and the French company's lines therefore connected Santiago de Cuba (the eastern extremity of plaintiffs' system) with Martinique, Paramaribo, Cayenne and Vizen, and it became possible to send messages from and to New York and London over plaintiffs' system. If plaintiffs should prove successful, defendants, by way of counterclaim, set out that the French company was in competition with defendants, and the agreement or arrangement between plaintiffs and the French company was prejudicial to the interests of defendants, and was a breach of the agreement. They claimed that by reason of such acts defendants had suffered great damage, and counterclaimed an injunction restraining plaintiffs from handing to the French company at Santiago de Cuba any telegraphic messages sent over plaintiffs' lines for transmission to Cayenne or Vizen or any place south of Martinique, except such messages as the sender thereof, without solicitation or suggestion, should in writing request plaintiffs to forward by way of the lines of the French company. They also asked for a declaration that defendants were entitled to a share in the amount of toll accruing to plaintiffs in respect of messages sent over the lines of plaintiffs and handed by them to the French company at Santiago de Cuba for transmission to Cayenne or Vizen or places south of Martinique which the sender might request plaintiffs to forward by way of the lines of the French company. By way of further relief, defendants claimed an injunction restraining plaintiffs from entering into or continuing any agreement or traffic arrangement with the French company or any other company or persons which might be prejudicial to the interests of defendants without their assent in writing.

After hearing lengthy arguments by counsel on both sides,

Mr. Justice FARWELL, in giving judgment, held that plaintiffs were entitled to succeed, but left the form of the declaration to be settled by counsel. He thought that the interpretation put on the agreement by defendants was much too narrow, and would lead to ridiculous results. He thought it was clear that plaintiffs' lines had been intended as a connecting link between the International Ocean Co. and defendants' lines. The general idea was a connection of the West Indian islands with North America. Competition was the keynote of the agreement, and the parties plainly intended that there should not be competition between either of the companies and any other company. His lordship accordingly gave judgment for plaintiffs, with costs.

Mr. HALDANE, for defendants, applied for a stay of execution for 14 days, with the view to an appeal.

The application was granted.

Ashwell and Nesbit (Ltd.) v. Stanton.

This case came before Justices Darling and Bucknill on Monday, on defendant's appeal from a decision of the Official Referee.

Mr. MANISTY, for appellant, said the action was brought by Messrs. Ashwell and Nesbit, Ltd., electrical engineers, London and Leicester, to recover £500, the balance of an account for an installation of the electric light. Defendant had filed a counterclaim claiming damages for non-fulfilment of contract to have the installation completed by a certain date. Defendant was about to open new premises in Leeds and was desirous of having the building lighted electrically, and entered into a contract with plaintiffs to do the work. By the original contract, no actual time was fixed for completion of the work, but which was to be carried out in an expeditious and workmanlike manner. Defendant advertised the opening of the premises and engaged assistants, but on the date announced was unable to get any light, and thereby incurred considerable expense. The matters in dispute came before the Official Referee, and plaintiffs then took the point that although the assurance was given with the knowledge that it was intended to be acted upon, the promise was a mere naked one and was without consideration. The Official Referee came to the conclusion that the promise was not an absolute one, and that plaintiffs could not be made responsible for the delay which had occurred in connection with the fitting of the gas engine which was to supply the motive power. Defendant appealed to the Divisional Court, which held that the assurance was absolute and binding, but on the point that the promise was without consideration they thought there should be further arguments. The matter now came before their lordships on that point.

Mr. Justice DARLING thought that want of consideration being raised they had better hear the other side.

Mr. POLLOCK, for plaintiffs, said that the whole difficulty arose by the breakdown of the gas engine, which was not supplied by plaintiffs. His point, briefly, was, that there was no consideration coming to him which would make the contract binding.

Mr. Justice DARLING considered that the promise from defendant came distinctly within the rule which made it in the eyes of the Court of Equity a real binding contract made upon good consideration. Therefore there should be judgment for defendant with costs. The case would go back to the Official Referee to enable him to ascertain the amount of damages sustained by defendant.

Mr. POLLOCK asked for and obtained leave to appeal.

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Binko v. Great Northern Railway Co.

In the Lord Mayor's Court (London) last week Mr. H. Binko sued the Great Northern Railway Co. to recover damages for injury caused to certain packages containing electrical appliances while in the care of the defendants in transit to Manchester. Mr. Lewis Glyn, for plaintiff, stated that on Feb. 17 his client sent to Manchester certain electric apparatus to be sold by auction. The goods were packed properly. When he heard that the goods arrived in a damaged condition, he at once informed defendants' agent, but the company refused to admit liability. The two cases contained three electrical sparking coils, sold in the trade at £12. 10s. each. In his letter to the auctioneer, he placed a nominal reserve price of £3. 10s. on each of the coils. Defendants' agents were informed that the cases contained electrical goods. For the defence it was contended that the cases were delivered in Manchester in the condition in which they were received by defendants, and that, if any damage was caused to the contents it was through negligent packing. Mr. Percy Huddleston, for defendants, said he inspected the cases in which the electrical apparatus were packed, and found they were good cases. He concluded that the coil had been damaged either before they were put into the cases or while being packed. He had sold similar instruments by auction at from £2. 15s. to £3. 10s. each, and that was considered a fair price. He put the instruments in the case up for sale, and had an offer of 30s. each. The jury found for plaintiff for £10. 10s. and costs.

Smoke Summonses.

At the West London Police Court on Saturday last, the Electric Traction Co. (Ltd.) were summoned by the Hammersmith Vestry for allowing quantities of black smoke to issue from two of their shafts in such a manner as to be a nuisance. Mr. Roskill (representing the Central London Railway) said that the Electric Traction Co. were the agents of that company. The shafts were used at the generating station of the new railway. Some evidence having been given, Mr. Roskill submitted that under the company's Act the defendants were not liable under the general law ; nor did the evidence prove that smoke was sent out in such quantities as to be a nuisance. The engineer in charge (Mr. Theodore Stevens) said that there had not been any negligence. The defendants had absolutely the best, latest and most approved plant for the conduct of their operations. It was true they were using cheap coal, the company not considering it necessary to incur the expense of purchasing Welsh coal for the experiments they were making. Mr. Roskill said that the two companies (the Central London Railway and the Electric Traction Co., Ltd.) were practically one, and with regard to the point he had raised as to the liability of the company, it was of such importance that he should ask for a case to be stated on the point. The magistrate said it was really a question of experiment and he thought a small fine only should be imposed. On this expression of opinion, Mr. Roskill did not press his application for a case to be stated. The company were ordered to pay £5. 5s. costs, and a prohibitive order against the company was granted.

Workmen's Compensation Act and the Assurance Companies.

At Woolwich (London) County Court recently, before Judge Addison, Q.C., Messrs. Thomas Carr and Son, contractors, Halifax, applied that payments of an award under the Workmen's Compensation Act to a painter named Folling should be determined, on the ground that he had not submitted himself to proper medical treatment, thus preventing his arm, which was injured, from properly healing. Mr. A. B. Bryceson represented Folling, and Mr. Willis the Credit Assurance and Guarantee Corporation, with which Messrs. Carr and Son were insured. Folling said that he had been to Guy's Hospital twice and had seen various doctors. Before the accident he earned £2 a week, and the assurance company had stopped the payment of 16s. per week for four weeks.

The judge remarked that it was a very high-handed proceeding and contempt of court. Execution should have been issued. It was a baseless application, and would be dismissed with costs.

PARLIAMENTARY INTELLIGENCE.

TELEGRAPHIC COMMUNICATION.

In the House of Commons on Tuesday,

Sir EDWARD SASSOON moved a resolution to the effect that it is desirable that an enquiry should be held into the commercial and strategic defects of Imperial telegraphic communication. The necessity for some such inquiry, he urged, was shown by the recent repeated failures that had occurred in the transmission of messages to and from the scene of our military operations in South Africa at a juncture when the efficiency of the lines and their freedom from interruption were matters of great importance to the nation. The associated telegraph companies, with the Eastern Co. at their head, had, he contended, neglected to supply public requirements at a period fraught with the greatest anxiety. He claimed that the subsidies granted to these companies were conditional upon telegraphic communication being in good working order and condition. Members of the House would remember that the East Coast of Africa cable was laid in consequence of the complaints made during the Zulu war. A period of 20 years had elapsed, and although the total subsidy and subventions to the associated companies amounted to £3,700,000, yet they had not duplicated their sections beyond the doubling of the Mozambique—Zanzibar cable. A legitimate commercial grievance was that the companies were earning a revenue largely in excess of what they had themselves declared to be an adequate return upon their capital and working expenses. He contended that the companies were bound to reduce their tariff. He called attention to the necessity that Parliament and Parliament alone should be the arbiter in the last resort as to what these tariffs should be and how the agreements entered into between Her Majesty's Government and the companies should be carried out. He might be told that the obvious remedy was for the State to buy up the cables, and he was prepared to argue the advantages of such a step when the time was ripe for this to be done. The companies had by degrees impregnably entrenched themselves behind mountains of conventions and joint-purse agreements, for which, as a business man, he admired their astuteness. He asked what was the most efficient means of altering this state of affairs, and urged that the inquiry which he proposed would give the solution to the problem. The situation of defencelessness to which great business communities were reduced was becoming a scandal, and an extraordinary part of the whole business was that one of the greatest sinners appeared to be the Indian Government, for their delegate at the International Telegraph Conference at Budapest in 1896 made strong efforts to obtain a reduction of the tariff to India, and while that attempt was defeated by the opposition of the Eastern Co. (on the admission of the Indian Government) their own cable from Kurachi to Bushire and Fao and their land lines from Bushire to Teheran had remained a stumbling block to the cheaper tariff advocated by their delegate at the Conference. As matters now stand, the Indian Government charged fourteen times as much from Fao to Kurachi as was charged by the Eastern Co. for identically the same length of submarine line—from England to Gibraltar. He found, on examination, that the Indian cable earned 85 per cent. of the whole sum earned by the Indian Telegraph Department, and that that department had been earning close upon 7 per cent., after paying over about £13,000 a year to the cable companies. The gross earnings of the Indian cable were £104,000 yearly. Assuming the gross value of such cables at £200 a mile—a very liberal estimate—a new line would cost about £240,000, so that the House would see that the cable earned no less than 50 per cent. annually. The charge to India remained 4s. per word, and to Australia—about double the distance—it was equally 4s. a word. This anomaly had wider-reaching consequences, inasmuch as the rates further east—to China and Japan—were maintained proportionately higher to the Indian rate. They knew that the Eastern Co. were content to receive only 1s. 2½d. or 1s. 4½d. for their share of messages passing through Bombay destined for Australia, so that they had, in the words of the Chancellor of the Exchequer, "a very considerable grievance." He urged that no reduction in the Indian rate would be at all satisfactory which did not reduce the charge to 1s. a word. He and those who were with him in this matter advocated joint guarantee by the Indian and the home Governments of one-third of any loss resulting from the lowering of the rate to 1s. a word. That was a matter which principally, though not exclusively, concerned the Indian Government. If the worst came and no augmentation of traffic followed, the utmost the British Treasury would be called upon to disburse would be about £30,000 on its half-share, and, curiously enough, a windfall of £28,000 a year, represented by the Red Sea annuities, would accrue to the Chancellor of the Exchequer in 1905. Then, as to the West African tariff. A message to Sierra Leone, to Lagos, or to the Gold Coast costs nearly 7s. a word, whereas a word to the Cape costs 4s., and a Frenchman was able to send a message to his West African possessions at 1s. 5d. a word. Whereas in France they could send a message to the furthest confines of Tunis and Algiers for ½d. a word, they in England had to pay no less than 1s. 9d. to cable to Egypt, or nearly 40 times as much. This brought him to the Pacific cable scheme. Although some of the signatory States to that project appeared to have been seduced from their allegiance, he fervently hoped that means would be contrived to prevent its collapsing. It had worked a truly chastening influence on the associated companies. The metamorphosis it had wrought had been miraculous, because, while they were asking £75,000 a year subsidy for the establishment of the Cape-Australian cable, since the birth of that scheme they had agreed to altogether waive that demand, accompanying that renunciation with a promise of lower rates. What was wanted in connection with this important subject was a State policy, far-seeing in its scope and embracing the comprehensive interests of the constituent portions of the Empire. He would humbly suggest that it should provide, among other things, in all future agreements with private contractors, the fixing of a scale of charges based upon the average earnings—say, for three years—and working on a sliding scale, and that no concessions either material or geographical should be granted to any system that diverged from or conflicted with the all-British route. It should also provide that no absorption of any new line by old companies should be permitted without the express sanction and concurrence of the State ; that the State should be able to assume ownership—and this was the point of cardinal importance —when such a step was dictated by the public interest ; that when a cable broke down for the best part of three months owing to avoidable causes some suitable penalty should be inflicted ; and, finally, that no exclusive privileges in restriction of competition, except when dictated by some imperious temporary necessity, should be granted. Another point was the terminal tax of 2d. a word, which, according to the International Telegraphic Convention, was leviable by the Treasury. This involved a sum of £90,000 a year. The House would see there were many points worthy the attention of a strong committee of business men and telegraph experts. No one could forget the eminent services rendered in the early days of cable enterprise by the late Sir John Pender, and his eminent successor Lord Tweeddale, but they held that those services by the parent company had already been requited, either in meal or in malt. It was time the public were considered. He concluded by moving the resolution standing in his name.

Sir C. DILKE said that this was a question in which the chambers of commerce and the trading classes were deeply interested. He agreed with the

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terms of the resolution, but would prefer to treat it from a different standpoint. The House had heard the commercial side of the subject, but he would deal with the strategic side. Personally he wished to see us get the largest number of cables in different parts of the world, because he was persuaded that our superiority at sea would be most powerfully aided in time of war by the greater number of cables we could possess. Much progress had been made. His great object was to obtain various alternative routes to be used in time of war, and he firmly believed that an important national object could be attained without heavy cost to the country. Cables would undoubtedly be largely cut in time of war, but it was highly improbable that all of them would be cut, and if we had alternative routes the probability was that one or two cables would remain intact, and that we would thus have an immense advantage over our opponents. During the Cuban war the United States cut certain cables, and paid compensation in certain cases. Of course in our case the payment of compensation would be a small matter. He wished to insist on the importance of deep-sea landing of cables, and pointed out that while the landings on the Cornish coast were shallow, those on the west coast of Ireland were in deep water. This was a matter to which he thought the Government should give their attention, not only from a strategical, but from a commercial point of view. He was one of those who favoured the purchase of the cables by the State at their real value or price. At all events, the purchase question was one worthy of inquiry.

Mr. VICARY GIBBS said Sir E. Sassoon had complained of the associated cable companies that they did their work badly and were very inefficient in the time of war, and that their charges were excessive. As to exorbitant tariffs, it was impossible to have a uniform mileage rate to the West Coast of Africa. The charge was high because the amount of traffic was so small. As to the land rate across India being reduced to a 1s., by an agreement between the Indian Government and the telegraph companies the rate had been reduced from 4s. to 2s. 6d., and that new rate would, it was believed, show a substantial loss. Of that loss the Indian Government would bear one-third and the companies two-thirds. The companies had also made large reductions both to South Africa and to Australia, and these were to be followed by further reductions. About 12 months ago the companies offered the Post Office to reduce their rates to 2s. 6d. provided they earned a certain minimum profit. That proposal was a fair one. The companies had made reductions from 4s. 9d. to 4s. to South Africa since May 1, and from 5s. to 4s. to Australia since September last. With regard to the new cable route to Australia, the companies did not ask for a subsidy, but that they should have the right of communicating directly with the public as was the case in this country. If the Government ultimately had their own Pacific cable and still retained control over the companies' telegrams, obviously the interests of the companies' trade rivals would be in the Government's hands, and no one would send messages by the company's cables when they could send them by the Pacific route. It was therefore most important in the interests of the public that the demand of the company should be conceded, and it had been conceded by the Governments of South Australia, Western Australia, and Tasmania. The companies had done a great deal for the Empire in providing strategic cables. With regard to the desire of the Government to have a cable constructed from Ascension to Sierra Leone, it appeared that the cost of such a cable would be about £15,000, and it was estimated that the return on such an outlay should be £11,000. The companies had agreed to make that cable for a subsidy of £4,500 a year, although the traffic was practically nil. An inquiry into the relations of the Government with the cable companies might be detrimental to the interests of this country in regard to foreign nations. He had no interest whatever in these companies, except to see that justice was done, and to give the House an opportunity of considering both sides of this question.

Mr. S. BUXTON said they all agreed that the Eastern and associated companies had done a great deal for submarine communication and towards placing almost the whole of the submarine lines in English hands, but it should be remembered that they had not made a bad thing of it. The Foreign Office, Colonial Office, and other Government departments interested in submarine telegraphy should have some settled policy whether the cables should be State cables or commercial cables. Their interests conflicted, and some general agreement should be come to. It was never intended, when the companies were subsidised and given charters, that they should combine into a monopoly to the detriment of the public interest.

Mr. R. W. HANBURY (Secretary to the Treasury), said in reply: The honourable member who moved this resolution was chiefly interested in the subject of cheap telegraphs. The right honourable gentleman opposite who seconded was, on the contrary, more interested in the question of the strategic cables. There is, therefore, *prima facie* a little inconsistency between the mover and the seconder of the resolution, because while commercial cables, to which we must principally look for cheaper telegrams, depend upon tapping every available source of traffic, the chief strategic cables, of course, avoid to a very great extent, or in fact wholly, foreign countries, which to an ordinary cable provide a very large source of traffic, and at the same time avoid all English stations which are not of considerable importance and which are not easy of defence. That being so, I think there is a little inconsistency in the resolution itself. As a matter of fact, this great system of submarine cables, like most other things worth anything in this country, has grown up quite haphazard, and the result is we have a system which is partly strategic and partly commercial, and which some people say has, therefore, got the merits of neither. I hope I shall be able to show that only a very little is wanting to give us not only good strategic cables, but also cheap commercial cables. Still, I admit that at the present time we have not got either completely. I think the hon. member opposite did a good service in calling attention to the really great work which these companies have done, because, after all, here are great private companies which have built up a great system with which the system of no other country can for one moment compare. They have given us great links between ourselves and the colonies, between ourselves and our coaling stations; they have put us into a position that we are able to get the first news from all over the world, and surely for a great nation like ourselves, in time of war and in time of peace, in diplomacy and in commerce alike, to get, as we invariably do, the first news is a matter of the very greatest importance possible. These companies have given us such an effective service all over the world that it is now exciting the jealousy of foreign nations, and complaints are now arising both in France and in Germany that so completely British is this system that we are excluding all foreign nations from participation in its benefits, and, of course, great complaints have been raised as to the way in which in time of war at any rate we are able to censor their telegrams. Take the case of France. It is the fact that with the exception of her West Indian colonies and Tunis and Algeria, France everywhere depends for communication with her own colonies upon British cables alone. I say that a company which will put this country in a position of that kind is a company to which the country is very much indebted. I will go further and say that to a great extent these companies have given us advantages which we could not have possessed even if these cables had been in our own hands, because, owing to the fact that these are private companies, at nearly all their foreign stations at which their cables land they are allowed to have as their employés all British subjects. Everybody can see what a great advantage that is to this country, but it is an advantage which certainly would not be allowed to us if those cables were owned by the Government or the State. The hon. member opposite said a great deal about the tax-payer—that it was unfair that the tax-payer should not have some voice in settling the rates demanded by these companies. But after all the tax-payers have had very little whatever to do with building up the companies, or with building up the system. No doubt we have to give subsidies for strategic cables, but beyond that we have done nothing at all. Take the great route to India. Did the taxpayer contribute a single farthing? Take the cable to China: He has not contributed to that. Take the route to Australia. The Australian colonies, no doubt, contributed something, but the Imperial taxpayer has not given one halfpenny. Therefore, after all, the connection between the taxpayer and the companies is not a very close one. Then there was the complaint raised as to these companies not duplicating their lines. That was raised by the hon. member for Hythe. What is the position in regard to that? I think if the hon. member will consult the War Office or the Admiralty he will find that they do not encourage the duplication of cables—at any rate, cables running side by side; in the first place because it is much easier to destroy communication, and, in the second place, because it is much more advantageous to the War Office that the cables should run in different directions connecting different places rather than that the two should run side by side. My hon. friend complained of certain rates. I noticed that he made no general complaint as to rates, but he singled out particular portions of the cables. He omitted to mention what I think is an important fact, that everywhere—I believe without exception—wherever those cables run, the British Government not only has priority, but also sends messages at half rates. That, of course, is a considerable advantage. The comparison of submarine rates with low rates was absurd. Complaint was made of the interruption of these two cables. I believe, as a matter of fact, that on one side of Africa the cables are interrupted on an average for 60 days in the year, and on the other side for 40 days. This is due to the very uneven formation of the bottom and also to certain upheavals which are constantly taking place and injuring the cables. In regard to submarine cables themselves, it is interesting to see what is the actual force of these rates when worked out to the number of miles a message can be sent for a penny. I have been supplied with the following information: Taking the Atlantic cables, where, of course, I admit there is a great deal more competition than exists in the case of the Eastern cables and the associated companies, between London and New York you can send a message 268 miles for a penny at the current 1s. rate. You are able to send messages to Australia at exactly the same rate—that is to say, taking Sydney, you are able to send 259 miles for a penny at the rate of 4s. To Singapore at the present rate you can send 157 miles for a penny; Hong Kong, 150; the Cape, 140; and Bombay, 135; and it really points to the fact that the proper rate to India, judging by the rates of the Atlantic cables, is 2s. I was surprised to hear my hon. friend ask the Imperial Government to subsidise or to guarantee the cables. I understand that the hon. member has taken part in a deputation to the Chancellor of the Exchequer which repudiated any idea of the sort. What is the position? No doubt we have subsidised the Indian cables, but I utterly deny that it is our duty to provide low rates at the public cost for the companies to pay high dividends. At present it would be perfectly and entirely wrong for the Imperial Government to supply public funds in order to benefit one particular class and one particular section of the community.

Then, my hon. friend, he wanted us to reserve the right to buy up these companies. With regard to strategic cables, in certain instances we have reserved that right already. My hon. friend knows that in the case of the cable going to Singapore by Borneo to Hong Kong we have reserved that right, and I think we can buy it up at £300,000. There is a similar stipulation with regard to the cable running in Egypt between Suez and Suakim; that, I think, the Egyptian Government, with the consent of our own Government, can purchase at any time for £200,000. But what is the good of a right to buy purely commercial cables unless the Government is going to buy up cables generally, and run those cables as a commercial system? That, at any rate, is a step the Government have not taken yet, and I sincerely hope it will be a long time before they think of doing so. But, even if the Government were to do that, I hardly think it is a fair thing to do to the companies, because the companies lay these cables with the intention of making them commercial successes. Are we to say to these companies, "Oh, if the cables are a failure you can keep them on your hands, but if they are a success we have a right to purchase them?" If the Government did buy the cables we should lose the advan-

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tages on foreign territory which the private companies at present possess. As to the question of competition—competition, it seems to me, is the remedy for this evil as it is for many others. One hon. member compared the existing cables with a company with regard to which he and I both had something to do, where a monopoly was claimed. But in this case there is no monopoly whatever claimed ; the cable companies do not for a moment contend that the Government is under any obligation whatever with regard to them, or has given them anything in the shape of a monopoly. We are under great obligations to these companies, and if they treat us fairly, we are bound to treat them fairly in return ; and it is only when they try to create artificial monopolies or charge unduly high rates that we could at all fairly enter into competition with them. The companies had in many cases reduced their rates considerably during the last nine years. In 1891 the rate to Hong Kong and Shanghai was 7s., in 1897 it was reduced to 5s. 6d. ; in 1891 the rate to Penang was 5s., it is now reduced to 4s. 6d. ; the rate to Singapore has been reduced from 5s. 9d. to 4s. 6d. ; to Japan from 10s. 8d. to 7s. 9d. ; to the Cape from 8s. 9d., in 1890, to 4s. at present. These are substantial reductions. My hon. friend complained of particular rates ; he complained especially of the rate to Egypt, the rate to West Africa, and the rate to India. Some curious illustrations of the kind of rates which these companies are expected to agree to have been given—the case of a halfpenny rate between France and Tunis and Algeria. I do not suppose that he himself expects that the companies are going to give us a halfpenny rate for distances of that sort. What is the fact? France deliberately treats Tunis and Algeria as being a part of France itself, and all these rates are treated as interior rates. Moreover, these are Government cables, and the whole traffic between France and Tunis and Algeria is carried on at an enormous loss to the French Government. My hon. friend does not expect either the British Government or these commercial companies to do their business at a loss like that, I am sure. Equally cogent reasons against adoption of the rates on the land lines from St. Petersburg to Vladivostok could be given. Then there is the case of the 1s. 5d. rate to St. Louis. He said, "It is perfectly monstrous that these cable companies should charge 6s. or 7s. to British Colonies in West Africa when it is possible for a Frenchman to send to his colonies at a cost of 1s. 5d. per word." What are the facts connected with the cable running between France and St. Louis? The French rate is a very low one, and when you get below a certain place two-thirds of the line belongs to the French Government and one-third to the French National Company, which I believe is really an English company. It is admitted that the service from Cadiz is carried on at a loss to the Government concerned, and it is further a fact that it is carried on at a great loss to the company which owns a third interest in the cable. It is a fact that in 1898 that company lost no less than £6,000.

Now, as to India. There is, first, the case of Egypt. This is not a monopoly, it is a privilege—that is to say, when a concession is asked for for a new line, the company has the right to say to the Egyptian Government, "Give us the first chance of making it." That privilege would entirely disappear if at any moment the line between Suez and Suakim was bought up by either Government at a cost of £200,000. As to my friend's idea that the company have any control over the Tripoli-Constantinople line, this is, the Company assure me, not the case. They have no more influence over that line than has my hon. friend himself. The Indian case is a wholly exceptional one. I do think that there the company tried to create an artificial monopoly, which was not in the public interest. I think the way in which they, in the first place, gained practical possession in 1887 of the Indo-European line, and then by a manœuvre, which was certainly ingenious, forced the Indian Government to come into the pool with them—I say it was very ingenious, but at any rate it does not put that company, so far as the rate to India is concerned, in a position to claim any very great consideration from the Government. The Indian rate was fixed at 4s. in 1886, and at 4s. it has remained ever since. Meanwhile, all the trans-Indian rates have been very largely reduced, and the result has been, no doubt, to block the cables on this side of India. Therefore, the question arises, even if the rates were reduced to India, would the carrying capacity of the existing cables be such as would be able to meet the increased traffic which would presumably follow? One hon. member said that if the companies could afford to charge cheap rates for a section of the line you have only to add the rates together and you would get a fair rate for the whole distance. But you cannot arrive at what is a fair through rate by merely adding interior rates together. The interior rates of a country are based upon a system both of short and long distances ; that is to say, a claim is made that we can afford to send a message for a halfpenny a word in England because a large number of those messages are short messages, but we could not undertake to send messages on a line from the south of England to the north of Scotland for the same price, because our calculations are not made on that basis. Exactly the same argument applies to the line to India. The result of the negotiations which have taken place between the Indian Government—which I think has made a very good fight with the cable company—has been already given by Mr. Vicary Gibbs. I understand it is practically arranged that there should be at once a reduction to 2s. 6d., and if the 2s. 6d. rate brings in a certain number of messages that rate will shortly be reduced to 2s.

Just one other word as to strategic cables. There again I think we owe a great debt to these companies. No doubt all British cables are to a great extent a new and recent idea, but very much has already been done by the companies to meet the demands for strategic cables. It is interesting to note that nearly all their existing cables run along the main routes of trade, and therefore are more easily defended by our fleet. Of course we have got a British staff in nearly every foreign station, and even where those lines do touch at foreign stations in time of war they could be easily cut, and give us a complete all-British cable even in those cases where cables are not at present all-British. What has been done recently, and within the last few years? We have got a new line complete from the Cape to St. Helena and Ascension all-British ; we have had a new line from Colombo to Gibraltar instead of touching at Lisbon ; we have got a new line to Singapore and Hong Kong ; we have got a new line from Bermuda to Jamaica ; and we have, in fact, got all-British lines to Malta, Cyprus, Egypt, Aden, India, Ceylon, the Straits, Hong Kong, Zanzibar, British South Africa, Canada, Bermuda, and Jamaica. We have not got them at the present moment to the Cape, but we shall get them by this new line passing from Durban to Mauritius, and so on up to the north. We have not got them to West Africa at present, but we shall get them when that line is completed ; we have not got them to Australia at the present moment, but we shall get them when the new line is completed. And though, undoubtedly, we have not got them to the West Indies, with the exception of Jamaica there is only one important point there, St. Lucia, which is not in connection with England by an all-British cable, and that is being considered by the Government, Not only is it the case that we shall get these all-British communications, but instead of depending upon single cables—certainly, if we get this Pacific cable and this line from Durban to Australia—we shall not only get these all-British cables duplicated, but probably triplicated and quadrupled. That is a very important consideration indeed. Then, of course, the last step which has been taken is the line running to St. Vincent and on to Ascension, St. Helena, and the Cape. I have shown that rates have been reduced in a great many instances, and steps are being taken to give us strategic cables practically all over the world. This motion for an inquiry is framed in very general terms, and I hope the inquiry by the Government will satisfy the hon. member. I would ask my hon. friend not to press for a public inquiry. These cables are largely strategic. Is it wise that a committee should go publicly into all these questions of strategic cables? There is also another consideration. I have stated the enormous advantages which this country possesses over other nations in the extent of our cables, and shown the great degree to which foreign nations depend upon British communications. Is it wise to parade this position before foreign nations? Is it not better, if we can, to continue to enjoy the opportunities which we still have, and not, by parading our present advantages, induce other nations to greater jealousy? I can assure the hon. member that if he leaves this matter in the hands of the Government, he leaves it in the hands of men who take the greatest interest in the subject and who are determined to meet not only the views in the direction of cheap telegrams, but also the views of the right hon. baronet with regard to strategic cables. These submarine lines are the true nerves of the empire ; they are the nerves by which all these colonies are brought into simultaneous action with ourselves ; they transmit to them, almost in a moment of time, those innumerable and unnumbered sympathies, those common joys and common sorrows which are shared between the Mother Country, the mother-land, and her many and distant daughters.

Sir E. SASSOON : This is the first time in the history of the House since the invention of telegraphy that any full discussion has taken place on the subject. My right hon. friend intimated that we should have an inquiry by the Government, and I must reluctantly accept this proposal. Did I understand him to offer a select committee?

Mr. HANBURY : No! I said the resolution asked for an inquiry, that we were perfectly willing to make that inquiry, that that inquiry could not be by a committee of the House, but by the Government in the different departments.

Sir E. SASSOON : Under those conditions no member of this House would have a right to ask for papers or information or to go into any matters connected with the inquiry. That would be highly unsatisfactory, and therefore I think I must go to a division.

Mr. A. J. BALFOUR : The hon. member appeared to be dissatisfied with the suggestion of the Secretary to the Treasury that the inquiry should be by departmental committee or some other machinery than that provided by the ordinary Parliamentary committee. He says that an inquiry from which members of this House are excluded would be highly unsatisfactory. But my hon friend must recollect that we have not merely to consider commercial interests in this matter, but also strategic interests. I cannot imagine anything which would be less expedient from a public point of view than an inquiry by a committee of this House into strategic considerations. Everything which he asks for in his resolution we are prepared to grant, but we cannot agree to a public inquiry, nor is that contained in the terms of his resolution.

Sir E. SASSOON : On patriotic grounds, relying on the assurance of my right hon. friend, I beg leave to withdraw the resolution.

The resolution was by leave withdrawn.

COUNTY OF DURHAM AND TYNESIDE ELECTRIC POWER BILLS.

On Wednesday last week, before the Special Committee of the House of Commons (presided over by Sir J. Kitson) to consider the Electric Power Bills now before Parliament, Mr. J. A. JECKELL, electrical engineer to the Corporation of South Shields, stated that he was appointed to the position in 1893, and had advised the Corporation with regard to the system of supply inaugurated under their Electric Lighting order. The generating station had been erected on a site on the river in the very centre of the works of the town, where there was a good supply of water and a cheap supply of coal. Asked why he advised the adoption of the single-phase system, he said that when the works were laid out there were three systems in use. One was the low-tension continuous current system, the second the high-tension continuous current, and the third single-phase alternating current. At that time the Board of Trade had not raised the pressure for low continuous distribution. They eventually doubled it, and thereby made it a good distributing current. To have supplied South Shields by a high-tension direct current system would have cost twice as much capital outlay as the single-phase alternating current system. The multiphase direct

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current system was then practically unknown in England. The ordinary periodicity of the alternating single-phase current was 100 periods, but this was unsuitable for motors, and the Corporation, therefore, reduced the periodicity to 50 periods. If a demand for power arose in the district that would increase the load factor, which was not very good now. South Shields had adopted the Brighton system of charging for current, which was absolutely equitable to all consumers irrespective of size. The Corporation was supplying its consumers profitably and well. Its undertaking was of considerable market value, and if any company, such as the Tyneside Co., purchased it would certainly be willing to give a much larger sum than it had cost the Corporation to instal it. At present 1,450 E.H.P. was available at the station, and by the end of August they would have 2,500 H.P. The capital cost of the present works, land, and distributing system was £60 per H.P. The distributing system alone had up to the present time cost about £30 per H.P.

Col. LONG: What is the lowest price at which you can supply electricity?—It depends entirely on the load factor.

Take an ordinary factory, working 10 hours a day, and doing an ordinary, fairly level amount of business?—Well, somewhere between 1½d. and ¾d. per unit.

Would it, then, in your opinion, be a hardship if we said that for power purposes the maximum they were allowed to charge for their first 100 hours must be 2d. under the sliding scale?—It rather depends on what the second 100 hours are going to be. I do not think it would be a hardship to fix 2d., because the lower the price the sooner people would take it up, and they would be recouped in that way.

As a matter of fact, in order to sell you must reduce the price?—Yes.

Mr. HANS HAMILTON addressed the Committee for the South Shields Corporation, and said that if the Tyneside Co. were willing to supply the Corporation in bulk without competing with them they would be welcomed, but the Corporation thought that competition in distribution would be most unfair, and that it was entirely unnecessary that fresh mains should be laid under the streets of the town.

Speaking for the Corporation of Jarrow, Mr. HANS HAMILTON said his clients were willing to have the electric supply placed in the hands of the County of Durham Electric Power Supply Co. They had satisfied themselves that the Company would be able to meet all demands in the present and future in Jarrow for all purposes, and that it was financially strong enough to carry out its undertaking. They objected, however, to competition in distribution between the two companies being permitted in their district.

Mr. MOON, for the Durham Electrical Power Distribution Co., said the Company was in a position, under the terms of provisional orders, to supply the municipal borough of Gateshead and Jarrow and the urban district of Wickham with electricity. It wished to be in a position to obtain electricity in bulk from the County of Durham Electric Power Supply Co., and it objected to the Tyneside Co. being allowed to compete in distribution with the County of Durham Co. even with the consent of the local authorities.

Mr. J. D. FITZGERALD, Q.C., for the Walker and Wallsend Gas Co., which under its Act of last year has power to supply the electric light, contended that the company could supply electricity at as low a rate as the Tyneside Co. His company was, he said, spending a large sum in laying down plant, and it would be a very wrong thing for Parliament, after passing the Act of last year, to allow another company to compete with it.

Mr. C. MERZ, who has advised the Walker and Wallsend Gas Co. with respect to their electrical undertaking, said he thought the amount of power likely to be required in the district, even for large works, had been exaggerated by the promoters of the Tyneside bill. He did not think that competition between the Tyneside Co. and the Walker and Wallsend Co. would be beneficial in any way. If the Tyneside Co. wished to supply the whole of the district contemplated in the bill he was of opinion that they would eventually have to build at least three generating stations. It would not be economical to transmit energy throughout the district from a single generating station, as loss in transmission would more than counterbalance economy in generation. The Walker and Wallsend Co. had provided an exceptionally good sliding scale for the benefit of the consumer, and under no circumstances could the company divide a bigger dividend than 10 or 11 per cent. The company had laid down cables and placed contracts to the extent of £30,000, and was in course of erecting a station in which some 5,000 H.P. would be provided. They looked forward to starting a supply in August next, and had made contracts to that effect. Special attention had been paid to the provision of a supply for manufacturers, and for the benefit of large manufacturers polyphase motors were being provided. The company had offered manufacturers a maximum rate of 4d. for the first hour per day throughout the half-year, and of 1d. afterwards. They had, however, made it known that they would charge the lowest price they possibly could, and they hoped eventually to bring down the price to 1d. per unit for the ordinary manufacturer. The company had made a working arrangement with the Newcastle Electric Supply Co., and the two companies in combination would shortly be able to supply not only Walker and Wallsend but a large part of Newcastle and the whole of Willington, Long Benton, and Gosforth. He contended that the prices of the Walker and Wallsend Gas Co. compared favourably with those of the Tyneside Co., and that while the Tyneside Co. would not be in a position to supply for at least two years, the Walker and Wallsend Co. could supply at once.

Mr. S. HUNTER, manager and director of the North-Eastern Marine Engineering Co., Wallsend, employing some 2,000 men, said the company had an agreement with the Walker and Wallsend Gas Co. for a supply of electricity at a price which he considered to be reasonable and fair.

Mr. S. T. HARRISON, chairman of the Wallsend District Council, said the Council last year supported the electric supply proposals then made by the Walker and Wallsend Gas Co. The Council had considered the question of competition between the Tyneside and Walker and Wallsend companies, and were of opinion that, in view of the arrangement come to last year and embodied in the Gas Co.'s Act, it would be inadvisable that another company should be allowed to come into the district. The Council had made special terms with the Gas Co., and they thought it reasonable that that company should have time to carry out their proposals. That was practically the unanimous feeling of the Council.

Mr. WILSON CARR, consulting electrical engineer, Newcastle-on-Tyne said he was electrical adviser to the North-Eastern Marine Engineering Co. which had made arrangements to receive 700 E.H.P. from the Walker and Wallsend Co. He considered that the system adopted by the last-named company was one by which electricity could be economically generated.

Mr. CHARLES HOPKINSON (Messrs. Hopkinson and Talbot), speaking to the point of compactness of area in the supply of electricity, said the district which the Walker and Wallsend Gas Co. and the Newcastle Electric Supply Co. proposed to supply was an excellent one for the purpose.

Mr. C. MERZ, recalled for the Newcastle Electric Supply Co., said the present generating station of that company being unsuitable for their extended undertaking, they proposed to acquire a new site on the river side in Wallsend. The Tyneside Co. also proposed to acquire the same site, which was the only one available near Newcastle for generating electricity at a cheap rate. The Newcastle Electric Supply Co., in the bill now before Parliament, had scheduled two other sites besides that at Wallsend. He was not aware that the owners of the Wallsend site had agreed to sell it to the Tyneside Co.

Dr. J. T. MERZ, vice-chairman of the Newcastle-on-Tyne Electric Supply Co., said the capital of the company was now £300,000, of which £200,000 had been allotted. In 1890 the company came to an agreement with the Newcastle District Electric Lighting Co., with the knowledge of the Corporation of Newcastle, that each company should confine its operations to certain districts in the city. He strongly objected to the bill of the Tyneside Co., his own company being able and willing to meet any demand for the supply of electricity in its own district. The Newcastle Electric Supply Co. had been in negotiation for the Wallsend site since February, 1898, and the site was scheduled before it was known that the Tyneside Co. were going to schedule it. An agreement had been made with the Walker and Wallsend Gas Co. to supply them with electricity in bulk, the gas company to be their own distributors.

Mr. J. S. WATSON, engineer of the Newcastle-on-Tyne Electric Supply Co., said they had been supplying electric energy for the last 12 years. Till two years ago the system in use was the alternating current. As it was found that some other system was needed, he visited all the electric supply works in this country and in Switzerland, and, as a result of the recommendations he afterwards made, it was decided to adopt the continuous current system. The company were prepared to supply manufacturers with the whole of their electrical equipment without initial cost to them. They were now laying cables capable of dealing with any amount of power required in the city. In order to meet the demand for power it was proposed to charge a rate which he believed was unprecedent at the present time—namely, 4d. per unit for the first hour's use per day and 1d. for the second and subsequent hours. These were the maximum prices, and all manufacturers understood that the company hoped to supply them at a lower price. The charge for lighting would be almost equally low—namely, 4½d. for the first two hours and 1d. after. These rates were not to be found in the company's provisional order, but they had offered to make contracts to supply at those rates. They had not sent out a circular notifying their intention of charging at such rates, but had negotiated with manufacturers, and had actually made contracts on that basis. The rates had not been lowered merely to meet the competition of the Tyneside Co., arrangements having been made before the Tyneside bill appeared.

Mr. ROBT. HAMMOND stated that he was for years the pioneer of the system of one large generating station for the supply of a large district, and was consulting engineer to about 28 local authorities. He had prepared an analysis of the Board of Trade returns respecting the cost of production in all the leading electric works in the country. The analysis showed that the load factors were in most cases low. In the case of Leeds, for instance, whose works he laid down himself, the load factor was little more than 10 per cent, and the cost of production was 1·29 of a penny per unit. No load factor of 25 per cent. existed in this country. He had compared the prices proposed to be charged by the Newcastle Electric Supply Co. in connection with the Gas Co., and those proposed by the Tyneside Co. They seemed to be reasonable prices. The area of the Newcastle Electric Supply Co. was one in which he thought that electricity could be as cheaply produced as it could be in the larger area proposed by the Tyneside Co. There was a point in the enlargement of works at which the limit of economy was reached. He put the figure of economy at between 5,000 and 10,000 kilowatts. The district mapped out by the Newcastle Electric Supply Co. was an extremely favourable one for an economical supply.

Prof. W. E. AYRTON stated that, in his opinion, the charges of the Newcastle Electric Supply Co. compared most favourably with the proposed charges of the Tyneside Co. He did not think the area mapped out by the Tyneside promoters north of the Tyne could be economically supplied from one station.

The Committee then adjourned till Wednesday.

THE ELECTRIC POWER BILLS.

At the meeting of the Committee on Wednesday, when proceedings on the Electric Power bills were resumed, Sir J. Kitson presiding, after Mr. Balfour Browne, Q.C., had addressed the Committee on behalf of the County of Durham Electric Power Supply Co.,

The CHAIRMAN said he wished to state, for the Committee, that the value of electrical energy as a means of power had been amply demonstrated and its importance to industries in this country was admitted

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The Committee felt that it was to the public advantage to facilitate measures which would ensure the general supply of electrical power to all consumers who might seek to avail themselves of the economy and efficiency offered in the service of these sources of the application of the power. The Committee, therefore, did not require the constant repetition of scientific evidence to prove that which had already been proved to their satisfaction.

LANCASHIRE ELECTRIC POWER CO.'S BILL.

Mr. WORSLEY TAYLOR, Q.C., then opened the case of the Lancashire Electric Power Co. He said their bill was one to authorise them to supply electric power over a large area lying south of the Ribble. The company was to have a capital of £3,000,000, with borrowing powers to the extent of an additional £1,000,000. Four generating stations were to be constructed—one near St. Helens, one near Wigan, one at Little Lever, near Bolton, and one to the south of Eccles, near Manchester. The only opposition came from the local authorities, and the question was one really of wayleaves. The company sought to supply in bulk those who were already authorised by Board of Trade licence, or provisional order, or special act to supply electricity. It would thus be seen that it was not proposed to compete either directly or indirectly with any of the local bodies. They did not propose, as was proposed in the Durham and Tyneside bills, to supply individual customers directly ; they simply asked to be allowed to be the agents or servants of those who had already had power to supply on their own behalf. Thus the powers asked for in this bill were much more limited than those asked for in the other electric power bills. In the proposed area of supply there was a population of 3,000,000, and the industries carried on were more varied than in any other part of the United Kingdom. There were 84 urban districts in the county, and of these 65 did not oppose the bill. There were also 12 rural districts, and not one of them opposed it. Manchester Corporation and a number of other corporations, however, did oppose.

Mr. F. E. GRIPPER, electrical engineer, managing director of Edmundson's Electricity Corporation, and one of the promoters of the bill, said he regarded the scheme as a very good one. Electricity had never been generated on anything like the scale on which the company proposed to generate it. He thought that, with the exception of Niagara, there was no place where electric power could be generated as cheaply as it could be on a large scale in Lancashire. Four generating stations were proposed so as to obviate the necessity of conveying the power to too great distances. The Aspull station, near Wigan, would be so situated that it would not be necessary to handle the coal at all. The coal would be sent by mechanical means straight from the pits to the generating station. There was also a canal and a railway running close to the station. The same remarks applied to the St. Helens and Little Lever stations. There were 129 separate local authorities in the proposed area of supply and of these 16 had electric works in operation, and there were also three small private electric stations. The total output of the whole of the existing electric stations in the area was last year about 15,000 kw. The company proposed to design each of its stations for producing 15,000 kw. The object of the bill was more especially to supply the smaller local authorities, and it was only proposed to supply in bulk to companies or local authorities authorised to supply in their turn. The only compulsory power was practically that of laying down mains in order to get through one district into another. A mains voltage of 10,000 was proposed, and that would be transformed down so as to suit the requirements of the different customers. The whole of the four generating stations were not to be erected at once. In the first instance only one would be put up. The estimated cost of such a station was £555,000, including the cost of 180 miles of mains, each main being sufficient to carry about 1,000 H.P. Assuming that they would get a load-factor of 25 per cent., he estimated that at a station with a capacity of 12,500 kw. the cost of generation and distribution to the consumer would be 0·7 of a penny per unit. He estimated that the receipts would be £142,500 per annum, and the profit £62,000 from the one station. The company hoped to be able to supply at an average price of 1·25 of a penny per unit.

Yesterday (Thursday) Mr. GRIPPER was cross-examined by Mr. Freeman, Q.C., on behalf of Liverpool Corporation, and stated that under the bill the promoters would be obliged to supply all local authorities who asked for electric power, but they would be unable to supply individual consumers unless the local authorities gave their consent. Public bodies and companies who received a supply would have to guarantee to take, for seven years, an amount of energy equivalent to 20 per cent. of the cost of laying the mains. In putting down the mains the company would have to select a line approved by the local authorities, but if they objected to the decision of the local authorities they would have an appeal to the Board of Trade.

The committee then adjourned.

ELECTRIC LIGHTING IN DUBLIN.

A peculiar three-cornered electrical contest is in progress before a Committee of the House of Commons, consisting of Mr. A. H. Brown (chairman), Mr. Arthur Moore (Londonderry), Mr. Trevelyan, and Mr. Rutherford. Under the provisions of what is called the Dublin Electric Lighting Bill, a company, composed of some of the leading ratepayers and electrical power users in Dublin, ask to be incorporated, with a capital of half a million, for the purpose of establishing a generating station and other electrical plant on the banks of the city, in order to supply electric light to the city, a business which has hitherto been in the hands of the Corporation.

Mr. BALFOUR BROWNE, Q.C., in opening the case said the object of the bill was to incorporate a company, and to empower them to supply electricity in the city of Dublin and the urban districts of New Kilmarnham, Drumcondra, Clonliffe, Glasnevin, and Clontarf. The bill was promoted by certain very large ratepayers in Dublin who were tired of the continued inability of the Corporation to supply them with electricity for the purpose of introducing competition, which was very badly required. The history of electric lighting in Dublin was a record of failure. The Corporation had expended £90,000 on their electrical enterprise, and instead of a profit they had an income of only £10,704, and a net revenue of £1,424 with which to meet the whole of the interest and sinking fund upon the £90,000. They first of all accepted the tender of the Electrical Engineering Co. of Ireland for the generating station which was £30,714, and then they sublet the contract to Mr. R. Hammond with the result that the capital expenditure on the generating station, instead of being £30,000, came close up to £85,000. Their maximum charge being 7d. per unit, the result was that people would not take their electricity, and at the present time they had only 350 customers. The cables broke down in 1896, and the mains had to be relaid at a cost of £30,000. The site of the generating station was one of the most unsuitabe that could be chosen ; it was in the heart of the city, and the noise and vibration and smoke and other nuisances arising from it were complained of by the neighbours ; they had no facilities for getting water, and they had to cart their coal in and their ashes out. It was no wonder that with their large capital expenditure and their small clientele the Corporation were unable to give a satisfactory supply and in these circumstances a number of manufacturers in the city had installed electricity for themselves. The local authority having thus grossly failed in their duty to the promoters of the bill asked leave to come in and compete. Sir Francis Marindin had laid it down, "That in the abstract, competition is desirable, as tending to keep down the price and to cause the manufacture and supply of electricity to be carried on with all the attention and energy which it is possible to devote to it." That was the promoters' case. They wanted to supply electricity to reduce the prohibitive price of the Corporation and to ensure that the supply and manufacture should be carried on with proper attention and energy. The Dublin United Tramways Co., which had a very large electrical station for the purpose of operating their tramways, some years ago offered to supply the Corporation with electricity at a comparatively cheap price, and quite recently the same company had again offered the Corporation electricity at a price much lower than that at which the Corporation were supplying to the people of Dublin. Both these offers were declined. Apparently, therefore, the object of the Corporation was to keep their dead hand down and to prevent any one else from supplying elertricity. These were the circumstances in which the bill was promoted, and he would ask the conference, after hearing the evidence, to say that if ever there was a place in which a Corporation had failed to carry out their duty in the matter of electrical supply, it was Dublin.

Mr. WILLIAM MURPHY, chairman of the Dublin United Tramways Co., one of the promoters of the bill, and a director of one of the largest drapery establishments in Dublin, disclaimed the suggestion that there was any connection between the Tramways Co. and the promoting company, which was composed of some of the largest ratepayers and users of electricity in Dublin. He was also a director of the late Electric Lighting and Tramways Co. The present price charged for electric current by the Corporation of Dublin was between 6d. and 7d. per unit, compared with 4½d. to be charged by the new company, who estimated to make a profit. The charge for current at Cork was rather under 3d. per unit. Current for motive power at Cork was supplied at a still lower price compared with 6d. at Dublin.

Questioned by Mr. MOORE, a member of the committee, Mr. MURPHY said that if the Corporation would withdraw their prohibition against co-operation between the new company and the tramways company he believed it would be possible to supply at a penny less than the rates now charged. He could not, however, imagine the Corporation assenting to any arrangement which would leave their electric plant on their hands, but if the new company took over the existing plant and generating station of the Corporation probably electricity could be supplied at 4d. per unit. The Dublin United Tramways Co., being in a position to supply electricity in bulk cheaper than it could be supplied by the Corporation, had offered on two occasions to either take over the Electric Lighting Order of the Corporation or to supply them with electricity in bulk at a cheap rate, but both those offers were refused. The terms on which the Tramway Company were prepared to supply electricity were, for a consumption of 650,000 units, 2½d. per unit ; 1,300,000 units, 2¼d. per unit ; 2,600,000 units, 1⅞d. per unit ; as compared with a cost under Mr. Hammond's scheme, including loss on transformation, of 650,000 units, 4·55d. per unit ; 1,300,000 units, 3·15d. per unit ; 2,600,000 units, 2·45d. per unit. Under this proposal the Corporation were to retain the entire monopoly and control of the electric lighting.

WITNESS was cross-examined at length by Mr Burke, Q.C., with a view of proving identity between the promoting syndicate and the Dublin United Tramways Co., in whose Act there is a provision "That nothing in this Act shall empower the company to use or supply electrical power for any purpose whatsoever other than lighting and moving the carriages used on the tramways, and lighting the premises of the company, and for lighting the standards and posts for their own use."

Mr. C. W. HEALY, another promoter, confirmed that there was no connection between the proposed company and the Tramways Co., and explained that on the strength of the Corporation undertaking to light his printing works with electricity he did away with all his gas lamps and brackets, which he had to reinstate in consequence of the failure of the electric light, although his works were only three or four minutes walk from the Corporation's generating station. Whilst the gas lamps were being replaced he had to use oil lamps. If he could have got electric current for the purpose he would have driven all his machinery by electric power, but the current produced by the Corporation was not suitable and

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consequently he used a large gas engine. There was, he said, a strong feeling amongst the shopkeepers and residents in Dublin in favour of having an independent supply of electric lighting in consequence of the dissatisfaction with the existing system, the prohibitive charges, and the inability of the Corporation to supply electricity.

Mr. HAMPTON SHAW, engineer for the township of Kilmainham, spoke as to the high charges for gas in that place, both for public and private lighting, and as to the demand for the supply of electricity in that district.

Mr. ARTHUR HANDLEY (Messrs. Handley and Shanks) said there were 270 subscribers to the Corporation supply, and the capacity of the present generating station was about 1,000 kw., equivalent to 1,500 H.P. for private lighting. There were also in Dublin about 70 private plants, with a capacity equivalent to 2,380 H.P. Even the new scheme of the Corporation did not provide for motive power, and it would certainly be of advantage to get competition.

Mr. ARTHUR EDWARD PORTE said that whereas in Cork, with a population of 80,000 they had 35,000 8 c.p. lamps actually burning at one time, in Dublin with a population of 250,000 they only had 27,000 lamps all told. In Dublin, again, there were no motors, while in Cork they had approximately 400 H.P. running daily. As a contractor he calculated that if they had had a similar amount of motive power in Dublin it would have meant £4,000 more into his firm's business. Under the rules of the Corporation it was practically impossible to have motors, as people were limited to a starting current which was of no use.

Mr. H. F. PARSHALL, consulting engineer to the Dublin United Tramways Co., said he had considered and worked out a proper system under the proposed scheme for the distribution of 2,000,000, 3,000,000, or even 5,000,000 units on the direct-current system. The sites for the generating stations were well chosen, and he believed the company would be able to supply electricity at a comparatively cheap rate. With a centrally-located station distributing electricity on a continuous-current system they would certainly be able to get 15 or 20 per cent. better efficiency, which was a most important matter where the cost of coal was very high. The main object was to get such a system of transmission and distribution as to obtain the highest efficiency with the least possible loss of energy. That was what the proposed system secured. If it was fit and proper to distribute 6,000,000 units for traction purposes, in this way it must be equally so for lighting purposes, because the losses in transmission of energy were identical. It was hoped under the scheme before the committee to combine with a lighting plant a supply of energy for power. The system which he desired to introduce was the best system for the distribution of power, because it was a demonstrated fact beyond dispute that continuous-current motors had energy factor unity in a higher degree than alternating-current motors. Electricity for power must necessarily be sold at a low rate because there were now in Dublin 3,000 H.P. gas engines, and the Gas Co. were in a position to supply power at a low rate. Such a price as 7d. per unit would be absolutely prohibitory and render it almost impossible to use electricity for power purposes in manufactories. Judging from his experience in the case of Cork he calculated that Dublin should consume from 2,000,000 to 3,000,000 units per annum, and that the receipts should amount to between £40,000 and £50,000. According to an official return the Corporation sold only 500,000 last year, and that would be more than doubled in twelve months if the people had a proper supply. After working the thing out carefully he came to the conclusion than an average price of between 4d. and 4½d. per unit would make the lighting remunerative, and that as far as power goes 2d. would be the outside figure. At these prices he calculated that the yield to the company would be £58,200, which, after deducting £15,000 for the cost of generation, would leave a net figure of £43,000. The current now supplied at the Corporation works was an 83 cycles 25-volt alternating current, and he proposed to supply a continuous current of 440 volts.

Mr. BALFOUR BROWNE, Q.C.: We know that you can get motors worked by alternating current, but not nearly so conveniently as by a continuous current?

WITNESS: Alternating current may be made to work motors physically satisfactorily, but I stand ready to prove by incontestible evidence that no alternating current motor can be shown to be as efficient as a continuous-current motor. Another point that I should like to bring out is that a continuous-current motor has energy factor unity, whereas in the case of an alternating-current motor no more than 90 per cent. of the current represents energy, so that to get the same result in your transmission and distribution system, which is of the utmost importance, the alternating current motor is at a distinct disadvantage.

Do you find, from your experience, that in many cases companies do their duty by the public in this respect just as well as corporations?—I think you may fairly say that companies can do better than corporations, for this reason: It is not one corporation in a dozen that can secure the services of a very high-grade man, for the simple reason that if he is a good man technically, he has to be a good deal of a politician in order to get anything done in a fit and proper way. That is a combination which is rarely to be found. The canny Scot, I think, has succeeded admirably in accomplishing this; but outside Scotland I am not sure that I have ever seen it accomplished.

Cross-examined by Mr. PEMBROKE STEPHENS, Q.C.: May I take it from you, as consulting engineer, to the Dublin United Tramways Co. that the works of the company are or are not adapted for electric lighting as distinguished from electric power?—The machinery could with some modification be used for electric lighting, but so far as distribution is concerned we could do nothing. The generators that we use are compounded for a particular drop in our mains. By cutting the compound-wound coils out, and getting the field-magnets rewound, and putting in a new switchboard, we could distribute if we had a proper system of mains.

Mr. PEMBER, Q.C., having addressed the committee on behalf of the Corporation of Dublin in opposition of the bill,

Mr. ROBERT HAMMOND was examined by Mr. Bushe, Q.C. He said the scheme of the Corporation, for which the estimate was £254,000, would cover the entire area of Dublin. He denied that the ex-mural generating station was a blot on the scheme, and asserted that in practice it would be found to work better than the low-pressure scheme advocated by the other side. He had just been through Europe, and he found that the idea of ex-mural sites for generating stations was becoming universal. The promoting syndicate proposed to use a continuous current, which had hitherto had the monopoly of the supply of motive power. On the other hand, he proposed in the case of the Corporation a current quite suitable for motive power, and one which was being used very largely inded for motive power, known as the three-phase alternating In connection with his Dublin scheme, he recommended a price of 4½d. per unit for private lighting and 2d. for public lighting, or an average of about 3½d.

The Right Hon. JOSEPH MEADE, Chairman of the Electric Lighting Committee of the Dublin Corporation, examined by Mr. J. D. Fitzgerald, Q.C., said as soon as the Corporation knew that the scheme now before the committee was fairly under way they consulted Prof. Kennedy, and arranged with him in the first instance to carry out the scheme, for which they took power to borrow £254,000. Prof. Kennedy, however, being under arrangement with the London County Council to go to America for them, Mr. Hammond was retained, and he prepared a scheme of which the Local Government Board approved, and sanctioned the expenditure of £254,000.

Mr. MARK RUDDLE, superintendent of electric lighting to the Dublin Corporation, explained the working of the present system.

Prof. SILVANUS P. THOMPSON, examined by Mr. Burke, Q.C., said that for motor purposes the three-phase alternating energy was more suitable than any other form of electric current. The scheme proposed by Mr. Hammond would supply motors adequateiy, and there was no foundation for the suggestion that a three-phase alternating scheme was inapplicable to motors. He also approved of the system of having the generating station outside the area of supply especially, in the case of large towns and cities. It was not economical to have the generating station in the centre of the area, and lighting stations ought to be few in number. In all these respects the Pigeon House Fort complied with modern theory.

Mr. George Pearson, of Bristol, Mr. Reginald Wigram, of Leeds, and Mr. Robert Styning, of Sheffield, expressed their preference to having electric lighting in the hands of corporations rather than of private companies.

Major PHILIP CARDEW (Messrs. Preece and Cardew), approved of the site selected by the Corporation of Dublin for a generating station outside the city. He did not approve of competition such as that sought to be set up by the promoting company, which he thought would involve the laying down of unnecessary mains.

Sir THOMAS PILE (Lord Mayor of Dublin) said they had formed a very firm determination to keep the lighting of the city in their own hands, and they meant to go on with the Order which they had obtained, and to spend the money which they were authorised to spend in extending and improving their system.

Mr. PEMBROKE STEPHENS, Q.C., addressed the Committee in the interests of the Alliance and Dublin Consumers' Gas Co., in opposition to the bill.

Mr. GORDON, Q.C., having summed up the case for the promoters,

The committee deliberated for some time in private. Ultimately the Chairman announced that the committee had decided to allow the bill to proceed on two conditions: (1) That the maximum price to be charged by the compeny should be reduced from 6d. to 5d. per unit; and (2) that a clause should be inserted in the bill enabling the Corporation to buy out the company if they should find it desirable hereafter to do so.

The inquiry lasted five days.

MANCHESTER AND LIVERPOOL ELECTRIC EXPRESS RAILWAY.

The consideration of the bill of the Manchester and Liverpool Electric Express Railway Company was resumed on Friday last by Sir John Kennaway's Select committee at the House of Commons.

The opposition of the Cheshire Lines Committee was continued.

Mr. CHAS. STEEL, the General Manager of the Great Northern Railway Company, and Mr. G. H. TURNER, the General Manager of the Midland Railway, spoke of the injury the proposed line would do to the existing railways.

Sir DOUGLAS FOX said he was the consulting engineer of the Great Central Railway Company and had, in 1893, carried out the Liverpool Overhead Electric Railway. That railway was formed to run over the existing dock railway, from end to end, and had the support of the Board, though it was now in the hands of a separate company. It was clear to him that whoever laid out the railway did not understand the local arrangements, otherwise the difficulty as to Salford could have been removed by running into a tunnel instead of on a high viaduct. In his opinion, by the introduction of electric traction there was good hope of attaining a high speed on ordinary railways properly worked, but he would never seek high speed in connection with the mono-rail. He did not wish to question the possibilities of electric traction. He believed it was the traction of the future, but did not think it should be applied to this railway, which was called a mono-rail but was really a railway of fire rails. If there was a settlement of a sleeper the train going at high speed would be derailed, with serious consequences. The brake question was a serious one. He was sure that the electric louvres would not have any appreciable effect.

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By Mr. NUSSEY (a member of the committee): It was possible to reverse a dynamo. but he thought it would be a risky experiment. What would be the effect of stopping a train short at that speed of 100 miles per hour he could not say.

Mr. LITTLER, Q.C., addressed the committee on behalf of the Lancashire and Yorkshire and London and North Western Railway Companies, and evidence was tendered on behalf of the Mersey Docks and Harbour Board.

Mr. POPE, Q.C., addressed the committee on behalf of the Mersey Board: If the committee considered the scheme was sufficiently real to justify the attempt to try it; if they thought it was of public importance to see whether a speed could be raised by electricity from 60 miles to 110 miles an hour he had nothing to say, except that the interests of the dock were so superior to the public advantage, so much more important, that such a scheme should not be sanctioned to their injury.

Mr. BALFOUR BROWNE, Q.C., on behalf of the promoters, said with reference to the suggestion for a tunnel made by the Salford Corporation, they had considered the matter most carefully and they could show it was an impracticable scheme. The cost of construction would add £250,000 to the scheme, and the water-laden strata through which they passed would involve considerable pumping. Replying on the whole matter, Mr. Balfour Browne urged that the scheme had been thoroughly considered and was supported by the men of the two cities who had the interests of their towns at heart. Practically the same opposition was made then as was raised against the first railway in 1825. The whole question was, why should there not be another railway between Manchester and Liverpool. Electric traction was cheaper and quicker than locomotive traction, and every competent person allowed that a speed of 100 miles to 110 miles an hour is easily to be attained. Their opponents had not called a single person who knew anything about electricity, for Sir Douglas Fox had never made an electric railway. Then the Cheshire Lines said the proposed railway could not pay. But how could they say that? They knew that at present there was between Liverpool and Manchester 174 trams each day, which in a year run two million train miles and only carry one million passengers. Compare that with the Liverpool Overhead Railway, which carried nine million passengers every year, or with the results of the tramway service of Glasgow, and they would see the benefit of electric traction. The question of brake power was the only real objection that had been raised. Their opponents sneered at the louvre boards, but on the Lyons-Mediterranean Railway the system had been entirely successful. Then they had the Westinghouse brake, and as Mr. Cottrell had told them, it was possible to retard the train by short circuiting the motor, and so turning it into a dynamo. None of the landowners through whose land the railway passed opposed the bill. In concluding, counsel said England, which was the pioneer in the great enterprise of locomotion, was to-day behind other countries in relation to electrical power and electrical traction. The proposed railway was a new departure in locomotion—in the locomotion of the future. Electrical traction will be the motive power of the future. If their scheme could be shown to be commercially feasible—and they were willing to take the risk of that—it would be inaugurated for all time. It was, therefore, in the interests of England generally that he asked them to pass the bill.

After a short consultation, the CHAIRMAN announced the decision of the committee. He said: It appears to the committee that the monorail system which is suggested for the proposed railway is likely, when fully matured, to make an important contribution to the development of railway traffic at high speed. In certain important respects, however, the present scheme is seriously incomplete. More particularly, the evidence given before the committee has not satisfied them that a safe method has yet been found of applying effectively brake power to trains running at the high rate of speed proposed. Apart, however, from such considerations as the above, the committee are of opinion that the proposed line has been laid out without adequate and reasonable regard to existing interests, bearing in mind that the intermediate districts would not participate in any of the advantages of the railway. The Corporation of Salford would seem to have just cause of complaint in this respect, and the interference of the proposed line with the use of land at Liverpool acquired by the Mersey Docks and Harbour Board for the construction of additional docks has weighed seriously with the committee. The committee are of opinion that in all schemes put forward for giving access to the heart of great cities the question of underground approach ought to be considered and adopted where practicable. On these grounds the committee are of opinion that the preamble of the bill is not proved.

SOUTHPORT AND LYTHAM TRAMROAD BILL.

On Friday last week, a House of Commons Committee, presided over by Mr. C. Seale-Hayne, commenced the consideration of this bill, which is being promoted by the Southport and District Tramroad Co., for powers to construct an electric tramway from Southport along the coast about 5 miles, where it is proposed to cross the river Ribble by a conveyor bridge, thence to Lytham.

Mr. RAM, Q.C., for the promoters, stated that a bill to construct the proposed tramway was before the House last year. It was now proposed to cross the Ribble higher up the estuary. At the present time Blackpool, St. Annes, and Lytham were connected by tramways. Last year Parliament sanctioned the construction of a tramway from Southport to North Meols, whence it was then proposed to make a tramway on the surface of the sand to the estuary of the Ribble and across the river to Lytham. By the present scheme the tramway could be continued between 3 miles and 4 miles further along the coast from North Meols to Guide's House, where the conveyor bridge would be constructed across the Ribble. The height of the bridge would be 147ft. The tramcar would be carried across the river by means of a suspended travelling cradle, driven electrically. The Preston Corporation, who opposed the Bill, contended that the bridge would interfere with the navigation of the Ribble and assist accretions in the estuary, but Mr. Ram argued that there was no possibility of the proposed works damaging the navigation of the Ribble.

Sir GEORGE PILKINGTON, M.P., Ald. GRIFFITH (Mayor of Southport), and others gave evidence in support of the scheme.

Mr. J. T. WOOD, C.E., one of the engineers of the scheme, described the proposed works. The piers of the bridge would be behind the training walls of the channel, and therefore would not interfere with the navigable portion of the channel. The bridge would be constructed on open ironwork supports fixed in the sands, so as to form pier and landing-stage suitable for vehicular and pedestrian traffic. The bridge would connect the tramway running through Hesketh-with-Becconsall with that at Warton on the northern training wall of the Ribble, and was intended for the conveyance, upon a platform or car suspended from the girder, of tramcars, carriages, waggons, passengers, animals and merchandise. The cradle or platform of the bridge would be from 50ft. to 60ft. long, capable of carrying an electric car and trailer or a waggon-load of hay, or other produce, with two horses, to the total weight of 25 tons. About 1½min. would be occupied in traversing the channel, and there would be duplicate machinery in case of accident. Two similar bridges had already been sanctioned by Committees of the House this session, one between Widnes and Runcorn, spanning 1,000ft., and the other, promoted by the Newport (Mon.) Corporation to cross the river Usk. The height of the girder from which the cradle was to be suspended at Runcorn was 82ft., that at Rouen was 167ft. The promoters of this bill had offered to increase the height of their girder from 130ft. above spring tide to 147ft. (6ft. higher than the Tower Bridge across the Thames). Its construction would follow on the lines of the bridge at Rouen. From a small upper deck a man would keep a "look-out," and the cradle would be under exactly the same control as an ordinary electric tramcar under that of its driver. The cradle could be stopped at any moment and moved backwards or forwards as desired. All the equipment for working was in duplicate and so arranged that it could be worked separately or combined. In connection with the bridge at Rouen hand power had also been introduced, but it had never been used, nor were they likely to want it in crossing the estuary of the Ribble although it was provided. If the "look-out man" saw a vessel was likely to be in the way of the cradle as it journeyed across, he would, of course, not start from the pier until the vessel had got clear. Assuming the cradle stuck at any point of the bridge, it would occupy only 50ft. out of about 550ft., and a ship would have plenty of room to pass. Although the rods by which the cradle would be suspended would be 130ft. long the cradle would not swing. A gale of wind might cause the cradle to take a slightly curved course, but it would be perfectly steady. There never could be a pendulum motion. Statistics showed that only 1¾ ships navigated the Ribble per tide. In fact there was no traffic to interfere with. At Bilbao, where a similar bridge had been working for seven years, there was ten times the traffic. The cradle attached to Bilbao bridge had never been stopped for an hour, although it was confronted by the full force of the wind from the Bay of Biscay. The proposed tramway would join up with existing tramways, making a practically continuous electric line from Southport to Blackpool.

Mr. G. F. Deacon, C.E., Prof. Harcourt, C.E., Mr. George Aberneathy, C.E., and Mr. H. Graham Harris, C.E., gave evidence that the influence on the tidal flow such a bridge would have was so infinitesimal as not to be worth mentioning.

For the opponents of the bill,

Mr. A. FOWLER, C.E., resident engineer to the Preston Corporation, stated that the Corporation had spent about £1,200,000 in improving the Ribble for navigation and had constructed a dock at a cost of £200,000. They, therefore, desired that the navigation should not only be preserved but that nothing should be done which would be detrimental to it. A tunnel could be constructed in lieu of the bridge, and this would not interfere with navigation to the port of Preston, against which master mariners seemed to have an objection more or less sentimental. They were making provision for vessels with masts as high as 160ft. and 170ft.

Capt. LEWIS DAVIES and Mr. R. W. LEYLAND, shipowners, Liverpool, and other witnesses having given evidence against the scheme, Mr. Pember, Q.C., for the petitioners, said that, subject to the adjustment of certain clauses, he had agreed with counsel for the promoters that the bill should proceed so far as the preamble was concerned. That was subject to the condition that the promoters would undertake to make the girder of their bridge 177ft. instead of 147ft. high.

The Committee decided that the preamble of the bill was proved.

MANCHESTER CORPORATION TRAMWAYS BILL.

A Committee of the House of Lords (Lord Newton presiding) began on Tuesday the consideration of a bill authorising the Manchester Corporation to construct additional tramways in and near the city, and to confer further powers on the Corporation and neighbouring authorities.

Mr. LEWIS COWARD, for the promoters, explained that the Corporation were the owners of the tramways within the city, which at present were leased to the Manchester Carriage and Tramways Co., and were worked by horse traction. The lease expired next April, when the Corporation proposed to work the tramways, and to adopt the electric overhead trolley system. In 1898 the Carriage and Tramways Co. unsuccessfully promoted a bill to enable them to introduce electric traction and continue the working of their system in connection with the local authorities. Meanwhile the Corporation had come to an agreement with a number of local authorities, under which the Corporation agreed to work the tramways as one continuous system. Negotiations were, however, now in progress between the Corporation and the Carriage Co. on the subject. In 1899 the Corporation obtained further tramway powers, including that to work and take leases of lines outside the city, and were authorised to take leases of tramways in Failsworth, Droylsden, Audenshaw, Gorton,

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Denton, Levenshulme, Heaton Norris, and Stockport. Since 1899 the Corporation had arranged with Stretford Council to lease their lines, but the agreement had not been actually signed, and negotiations were also pending with the Withington and Moss Side Councils. In the present bill the Corporation took power to arrange also with Middleton, Reddish, Prestwich, Whitefield, and Radcliffe. The bill would further authorise the construction of certain tramways within the city aggregating to 37 or 38 miles of single track. It was proposed to operate in a manner entirely different from that adopted by the Manchester Carriage and Tramways Co, who ran from the suburban districts to a central point in the city and back again by the same line of route. The experience of other cities showed that the proper course was to have through routes, running from north to south or from east to west. This was found a good means of regulating the traffic. The Tramways committee had a scheme of through routes under consideration. The British Electric Traction Co., who were undertakers of the Middleton Light Railway Order of 1898, among others opposed the bill. The borough of Middleton was, however, in accord with Manchester, and the latter would not make connections with the company's lines without its consent, The practical opposition, however, came from the frontagers, and he urged that the Corporation were of necessity the best judges as to the width of streets and similar questions.

Mr. BOYLE, chairman of the Tramways committee, gave evidence in support of the scheme. The electric cars, being without horses, would take up much less room than ordinary tramcars, and the through system of working would help the flow of traffic. It was proposed to have fixed stopping places for taking up and setting down passengers, and this also would be a great improvement. Some of the proposed lines were intended to be used as alternative routes.

On Wednesday the evidence included that of

Mr. J. McELROY, general manager of the Corporation tramways, who said that several of the proposed tramways in the central part of the city were absolutely necessary as alternative routes in case of breakdown on other lines. Upon a through system worked by electric traction alternative routes were indispensable.

The TOWN CLERK of Middleton stated that his Council had voluntarily entered into the agreement in regard to a tramway system connecting Middleton and Manchester, and he considered the arrangement would be for the advantage of the district.

Evidence on behalf of the Horse Owners' Union and other petitioners was then taken, and the bill was passed as amended. It was announced that an arrangement had been arrived at with respect to the bill promoted by the Withington District Council for the construction of tramways.

BLACKPOOL, ST. ANNE'S, AND LYTHAM TRAMWAYS BILL.

On Tuesday a House of Commons committee, presided over by Mr. W. Holland, considered this bill, which is promoted by the Blackpool, St. Anne's, and Lytham Tramways Co., and seeks power to construct a double line of tramways between Blackpool and Lytham.

Mr. MELLOR, for the promoters, explained that the company were anxious to increase the powers already conferred upon them. The existing line had been open since 1898, and gas traction had been used, but it was found necessary, owing to the rapid development of St. Anne's-on-Sea and Lytham, to increase the tramway facilities and to adopt electric traction. Negotiations were proceeding with one of the objectors, the Blackpool Corporation, with the object of coming to an agreement. Other objections was to the construction of a double line, but arrangements had been made for widening the road so far as concerned the part affecting the petitioners. At present the trams were permitted to run at eight miles an hour, but the company asked to be allowed to increase this to 12 miles. The Board of Trade had sanctioned the increased speed. After hearing evidence, the committee found the preamble of the bill proved.

HUDDERSFIELD CORPORATION TRAMWAYS BILL.

The Select Committee of the House of Commons, presided over by Mr. Jeffreys, on Tuesday reconsidered the tramway portion of the bill, in respect of which the bill had been recommitted. The tramway extensions to Holmfirth, Holmbridge, New Mill, Mirfield, Kirkburton, Marsden, and Brighouse, were rejected by the committee on the ground principally that the subject of Municipal Trading was about to be considered by a Joint Committee of both Houses of Parliament, and also because they thought the proposal of the Huddersfield Corporation to construct tramways through outside districts, which, although consenting, were not contributing to the cost of the scheme, would infringe some of the rules of Parliament. The Chairman intimated that the House of Commons had now relieved the committee of this difficulty by authorising the committee to reconsider the bill in respect of the tramways lying outside the borough.

Mr. BALFOUR BROWNE, Q.C., for the Corporation, said the opposition of the Lancashire and Yorkshire Railway Co. to the outside tramways had been withdrawn. He cited various precedents in favour of the proposed extensions, including Halifax, Bradford, and Glasgow. If the borough of Huddersfield were not in the centre of the whole district, it was possible that some great traction company might come in and supply the wants of the outside areas, but under present circumstances, with Huddersfield possessing the key to the situation and all the best paying part in the centre, it was impossible for any body to supply the tramways for the outer districts except the Corporation. The Corporation did not want to do that at a loss, and he thought that the committee would be convinced that these tramways could be constructed and worked at a considerable profit. Owing to the introduction of electric traction, a great many difficulties in regard to tramways had been removed. Evidence was then heard, and the committee passed the preamble of the bill in respect to the outside tramways portion, and the bill was ordered to be reported with the tramway extension clauses re-inserted.

MERSEY AND WIRRAL RAILWAY BILLS.

The Committee of the House of Lords, presided over by Lord Morley, on Friday passed the Bills promoted by the Mersey and Wirral Railway Co.'s in which powers are sought to work their undertakings by electricity, and, if found expedient, to form a joint committee for constructing joint generating stations, and the proposed joint committee are empowered to borrow £500,000 for that purpose. In addition the Mersey Co. are empowered to raise £428,750 by the issue of further redeemable debenture stock for their own undertaking, whilst the Wirral Co. also obtain £240,000 additional capital powers.

HALIFAX CORPORATION TRAMWAYS BILL.

A Select Committee of the House of Commons has approved this bill. For the promoters, Mr. BALFOUR BROWNE, Q.C., said the Corporation had worked the existing tramways successfully during the last two years, having made nearly £6,000 profit and earned 7½ per cent. on the capital outlay. The lines already authorised were over 77 miles in length, and the proposed extensions were 10 miles within and 27 miles 6 furlongs outside the borough. The lines would go through 15 urban and rural districts, and the borough of Brighouse, but all the local authorities were in favour of the scheme. The estimated cost of the extensions was £326,800. The tramways carried 7,000,000 passengers per annum.

The CHAIRMAN said the principle of the extension of tramways outside boroughs had already been sanctioned by Committees of Parliament, and the Committee would only require evidence as to the cost of the lines, their local necessity, and the consent of the municipal authorities through whose districts the lines were taken.

Ultimately the clauses were passed by the Committee.

LIVERPOOL OVERHEAD RAILWAY BILL.

As the Liverpool Overhead Railway Co. have inserted new clauses in their bill for powers to supply electricity the Liverpool Corporation have petitioned against the bill.

MUNICIPAL TRADING.

The Lords and Commons Joint Committee on Municipal Trading held their first public sitting on Tuesday. The Earl of Crewe presided, and there were also present Viscount Peel, Lord Rothschild, Sir L. Lyell, Sir W. Foster, Mr. L. Fry, Mr. Grant Lawson, and Mr. Hobhouse.

The first witness called was Sir COURTNEY BOYLE, permanent secretary of the Board of Trade. In cross-examination by the Chairman he said that while gas, water, and tramways were regarded by Parliament as monopolies, electric lighting had always been on a different footing. The Electric Lighting Act of 1888 contemplated competition, and the plan adopted by the Board of Trade, after the passing of that Act, was to permit competition between two bodies of undertakers, but not more. In regard to gas, he could not trace any great advantage to the consumer in point of price in being supplied by a local authority as against a company, but there was a slight advantage.

The CHAIRMAN: As to electric lighting, how many corporations own electric lighting installations?—There is a hiatus in our statistics there. I think that about 300 are authorised, but only about 99 are working, the rest being authorised, but in suspense. Witness went on to say that he did not think he ought to go into the question of the supply of electric power, as a Special Committee of the House of Commons was now engaged in dealing with it. He might say, however, that before the Act of 1888 was passed a considerable number of local authorities obtained electric lighting powers which they did not exercise, and thus kept others out of the field. It was with a view of remedying this state of things that the clause which permitted competition was inserted in the Act of 1888. As to the effect of allowing a local authority to supply electricity outside its own district, he said the result would naturally be to make the local authority a trading company outside its own district. Whether it was desirable that this state of things should be allowed or not he did not express an opinion. Some local authorities had made applications to Parliament for permission to supply electric lighting fittings and other goods to the public. He thought that these applications had a tendency to increase, but the Board of Trade had set their faces against them very strongly. The Board were willing to authorise the supply of machinery if such supply was necessary and incidental to the supply of electricity, but not otherwise. For instance, the provision of a good supply meter (when one was found) might well be entrusted to corporations, but not burners and things of that kind. The wiring of houses for electric lighting had never been entrusted to corporations. The corporation asked for leave to provide and maintain omnibuses in connection with the tramways. That was a new power, and one which had been resisted. Another corporation wished to provide a refrigerator and cold-air store. One wanted to supply bathing tents, and another to provide Turkish baths. At Battersea it was proposed to start a printing establishment, but he did not think it was carried out. Other cases where when powers had been sought to erect dining-rooms and to provide and make a charge for the use of apparatus for games in recreation grounds. He could not tell if there was a municipal authority which owned a dock of its own, but he should be disposed to say there was not. Some municipalities had power to supply electric current outside their own area. The power was either given direct by Parliament or it had been acquired by the absorption of powers possessed by others. Several instances had arisen

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of this transfer of powers. In some instances Parliament had authorised the supply of electricity in bulk to outside districts; but, as a rule, the Board of Trade tried to confine a concession asked for to a given geographical area. He knew of no instance where a forcible transfer had been permitted.

Questioned as to the policy of allowing local authorities to work tramways outside their own boundaries, Sir COURTNEY BOYLE said it was a matter for consideration whether it would not be better to have tramways worked by joint boards, instead of allowing local authorities to go outside their own boundaries. A local authority which made or worked tramways outside its own district became a trader outside that district. If it made a profit, that profit would come out of a district under the jurisdiction of another local authority; while if it incurred a loss, its ratepayers would have to make it good for the benefit of the outside area. The ownership of tramways by municipal bodies was authorised by the Act of 1868; the working of them by those bodies was of comparatively recent date. It began with the passing of the Glasgow Act. After that Huddersfield got power to work its lines because no lessee could be found to take them up. For some years the Board of Trade refused this power to corporations. Then separate applications were made to Parliament, and as the result of a conference between the authorities of Parliament and the Board of Trade it was decided to grant the powers asked for, and the Huddersfield clause was introduced in many cases. There were now, he believed, 17 corporations working their own tramways. The tendency on the part of local authorities to go outside their own areas was a growing one. Circumstances had forced it upon the attention of Parliament, and no definite policy had yet been thought out.

The CHAIRMAN: Do you trace any association between the demand for these powers and the invention of electric traction?

WITNESS: Yes, and if electric traction spreads, as I hope it will, we may expect that tramway systems will become larger than they are—that is to say, that the lines will become larger.

And it is desirable that the supply of electricity should be made from some central point?—Yes.

That, as a matter of fact, is likely to lead to fresh applications being made?—Yes.

Lord ROTHSCHILD: And larger systems being constructed?—Yes. Witness added that, so far as the Board of Trade figures went, they showed that corporations as a whole had done very well in working tramways. He should be sorry if anything he had said in his evidence were construed into a disposition to distrust local authorities. The point he wished to make was merely that when such authorities went out ide their own districts to trade Parliament should consider on what principles, with what limitations, and with what organisation they should act.

Mr. GRANT LAWSON: As an alternative to allowing municipalities to go outside their own areas to extend their tramways, you suggest they might work by joint agreement. How do you suggest that the accounts should be kept in that case?—It would be a difficult matter of adjustment, but I don't think it would be a greater difficulty than is overcome every day by the Clearing-house.

Would you do it by running powers?—I think that would be a very good way of doing it.

Sir L. LYELL: When a municipality buys out an electrical undertaking which is partly within and partly without its own area, what becomes of the statutory right of a local authority to purchase the undertaking outside the municipal area?—It is not destroyed.

Sir W. FOSTER: With reference to the question of tramways outside the area of a municipality, has it occurred to you that in many instances, if some such scheme as you suggest of a joint board to supervise the working of the whole area where not initiated, you would put a great incentive upon a large municipality to extend its boundaries, and to incorporate small local authorities?—That is a point which has not been mentioned to-day, but it has certainly been present to my mind, and it is one that will have to be considered, because I am quite certain there is a tendency on the part of great corporations to grasp outside areas.

The Committee then adjourned till to-day (Friday).

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aldershot.—The Council have determined to carry out the terms of their provisional order and tenders are to be invited for electric lighting plant.

Aylesbury.—A committee was recently appointed to visit the electricity works at Harrow, Windsor, and Wycombe, and to report upon the question of carrying out the provisions of the Aylesbury Electric Lighting order. The committee report that in all the places visited there exists a demand to an extent which will not be equalled in Aylesbury for some time at least, but that unless favourable terms can be obtained from a transferee the proper course will be for the Council to themselves carry out their powers

Battersea (London).—The Vestry on Wednesday resolved to oppose the London County Council Tramways (No. 2) bill in the House of Lords, in order to obtain certain amendments. The Board of Trade recently granted a provisional order to the County of London Co. for a portion of Battersea, and the Special Parliamentary committee reported that they had suggested to the Board that they should impose on the company conditions requiring them eventually to cease supply in those portions of their existing area which, under the re-arrangement of boundaries, will be transferred to the new borough of Battersea. The committee had received a letter from the Board, stating that the matter is not one which can be dealt with in connection with the grant of the order, but that the Board are considering the question of the re-arrangement of the electric lighting areas with the view of making them coincide with the new borough boundaries, and hope to be able to take such steps as will give the Council of the new borough of Battersea full control of the supply of electrical energy within the area under their jurisdiction.

Bermondsey (London).—A report has been prepared by the consulting engineers (Messrs. Kincaid, Waller and Manville) in reference to the specification for the supply of feeders and distributing mains for the Vestry's electric lighting extensions. In their original report they proposed to lay distributing mains for the supply of 4,000 8c.p. lamps alight, and they now suggest that in extending the mains provision should be made for double that number or the equivalent of 10,500 lamps connected to the mains. The total cost of the mains and feeders, together with conduits, street boxes, &c., is put at £6,000. The Electric Lighting committee having considered the report thought it would be desirable to include Long-lane and Southwark-park-road in the streets proposed to be lighted by arc lamps, and that alternative prices should be obtained for the laying of larger mains so that a supply could be given to the whole of the new borough of Bermondsey. The committee had accordingly obtained a further report from the consulting engineers, who estimated that the cost of the additional works would amount to £3,310. The committee recommended the Vestry to approve the reports and to instruct the engineers to prepare a specification, and that tenders be invited for carrying out the works. This recommendation was adopted by the Vestry on Monday.

Bill Withdrawn.—The London, Walthamstow, and Epping Forest Railway Co. (which was to have worked electrically) give notice of intention to promote a bill to authorise them to abandon the railways and works covered by their Acts of 1894 and 1895, and to authorise the dissolution of the company.

Birmingham.—The first report of the Corporation Electric Supply committee was presented on Tuesday. The accounts for the year ended December showed a gross profit of £23,489, an increase of £5,962. 11s. over 1898. There was a steady increase in the demand for electric current, for during the past three months the increase was at the rate of 35 per cent. per month, compared with 30 per per cent. last year. The Birmingham company had set aside annually a certain sum for reserve, and the committee have decided to continue this fund. The amount on Jan. 1 was £25,856. 8s. During 1899 the total units sold amounted to 2,252,692, against 1,722,327 in the previous year, an increase of 30·8 per cent. The lamp and motor additions on the various circuits, reduced to a 16 c.p. factor, amounted to 12,694, bringing the total to 62,705, against 50,011 in 1898, an increase of 25·3 per cent. The gross revenue during 1899 amounted to £43,245. 18s. 9d. against £33,462. 18s. 11d. in 1898, an increase of 29·2 per cent. The committee have decided that, as the financial year of the Corporation ends on March 31, the accounts shall be made up to that date in future. The statements for the last three months show a balance, after providing for interest on the £500,000 loan, of £2,707. 4s., and the committee have decided to apply this balance towards meeting the cost (estimated at £6,200) of relaying certain of the older mains in the centre of the city. The mains laid by the company were of two kinds, copper strips in open culverts, and mains laid in solid bitumen, and the committee have decided to take up the copper strip and employ the solid system. The chairman (Mr. Johnstone) thought the report was one with which the Corporation might be well satisfied, and there was no doubt the electric supply department would take its place alongside the gas department, and in the course of a year or two furnish something in aid of the rates. The report was adopted without discussion.

We have received a copy of the *Birmingham Magazine*, which is described as an "electrical" number. A brief historical *resume* of the events which led up to the introduction of public and private lighting is given, more particularly in connection with their application to Birmingham. This retrospect is followed by an illustrated account of the City of Birmingham electric supply undertaking recently acquired from the Birmingham Electric Supply Co., Limited. The magazine is a very creditable production. It is, however, an expensive publication at 1s.

Boulogne.—The electric tramways established in this popular resort are very prosperous, and the line is at present being extended to Wimereux. Further extensions are projected.

British Columbia.—The Stave Lake Power Co. (Ltd.) has been recently incorporated in Vancouver (Columbia), with a capital of £200,000. The company has acquired a waterfall on the Stave River, 42 miles from Vancouver, where power will be generated and transmitted to that city. The company is about to expend £100,000 on new plant, apparatus and material.

British Institution of Draughtsmen—At the half-yearly meeting of the Council of this Institution, on 14th ult., the resignation of Mr. J. Gillaird, London, as hon. secretary and treasurer, was

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accepted. Mr. C. L. Groundwater, Manchester, and Mr. J. F. Wakeham, Newcastle, were unanimously elected hon. secretary and hon. treasurer respectively. It has been decided to alter the title of the Society from the British Association of Draughtmen to that of British Institution of Draughtsmen.

Cable Manufacture in Spain.—A company, entitled La Sociedad de Cables Electricas de Algorta, has been formed at Algorta, Vizcaya, to establish works for the manufacture of electric cables.

Carthagena (Spain).—A concession has recently been granted for the construction of an electric railway from Carthagena to Cape Palos, passing through the mining and smelting district, with a branch to Portman. Construction works are to commence immediately.

Cheltenham.—The order (see our last issue) recently placed by the Corporation with Messrs. Witting Bros. (Ltd.), 49, Cannon-street, London, E.C., for a standard railway generator has been repeated. Two over-compounded machines are to be supplied, arranged for coupling to Belliss engines, the combined sets furnishing current to a local light railway.

Chicago.—A complete electric lighting and power plant has been put down at the great produce packing establishment of Messrs. Armour and Co. The new plant, which has cost over £200,000, is stated to be the largest isolated set of electrical plant ever put into operation. Ice machines, refrigerators, hoisting contrivances, meat trolley lines, machine shops, &c., are all to be worked by electric motors.

Dalkeith.—Proposals of the Electric Supply Corporation for the erection of electricity works for Dalkeith and Eskbank have been submitted to the Burgh Commissioners, and a committee has been requested to report.

Dover.—The accounts of the Corporation electric tramways for the past year show a profit of £3,155, a considerable increase on the preceding year.

Dunfermline.—A report on the proposal to erect joint electricity supply and refuse destructor works has been prepared by the burgh engineer (Mr. A. W. Bell).

Edinburgh.—On Tuesday the Corporation discussed a recommendation of the Electric Lighting committee that the charge for electric current, from May 15 next be 3¾d. per unit, for each public lamp £13 per annum, and for motor power as at present (1½d. per unit). Bailie Mackenzie said that for the first time it was his duty to ask the Council to raise the charge for electric current for private lighting. They began five years ago with a charge of 6d. per unit. A year later this was reduced to 5d., the following year to 4d., and two years ago to 3½d. Last year there was no change. The circumstances which necessitated the rise were the great increase in the price of coal and the large expenditure put upon the undertaking by the commencement of the new M'Donald-road station. Two years ago, when the present rate of 3½d. was fixed, coal cost 7s. 8d. per ton. This year the price was 12s. 10d., and at M'Donald-road 12s. 6d., which would make a difference on the year's consumption of £7,750. Contracts had been made for three months only, as they were advised that in all probability the price would fall, but meantime it was safest to count on the full price for the whole year. Separating their two stations at Dewar-place and M'Donald-road, and making, as it were, an estimated balance-sheet for each, they come out as follows for 1900-1901: Of the total estimated expenditure of £45,715, M'Donald-road must be debited with £14,599, and of £40,000 for interest and sinking fund the proportion was £11,292, total £25,891. Of the total revenue of £90,000, M'Donald-road could only be credited with £22,900, leaving a loss of £2,991 on that part of the undertaking. On Dewar-place there was an estimated profit of £7,276, leaving only £4 285 surplus profit on the whole undertaking. Some members of the Council had suggested that the rise in the price should be one halfpenny per unit, but the majority of the committee thought otherwise. In view of the resolution of the Council to make up the reserve as soon as convenient, the committee thought a light rise in the price would be sufficient, as undoubtedly the M'Donald-road station as soon as reasonably full would show a balance-sheet similar to Dewar-place, and in all probability coal would fall in price. The Portobello part of the undertaking had shown a loss for the year of £844, and for the coming year it was estimated the loss would be about £700. Some members of the committee expressed a fear that too little provision was being made for reserve, but it should not be overlooked that, of the money spent during the last two years (over £300,000), a large part had been expended on land, buildings, subway, copper strip, and Callender cable; and the machinery and plant obtained in these two years might be said to be only just started, so that in reality it was only the more perishable portions of the early plant that need be considered at the present stage. The recommendation that the public lighting be reduced in price to £13 per lamp was on the understanding that an increase of about 72 lamps was made. With the rise to 3¾d. or even 4d. for light, which would give an average of 3½d. the charge was still about the lowest in the kingdom, there being only four places where the average price was a shade under 3½d. There were, however, 15 places where current for power was 1½d. per unit and under. There had been the most gratifying increase in current for motor power in the last two years. The engineer estimated the output for private consumers this year at 6,000,000 units, and for public lighting 1,300,000—in all, the enormous output of 7,300,000 units. The total 8 c.p. lamps or equivalent at May 15 was 296,569, with about 20,000 more applied for. The number actually joined during the year was 69,832, the largest that they, or, he believed, any other electrical undertaking had ever connected, and over 2,000 more than Glasgow. On the five years' working there had been a total capital expenditure of £595,000. There had been repaid to sinking fund £42,600, to which £20,750 further would be added this year; placed to reserve £14,600, not including this year's surplus; paid to the general improvement account £10,374; paid in local taxation about £10,000, and paid to the general expenses of the City Chambers, &c., £5,387. A large proportion of the latter charge, as well as the £4,451 to be paid for local rates, should be looked upon as a fair return to the ratepayers—as distinct from users of electric light—for the security of the rates. Treasurer Cranston moved an increase to 4d. per unit. Mr. Auldjo Jamieson supported the amendment, and criticised severely the policy of municipalities generally in the piling-up of their public debts. He warned the Council against some of its financial methods, whose tendency was to bind a heavy burden on the ratepayers. By 37 votes to 5 it was decided to reduce the public lighting from £14 to £13 per lamp, and by 29 to 13 to increase the charge per unit for electric energy by one farthing (to 3¾d.).

Electric Traction and Lighting Enterprise in Spain.—Owing to the electric lighting of Corunna being practically a monopoly in the hands of the local gas company, very little advance has been made in installation work, and the charges for current have ruled very high. To obviate this state of affairs the Sociedad Co-operativa Electrica Coruñese has been established to instal and supply electric light for public and private uses at lower rates than have previously prevailed. Besides the Co-operativa Co. another undertaking has been established, with a capital of 2,150,000 pesetas, for supplying electric current in Corunna. This latter company has been established by Bilbao capitalists, and the capital was largely over-subscribed. Water power has been acquired at some distance from Corunna. This undertaking is awaiting final consent from the municipality.

At Villagarcia an electric supply company has been established, entitled La Electra de Segad. This company obtain about 1,000 H.P. from a power station at Caldas de Reyes. The towns of Villagarcia, Carril, Caldas, Cesures, Padron, and Cambados are supplied with electric current by this company. The shareholders are French and Spanish. The lamps used are from Budapest, the cables were manufactured in France and Germany, and the generating machinery is wholly French.

A concession has lately been granted to a German syndicate for the construction of an electric tramway between Cadiz, San Fernando, and Chiclana, the estimated outlay on these works being put at 2,000,000 pesetas (at 35 pesetas to the £=about £57,000). German energy and capital has recently converted the tramway system of Seville from horse to electric traction.

Electric Traction in Australasia.—Mr. W. G. Bingham has obtained a concession from the Adelaide (South Australia) City Council for the construction of electric tramways in Adelaide. A similar concession was recently obtained by Mr. Bingham from the Auckland (New Zealand) Corporation.

Electricity in Baking.—Messrs. J. W. Henderson & Co., South Shields, recently decided to introduce electric machinery for kneading purposes in connection with their bakery. Current is supplied from the town mains to a 2 H.P. electric motor for driving the kneading machine.

Engineering Magazine.—The May issue contains articles on "Electrical Appliances in Military Operations," "Works Management for the Maximum of Production," "Labour Questions in England and America," and "Manufacturers' Associations, Labour Organisations, and Arbitration."

Exhibitions.—An exhibition of electrical novelties and apparatus will be held at Kiel, between June 16 and July 1, in connection with the eighth annual meeting of the Verband Deutscher Elektrotechniker, which will be held in the town between June 17 and 20.

An electrical exhibition will be held in Vienna, in 1903, in connection with the celebration of the twentieth year's existence of the Elektrotechnischer Verein of Vienna. Prof. Carl Schlenk has been designated president.

Fenton.—The Council has been informed by the Hanley Corporation that they could not at present entertain the request to supply electric current to Fenton for a period of 10 years.

French Submarine Cable Exports.—The Société Industrielle des Téléphones exported during 1899, from its extensive works at

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Calais, 220 miles of submarine cable for a destination not given, and also 160 miles for Venezuela and 170 miles for the United States. These exports show a considerable increase over 1898.

Gosforth.—The Council have entered into an agreement with the Newcastle-upon-Tyne Electric Supply Co. for a supply of current in the district, at a price not to exceed that charged in Newcastle.

Govan.—Mr. James Brown, burgh electrical engineer, in a report just presented, approves of the principle of allowing the National Electric Wiring Co. to undertake the wiring of consumers' premises on the easy-payment system on the ground that it would secure an increased demand for current. Mr. Brown, however, considers the charge of 1d. per unit for all current used a high one, and proposes that it shall be 1d. per unit at maximum demand rate, and ½d. per unit after.

Granada (Spain).—It has been decided to erect a colossal cross upon the summit of El Pichacho de la Veleta, and the arms of the monument are to be lighted by electricity in order that the cross may serve as a beacon, and be seen afar at all times both by land and sea. The movement for the erection of this monument is receiving enthusiastic support in Granada and Madrid.

Greenock.—The Corporation have received 53 applications for the position of burgh electrical engineer vacant by the resignation of Mr. S. E. Fedden. This number has been reduced to seven, from whom a final selection will be made.

At present there are 97 customers of the electricity department, representing an equivalent of 6,258 8 c.p. lamps connected for private lighting.

A special meeting of the Police Board will be held on 29th inst. to consider the terms of the agreement for leasing the tramways within the burgh to the Greenock and Port Glasgow Tramways Co. The lease is for 28 years, with option to the board of terminating it at 14 or 21 years on six months' notice. The company bind themselves to reconstruct, equip and maintain their own and the board's tramways, so far as possible, as a double line, to erect the necessary electrical equipment on the overhead trolley system, and to complete the work by May 15, 1901. An annual sum of £1,200 is to be paid as rent in lieu of maintenance of streets, £450 per annum for the 4½ miles of tramway within the burgh, and in addition the cost of repairing all disturbances to the roadway occurring from reconstruction, repairs or renewals of the rails, &c. Also one-third of the net profits on the tramways within the burgh in excess of the cumulative dividend of 6 per cent. per annum on the capital is to be paid to the Board. Electrical energy is to be taken from the Board for working the tramways within the burgh, and so far as the company lawfully may within the adjoining burghs of Port Glasgow and Gourock, one of the conditions being that the company shall pay the board for a minimum supply equal to 500,000 units per annum at 1½d. per unit, the company also to pay for the use of poles erected by the board for street lighting, for the use of feeder-ways, pipes, or other works belonging to the board. The company must maintain a ten minutes service of cars during 16 hours per day, the charges not to exceed 1½d. for each half-mile, and 3d. for the 4½ miles within the burgh, and special service is to be provided for workmen.

Halifax.—The North Bridge Stump Cross electric tramway section has been completed and is ready for Board of Trade inspection. The line will be opened for traffic next week.

Hammersmith (London).—The Electric Lighting committee have issued the accounts of the electricity department for the year ended March 25. The chairman of the committee (Mr. A. Ebbs) stated that the capital expenditure had increased from £72,425. 11s. 6d. to £104,498. 8s. 11d. Of this sum £80,000 is the expenditure for the year to March 25. On this capital the profits have amounted to £5,894. 11s. 6d., equal to a dividend of over 7 per cent., and this notwithstanding the reduction in price of current which took effect last June. The total sales were £13,835. 11s. 4d. Mr. Ebbs said he had hoped they might this year have discontinued the use of the demand indicators, and have made a uniform charge for electricity. There was, however, a doubt whether this might not have increased the demand upon the station plant without corresponding increase of revenue, and also some difficulty in suggesting a fair compensation to long-hour consumers. The committee had, therefore, decided to carry forward the balance of £2,335. 19s. 9d. The quantity of current generated had been 1,247,730 units, sold 891,451 units, used on works 252,389 units. The number of public lamps was 150, and the maximum demand 700 kw. The report of Mr. G. G. Bell, the engineer and manager, states that the number of consumers had increased from 275, with 19,390 8 c.p. lamps, to 464, taking 26,365 8 c.p. The average number of lamps per consumer had decreased from 70 to 56, due mostly to the number of small flats in the parish wired for electric lighting. The department has received £3,375 for lighting and maintaining the 150 street arcs, a reduction from 3¼d. per unit to 2·9d. per unit; 63 additional arcs were added during the year. For private lighting the 620,078 units sold produced a revenue of £10,274. 5s. 7d., or barely 4d. per unit. The average lighting hours of the lamps had increased from 840 to 900 per annum, but owing to the reduction of practically ½d. per unit in the price, the annual revenue per lamp had been 9s. against 10s. 10d. the price paid for current in Hammersmith being the lowest but one in the London district. The total cost of generation, distribution, &c., was £7,764. 14s. 11d, or 2·05 per unit, a decrease of nearly ½d. per unit, being 56·5 per cent. of the revenue, leaving a gross profit of £5,974. 0s. 10d., or 43·5 per cent. towards interest and sinking fund charges. The result of the year's working was a net profit of £1,615. 4s. 8d., after deduction of interest and repayment of capital. The machinery now installed and in working condition is equal to supply a further 10,000 8 c.p. lamps, allowing ample margin for reserve.

Hunslet.—The District Council have been asked to sanction an application for a provisional order.

Ilkeston.—An inquiry was held last week into the application of the Council to borrow £18,271 for electric lighting. The town clerk (Mr. W. Lissett) said that in 1899 provisional orders were obtained to authorise electricity supply, and also to construct tramways. The present loan was for electric lighting. The estimated cost of the generating station was £28,452, and this was to be divided equally between the tramways and electric lighting schemes. This showed £14,226 to come out of the loan applied for that day, the balance of £4,045 being for the laying of mains, &c. The consulting engineer (Mr. V. B. D. Cooper) gave technical details, and pointed out that it was intended to erect a refuse destructor. The cost of generation would not exceed 2d. per unit. The number of lamps already applied for was equivalent to 3,100 8 c.p. He had no doubt that in a short time the whole of the 6,000 lamps, the capacity of the proposed station, would be taken up.

Insurance.—The Shoreditch Vestry are about to issue invitations to the metropolitan local authorities to appoint delegates to attend a conference to consider the question of municipal fire insurance. The letter states that the Vestry have recently had under consideration the large premiums exacted for insurance, especially for electricity works, and as they now pay £450 per annum for insurance, the sum total of municipal insurance of local authorities in London must have reached an amount sufficiently large to warrant the establishment of some scheme for mutual insurance with every prospect of success. The Corporations of Glasgow and Nottingham obtained in 1898 power to insure their own property, and a combination including the large number of municipal properties in London would (the Vestry urges) seem to offer special chances of success, and reduction of the present premiums. The Vestry have accordingly decided to call a conference of metropolitan local authorities to discuss this question, and the best means of carrying into effect some such scheme.

Inverness.—A special meeting of the Council was held on Tuesday to consider the question of tenders for electric lighting plant. It will be remembered that the consulting engineer (Mr. E. G. Craven) recently recommended the acceptance of the tender of the Brush Co. for the supply of the whole of the generating plant, but the Council referred the matter back for further consideration as they thought that by letting the tenders in sections a saving would be effected. After a discussion, which lasted over three hours, it was decided, on the motion of Provost McBean, to refer Mr. Craven's scheme to a neural expert for report.

Jaroslaw (Russia).—A company, entitled the Société des Tramways de Jaroslaw, has been formed in Belgium, under the auspices of the Compagnie Generale de Traction et d'Electricité, with a capital of £100,000, for constructing electric tramways in this town.

Keighley.—An inquiry was held here on Wednesday into the application of the Corporation to borrow £45,000 for electric lighting. There was no opposition.

Kilmarnock.—The question of a site for the proposed electricity works has been referred back to the Electric Lighting committee for further consideration. At a special meeting of the Council last week the consulting engineer (Mr. W. A. Bryson) submitted plans and specifications of his electric lighting scheme. Discussion arose as to the suitability of the proposed site at Riverbank, Riccarton. Mr. Bryson stated that the site would involve an increased cost of about £2,000 for copper compared with a more central site, but the buildings could be easily altered to suit the electricity station.

Lewes.—The Corporate seal has been fixed to the deed of transfer of the Lewes electric lighting order to the County of Sussex Electric Power Distribution Co.

Light Railway Orders.—The Light Railway Commissioners have submitted the Gateshead and District Light Railways order to the Board of Trade for confirmation. Objections by June 9.

The Board of Trade have approved the Cheltenham (extension) light electric railway order.

Light Railways.—An inquiry was held on Monday at Westminster by the Light Railway Commissioners into the application of the Middlesex County Council for permission to construct electric tramways from Harlesden, through Sudbury, Wembley, and Harrow on the one side, and from Southgate to Finchley on the other. The total length of the lines is about seven miles, and the cost of con-

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struction and equipment was estimated at £117,000. Evidence having been given in support of the scheme, the Council withdrew two schemes for lines from Harrow to Watford, and Mr. Cripps, Q.C. (who appeared for the Council) incidentally mentioned that the differences between the Council and the North Metropolitan Tramways Co. (who were joint promoters of the scheme which the Commissioners had passed) would soon be settled. The inquiry was adjourned, the chairman stating that the Harlesden to Stonebridge section was passed.

An inquiry will be held at Leeds on June 7 into the application of the British Electric Traction Co. to construct light electric railways in certain districts of the West Riding of Yorks. One of the applications refers to Morley and district, another is for an extension of the Spen Valley, Dewsbury, and Ravensthorpe tramway scheme by constructing a line from Cleckheaton to Hightown, and to extend the projected line in Dewsbury through Savile Town, Thornhill Lees, and Thornhill, to the Combs.

The International Electric Traction and Power Syndicate propose to apply for powers to construct a light (electric) railway between Warrington and Runcorn.

Lincoln.—An inquiry was held here on Friday into the application of the Corporation to borrow £6,000 for electric lighting extensions. The deputy town clerk said that two loans had already been sanctioned—£20,650 in 1897 and £19,000 in 1899, of which £4,500 was still unexpended. The present loan was for laying cables in the southern part of the city. There are at present 200 customers of the electricity department, and the capacity of the station is about 18,000 8 c.p. lamps. The city electrical engineer (Mr. C. S. Vesey Brown) gave technical details.

Lissa (Austria).—The Gubavica Falls, near Almissa, on the Cetina, which, when regulated, will supply many thousand horse-power, is being regulated by a Vienna company. Already numerous applications for water power for industrial purposes have been made, and as the Government has lately constructed a fine iron bridge on the Cetina and made good roads in the adjacent district, a large development of this extensive source of power is likely to follow immediately. The industries in this neighbourhood are chiefly in the hands of foreigners, on account of want of local capital and enterprise.

London County Council.—At Tuesday's meeting the recommendations to double the existing tramway lines at Battersea, Wandsworth, &c., and to construct them for electric traction, as mentioned in our last issue, were approved, as was also the recommendation not to appeal against the decision of the Light Railway Commissioners in respect to the Council's application for powers to construct light railways at Deptford, Shooters Hill, Lewisham, and Clapham.

The Highways committee reported that in view of the probability of the London County Tramways (Electrical Power) bill becoming law this session, they had in preparation the specification and form of contract for the supply of rails, &c., which would be required in connection with the reconstruction of two sections of the Council's tramways (Westminster Bridge and Tooting, and Blackfriars Bridge and Kennington). Having consulted Prof. A. B. W Kennedy and Sir David Dale, the committee recommended that, as regards contracts for the supply of the rails, fish-plates, &c., required in connection with the reconstruction of existing, and the construction of new, tramways, the operation of the Council's standing order No. 212 be suspended so far as to permit of the omission of the usual clauses relative to hours and wages, and the insertion of a special clause as follows:—

All wages to workmen for work executed under this contract must be paid at the rates arranged between the employers and workmen in the rail trade in that part of the country where the order is placed. The Council reserves power to cancel this contract, so far as relates to any part of the articles specified therein not totally or partially manufactured, at any time on one week's notice, should it be proved to the satisfaction of the Council, after hearing both parties, that lower rates than the standard rates of the district have been, or are being, paid in the execution of this contract.

This was agreed to.

Long Distance Telephony.—It is announced that telephonic communication will shortly be established between St. Petersburg and Warsaw.

Lynn.—A loan of £2,500 has been sanctioned for electric lighting extensions.

Manly (N.S.W.).—The Council have resolved to ascertain the cost of lighting the district electrically, as the contract for gas lighting is about to expire.

Melrose.—Proposals for the erection of electricity works having been submitted to the Burgh Commissioners by Messrs. Crompton and Co., a deputation has been appointed to visit Edinburgh to obtain information on electric lighting matters.

Municipal Telephony.—The Belfast Law and Improvements committee are considering the advisability of establishing a municipal telephone exchange.

Municipal Trading.—The Association of Trade Protection Societies discussed the question of Municipal Trading at their annual meeting last week. A motion was submitted on behalf of the Leicester Society in condemnation of Municipal Trading, but Ald. Southern (Manchester) proposed an amendment to the effect that any enterprise requiring interference with public streets, such as gas, water, electricity, hydraulic power, or telephones, should be in the hands of municipalities, but that it was undesirable for municipalities to indulge in retail trade. After discussion the original resolution was withdrawn and the amendment was agreed to.

Palestine.—So far neither the electric light nor gas has been introduced into Palestine. Paraffin lighting affords the chief means of illumination, supplemented by a small supply of candles. Owing to the development of the orange-growing industry and the continued increase in the value of general exports, the wealth of Palestine is rapidly increasing.

Portsmouth.—An inquiry was held last week into the Corporation application to borrow £9,775 for electric lighting extensions. Ald. Ellis explained that the loan was required chiefly for main extensions. The demand for current was steadily increasing, and during the past year they had connected up the equivalent of 14,000 8 c.p. lamps. Technical evidence was given by the superintendent (Mr. E. Price). There was no opposition.

Railway Station Lighting in Germany.—The Rhenish-Westphalian Electricitäts Gesellschaft has secured a contract from the Prussian State Railway authorities for the electric lighting of all the railway stations in the Essen district.

Redcar.—A special meeting of the District Council was held last week to consider a proposal to erect electricity works. Mr. Eldridge, electrical engineer of the Tees Union Shipping Co., attended and advised the council to construct electric tramways in addition to supplying electric current for lighting. The joint scheme would, he said, undoubtedly prove remunerative. The consideration of the matter was adjourned.

Rosario (Argentina).—There is every probability that the tramway lines in this city will shortly be converted to electric traction, a joint stock undertaking with British capital having arranged with the present owners for the purchase of the lines. The Municipality have been asked to grant the company a concession, and upon the satisfactory completion of the negotiations in this matter depends the early conversion of the lines to electrical working.

St. Louis, Mo. (U.S.A.).—There are 450 miles of single track of electric and cable street railroads in this city, the greater portion of which is electric or is being converted to electric traction.

St. Martin-in-the-Fields (London).—The streets in this district, including the Strand, Haymarket, Trafalgar-square, and Leicester-square, are now lighted electrically. The annual cost of lighting the parish will be £1,362 for the first seven years, and £561 more than the present cost of gas thereafter. The illuminating power of the arc lamps is 79,000 c.p. more than the old gas lamps. Current is supplied by the Charing Cross and Strand Corporation.

Salford.—At the Corporation meeting on Friday a letter from Mr. C. L. Turner, borough electrical engineer, was read:—

Mr. Turner stated that he was unable to comply with the Council's request that he should resign his office, as he could not see any reason why he should resign. He knew that the charges brought against him were without foundation, and he considered that the evidence he produced to the Special committee was sufficient to disprove them. If the Council thought otherwise they must act accordingly.

The mayor (Ald. Rudman) then moved that in view of Mr. Turner's refusal to comply with the resolution of the Council requiring him to resign forthwith, the Council hereby determined his appointment and instructed the borough treasurer to pay Mr. Turner three months' salary in lieu of notice. Ald. Phillips seconded. Ald. Mandley did not think this action was quite judicious. Either Mr. Turner had been guilty of acts which justified the Council in dismissing him or he had not. If he had not done the things alleged against him the Council would be doing him a great injustice by turning him away in this manner. If he had done what had been charged against him it was an absurdity to give him three months' salary. Mr. Desquesnes thought it the best way out of the difficulty. If they dismissed Mr. Turner without notice or salary in lieu of notice they would render themselves liable to an action at law. It was, therefore, best to adopt the plan now recommended. Mr. G. H. Jones expressed his belief in Mr. Turner's innocence, and urged that in simple fairness they should give Mr. Turner the opportuity of clearing himself or justifying the Corporation's action in dismissing him. The resolution was adopted with three dissentients. Mr. Haworth subsequently made a personal statement in reply to a question.

The electric lighting accounts were presented at the Corporation meeting on Friday. There was a deficiency of £2,028 on the year's working, against £859 in 1898, an increase of £1,169 to be rated for this year. Of this increase about £800 was calculated to belong to the interest on loans and sinking fund and preliminary expenditure chargeable to revenue with respect to the new electricity station, &c. The Tramways committee, instead of estimating to hand over a sum of £591, estimated to require £2,014, making a total extra requirement of £2,605. This was necessitated by the provision required to

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be made for loans to meet the expenditure now being incurred on new electric tramways.

Scarborough.—The Streets and Buildings committee have decided to obtain a report from a consulting engineer as to the construction of an electric tramway from the top of the North Cliff to Clarence Drive.

Sheffield District Railway.—On Monday the Duke of Portland opened the new Sheffield District Railway, part of an important new line running, or ultimately to run, from Attercliffe, Sheffield, to Sutton-on-Sea, Lincs. The Sheffield District Railway forms part of the Lancashire, Derbyshire, and East Coast Railway (known as the "Dukeries" route) which will join at Lincoln the Lincoln and East Coast Railway, which again joins up the Great Northern system on to Sutton-on-Sea, Lincs. This L.D. and E.C. line taps a very important district, and is not without interest in connection with the electric power bills now before Parliament. By the completion of the Sheffield District Railway a new main road between Sheffield and London is opened, and access is given to a district in which is situate some of the most famous historic homes of England. At Attercliffe a goods station of over 40 acres in extent has been erected in the immediate neighbourhood of many of the largest engineering firms of the country, including Hadfields, Vickers, Son and Maxim, John Brown and Co., Hawksleys, &c. Mr. H. Willmott, general manager of the L.D. and E.C. Railway is also general manager of the Sheffield District line. Mr. R. Elliott Cooper, chief engineer of the L.D. and E.C. Railway, and Mr. J. Wilson, of the Great Eastern Railway, have designed the works, which have been carried out under the supervision of Mr. E. O. Ferguson, resident engineer. The contractor is Mr. C. J. Wills, of London and Manchester.

Siam.—There are 26 rice mills at Bangkok, seven of which have independent electric lighting plants. The generating plant and apparatus is chiefly British. Another important industry of this district is the teak wood sawmills. Three of these mills are lighted electrically by independent plants of British manufacture. This is in addition to the old-established installation for lighting the city of Bangkok and for the supply of current for domestic purposes. The city has also two power stations for the electric tramway system, which has become firmly established in public favour in this comparatively up-to-date Asiatic city.

Surbiton.—A site for an electricity generating station has been purchased by the District Council.

Syra (Greece).—The public lighting of this town has been carried out by the Hellenic Electric Co., of Athens, an undertaking allied with the French Thomson-Houston Co. The Hellenic Co. is providing installations for public and private lighting in Athens, the Piræus, Patras, Calamata, and the Ionian Islands. The concession for Syra has been granted for 45 years by the municipality, who, for public lighting, have contracted for 200 16 c.p. and 200 10 c.p. incandescents and for a number of 500-c.p. arcs, at a total charge of £950 per annum at current exchange. The generating plant at the Syra station consists of Babcock and Wilcox boilers, Escher-Wyss engines and Thomson-Houston dynamos. The electric light is proving a serious rival to the acetylene gas undertaking established last year, the charge for electric current being about on a par with that charged for the acetylene gas lighting.

Telegraph Rates to India.—It is quite refreshing to record the proceedings at a meeting of the directors of the Glasgow Chamber of Commerce. Usually at meetings of Chambers of Commerce the subject of the reduction of telegraph rates is discussed without any regard to whether the drastic reductions recommended by members can or cannot possibly be made. At Glasgow, however, Mr. John Galloway was able to put the matter forcibly and logically before the directors when dealing with a draft memorial to be presented to the Postmaster-General on the subject of reduction of rates between this country and India. Mr. Galloway said he was in agreement with the committee in the desirability of securing a reduction in the telegraph rates to India. He objected, however, to endorsing the view of the Liverpool Chamber, quoted in the memorial, that the rate ought to be reduced from 4s. to 1s. a word. Before they could take such a position they would require to take into consideration the amount of capital involved in the laying down of telegraph cables, the amount of working expenses, the risks of breakage of cables, and the cost of upkeep. The Glasgow Chamber, he thought, would be placing themselves in an exceedingly wrong position if they were to endorse the view of the Liverpool Chamber. It would be sufficient to frame the memorial to the Postmaster-General in general terms. He further urged that it should not be taken for granted that the companies intended to maintain the present rate of 4s. per word. Official communications had been received from the Eastern Telegraph Co. by the Chamber stating that they were willing to reduce the rate to 2s. 6d. a word, even though the Government did nothing in the way of providing a subsidy. He thought that the memorial should be altered in these respects. Mr. W. F. G. Anderson asked why the companies had not made the reduction if they were willing to do it. Mr. Galloway said that negotiations had been going on for two years. Meantime the companies were waiting to see if the Government would meet them and help them to reduce it still further. It was agreed to adopt Mr. Galloway's suggestion and to frame a memorial in general terms.

Telegraphic Communication with Germany.—In the preamble of the bill laid before the German Federal Council for the laying of a fifth submarine telegraph cable from Germany to England, the following particulars are given regarding the steady increase of traffic. The number of telegrams amounted in 1895 to 1,867,868, and in 1899 to 2,465,613, an increase of 32 per cent, of which nearly 13 per cent. was in 1899 alone. In consequence, the lines are so overburdened that in commercial circles complaints are frequent, and Bremen especially claims better telegraphic communication with Liverpool, in the interests of the German cotton industry. The Bremen Cotton Exchange has had to make use of the roundabout and expensive route *viâ* New York to get its market telegrams from Liverpool, and has in this way received them two hours earlier than *via* London. The new cable of four conductors is to start from Borkum and end at Bacton.

Telephone at Manchester.—Ald. Southern has resigned the chairmanship of the Manchester Special Telephone committee. In the letter communicating his decision to resign, Ald. Southern states that he does so because he feels he will be able to do better service to the cause of cheap and efficient telephony by no longer remaining a member. He is of opinion that this cause would be best served by municipal exchanges within urban areas, the trunk lines being worked by the Post Office department, with free interchange of terminal facilities. But on this question Manchester is in a different position from any other town. The City Council had approved the application of a competing company for a licence within the Manchester area. It had been decided by the committee to purchase (if possible on reasonable terms) the Manchester exchange of the National Telephone Co., and that company had been asked whether it was willing to sell and upon what terms, it being the purpose of those who recommend this course to also recommend that any injustice done to the Mutual Co. should be recompensed by a pecuniary consideration. It appeared to him (Ald. Southern) that the National Co. could prolong the present state of things for almost any period they chose, and he regarded this as intolerably unfair alike to those citizens who were wishful for a more efficient and cheaper telephone service and to those who, encouraged by the attitude towards them of the Corporation, had incurred serious responsibilies in their efforts to supply a competing system affording those qualities of efficiency and cheapness which were desirable. This letter will come before the Council at its next meeting.

Telephonic Communication with the Continent.—The following communication has been received by the Secretary of the Association of Chambers of Commerce in the United Kingdom from the Postmaster-General:—

"The obstacle to the establishment of telephonic communication with countries other than France has consisted in the fact that it has not hitherto been found possible to devise a type of cable which would render conversation practicable across stretches of water much wider than the Straits of Dover. Various types of cables were devised and tested, and ultimately a cable, constructed on a new and apparently very promising principle, was laid between North Wales and Ireland, in the hope that the experience thus acquired would enable this Department to make practical proposals for telephonic cables to Belgium and the Netherlands Unfortunately, however, the experiment proved unsuccessful from a telephonic point of view; and, while the problem is still being closely studied, it cannot be said that a solution is in sight. In these circumstances, the Postmaster-General is unable to hold out the prospect of the establishment of telephonic communication with the Continent generally at an early date, but he will continue to give the matter his best attention, and meanwhile he is negotiating with the French and Belgian Administrations with a view to the establishment of a telephonic service through France to Brussels and Antwerp."

The Hague.—The Elektricitäts Actien-Gesellschaft Schuckert and Co., Nuremberg, have obtained the contract for the conversion of the local tramways to electric lines.

Trowbridge.—The Lighting committee have been requested to report upon the desirability of obtaining electric lighting powers.

Twickenham.—The Twickenham and Teddington Electric Lighting Co. have obtained a provisional order for this district.

Watford.—The demand for electric current is so great that the electrical engineer (Mr. W. H. Colebrook) has been directed to inquire as to whether secondhand or other supplemental plant can be obtained to meet the extra supply through the winter, and to report how long it will take to obtain permanent plant. In view of the absolute necessity for the provision of additional plant, a resolution, passed in October last, that no further extension of mains be carried out until the Council have completed all the works in hand, has been rescinded.

Yeadon.—The Board of Trade has been asked to extend the time for complying with the Yeadon provisional order, obtained in 1894, and the Leeds Council have been asked for terms for supplying electricity in bulk for lighting and traction in the district.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Durban (Natal) Corporation invite tenders for (*a*) the supply, delivery and erection of the overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, &c. ; (*b*) the supply, delivery and erection of 22 double-deck motor cars complete ; (*c*) the supply and erection of electricity generating plant, including three 250 kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, &c. Further particulars are set out in an advertisement, and specifications may be obtained from the agents to the Corporation (Messrs. Webster, Steel and Co.), 5, East India-avenue, Leadenhall-street, London, E.C., after 29th inst. Tenders in duplicate must be delivered to the agents by June 29, or to the town clerk of Durban by mail delivery on or about Monday, July 23.

South London Electric Supply Corporation invite tenders for a complete installation of 3,000 lights on the premises of 500 consumers in any part of the company's area of supply, and also for the installation of two arc lights on the premises of any consumer in the same area. Specifications may be obtained from the secretary (Mr. H. H. Boyer), 54, Bengeworth-road, Loughborough Junction, London, S.E., and tenders must be in by Saturday, June 2. See advertisement.

Dundee Town Council require tenders for the overhead equipment of four electric tramway routes particulars of which are set out in an advertisement. Specifications, &c., may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), and tenders must be lodged with the town clerk (Sir Thomas Thornton, LL. D.), City Chambers, Dundee, by 31st inst.

Dundee Gas Commissioners invite tenders for small coal and electricity meters. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders must be delivered to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 31st inst. See advertisement.

Sutton Coldfield Corporation invite tenders for the supply and erection of electricity generating plant, particulars of which are set out in an advertisement. Specification may be obtained (after 24th inst.) at the offices of the town clerk (Mr. Thos. V. Holbeche). The contracts will be carried out in accordance with the plans and specification of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E C, from whom further information can be obtained after 24th inst. Tenders must be delivered to Mr. Holbeche before noon of June 21.

Manchester Tramways committee invite tenders for the overhead equipment of three tramway routes. Specification may be obtained from the general manager (Mr. J. M. McElroy), tramways department, Town Hall, Manchester, and tenders (addressed to chairman) must be in by June 9. See also advertisement.

Bootle Corporation invite tenders for supply and laying of underground electric cables, erection of arc lamps, and the supply of mechanical stokers. An advertisement contains further particulars, and specifications may be obtained from the borough electrical engineer (Mr. W. R. Wright). Tenders to the town clerk (Mr. J. Henry Farmer) before June 16.

Chester Corporation invite tenders for steam, exhaust, feed-suction, condensing water pipes and valves. An advertisement gives further particulars, and the specification may be obtained from the city electrical engineer (Mr. F. Thursfield). Tenders to town clerk (Mr. S. Smith) by 10 a.m. of June 4.

North-Eastern Railway Co. invite tenders for telegraph apparatus, telegraph wire, and line stores. Forms of tender can be obtained from Mr. A. Graves, telegraph department, York, and tenders must be sent to the secretary (Mr. C. N. Wilkinson), York, by June 4. See advertisement.

St. Pancras (London) Vestry invite tenders for re-arranging and making additions to bare copper strip conductors. Specification may be obtained at the offices of the Electricity department, 57, Pratt-street, N.W., and tenders must be sent to the vestry clerk (Mr. C. H. F. Barrett) by noon on Friday, June 7. An advertisement contains further particulars.

Bradford Corporation require tenders for the supply and erection of a switchboard, or for alterations to existing switchboard, at the Valley-road electricity works. Specification can be obtained from the city electrical engineer (Mr. R A. Chattock), Town Hall, and tenders must be sent to the town clerk (Mr. Frederick Stevens), by June 7. An advertisement contains additional particulars.

Bradford Corporation require tenders for coal-conveying apparatus, hoppers and ash-conveying apparatus for their Valley-road electricity works. Tenders to town clerk (Mr. Frederick Stevens) by 31st inst.

Corporation of *London* Streets committee invite tenders for the supply on hire of electrically-driven dust carts. Tenders to town clerk (Sir John B. Monckton), Guildhall, E.C., by June 1. See advertisement.

Messrs. Andrew Barclay, Sons and Co. (Ltd.), Caledonia Works, Kilmarnock, require tenders for a 60 kw. (or 80 kw.) dynamo. Tenders by Wednesday, 30th inst. See advertisement.

Sleaford Council invite tenders for electric lighting plant. Tenders to clerk by June 12.

Ealing District Council invite tenders for a storage battery and a steam alternator. Tenders to clerk by June 11.

The Provost, Magistrates, and Commissioners of the burgh of *Partick* invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught furnaces. Tenders to Mr. Jas. Donaldson, town clerk, 97, West Regent-street, Glasgow, by noon of June 8.

Leeds Lighting committee invite tenders for two or three 630 kw. two-phase generators and one or two sets of surface condensing plant. Tenders to town clerk (Mr. W. J. Jeeves) by 10 a.m. of 28th inst.

Great Grimsby Corporation invite tenders for the supply and delivery of arc lamp posts and brackets. Tenders to town clerk (Mr. W. Grange), St. Mary's Gate, Grimsby, by June 1.

Great Grimsby Corporation also invite tenders for the supply and delivery of electricity meters. Tenders to Mr. Grange by June 1.

Newcastle-upon-Tyne Tramways committee invite tenders for pumping apparatus. Tenders to town clerk (Mr. Hill Motum) by June 1.

Fulham (London) Vestry require tenders for the wiring of their electric lighting works. Tenders to Mr. W. J. H. Denselow, clerk, Town Hall, Walham Green, S.W., by June 4.

London County Council's Asylums committee invite tenders for the installation of electric lighting and power (except generating plant) and the installation of telephones, tell-tale clocks, fire alarms and call bells at the Horton Asylum, near Epsom, Surrey. Tenders to the committee, 6, Waterloo-place, S.W., by 10 a.m , June 16.

Walthamstow District Council invite tenders for the supply and erection of arc lamp posts and accessories and glow lamps on posts and on existing gas standards. Tenders to clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m. 29th inst.

Southampton Corporation invite tenders for a water-tube boiler with steam and other pipes and sundry ironwork. Tenders to town clerk (Mr. R. R. Linthorne) by 28th inst.

Bridgwater Town Council invite tenders for the supply and erection of electricity generating plant. Tenders to town clerk (Mr. W. T. Baker) before 3 p.m. on June 7th.

Glasgow Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders to town clerk (Sir J. D. Marwick) before10 a.m., June 12.

Wolverhampton Tramways committee invite tenders for the construction of nearly two miles of tramway. Tenders by June 26.

Tenders are invited for wiring the *Leeds* Central Fire Station. Tenders to town clerk by 28th inst.

Heywood Council invite tenders for the erection of electricity station buildings. Tenders by 28th inst.

Luton Town Council require tenders for the erection of electricity station buildings. Tenders by June 18.

Swedish Telegraph Administration invite tenders until 28th inst. for 10,000 metres of copper wire.

Alexandria (Egypt) Harbour Authorities invite tenders until July 1 for supply and erection of electric lighting plant at Port Said harbour.

Tenders are invited until June 4 by the municipal authorities of *Fuente de Cantos* (Badajoz, Spain), for the electric lighting concession for 20 years. Tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

Walsall County Council have accepted the tender of the Electrical Power Storage Co. for repairing and renewing the storage battery at the St. George's Hill transformer station for £495, and that of Mr. A. Lynex for engine and boiler foundations for £190. 15s.

Barnes District Council have accepted the tender of Messrs. G. Munday and Sons for the erection of electricity station buildings at £5,719.

Kingston-on-Thames Town Council have accepted the tender of Mr. T. Robinson for foundations for new steam alternator at £150.

Hertfordshire County Council have accepted the tender of Messrs. Hayward Tyler and Co. for the electric lighting of the Isolation Hospital at the Hill End Lunatic Asylum for £254. 13s. 6d.

Walthamstow District Council have accepted the tender of the W. T. Henley's Co. for supplying and laying mains and cables at £10,658. 18s. 6d.

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Subject to approval of the Local Government Board, the Visiting committee of the Northumberland Lunatic Asylum have accepted the tender of Messrs. McAulay, Clark and McLaren, Glasgow, for the electric lighting of the asylum to the specification of Mr. A. A. Campbell Swinton. Thirty-one tenders were received.

The Bermondsey (London) Vestry have accepted the tender of Messrs. Hughes and Stirling for the erection of the chimney shaft at the electric light and refuse destructor works for £2,581. The tender of the same firm was recently accepted by the Vestry for the refuse destructor and boilers.

APPOINTMENTS VACANT AND FILLED.

An assistant lecturer and demonstrator in electrical engineering is required for the University College of North Wales, Bangor. Applications to the secretary and registrar (Mr. J. Lloyd, M.A.), not later than June 9. See advertisement.

A head-master is required for the Industrial School, Lucknow, India. Some additional information is given in an advertisement. Forms of application and further particulars can be obtained from the Director-General of Stores, India Office, Whitehall, London, S.W.

Brighton Corporation require an engineer in connection with their proposed electric tramway scheme. An advertisement contains further particulars, and applications must reach the town clerk (Mr. F. J. Tillstone), Town Hall, Brighton, before 10 a.m. on June 8.

The Belfast Electric committee require an engineer-in-charge and a junior assistant for their electricity works. Applications to city electrical engineer (Mr. Victor A. H. McCowen) by June 5. See advertisement.

The engineer to the Bury electricity works (Mr. S. J. Watson) has a vacancy for an improver. See advertisement.

A shift engineer and an engine driver are wanted at the Stafford electricity works. Applications to manager (Mr. J. F. Bell). See advertisement.

There is a vacancy for an improver at the Dundee electric light and traction station, of which particulars will be found in an advertisement elsewhere.

Johnson and Phillips' Electric Cable Works, Old Charlton, Kent, require a draughtsman and a shop foreman for their additional lead-covering cable factories. Particulars will be found in an advertisement on another page.

Southport Corporation require a manager for their tramways. Applications to town clerk (Mr. J. Ernest Jarratt), Town Hall, Southport, by 28th inst.

An assistant engineer is wanted at the Shrewsbury electricity works. Applications to town clerk by 31st inst.

Cardiff Corporation invite applications for the appointment of a tramways electrical engineer, at a commencing salary of £500 per annum. Applications to Mr. J. L. Wheatley, Town Hall, Cardiff, by June 1.

There is a vacancy for an assistant superintendent in the telegraph department of the Government of India. Further particulars may be obtained on application to the India Office, and applications should be sent to the Secretary, Public Works Department, India Office, Whitehall, London, S.W., by June 30.

Mr. Robert Maclean, local manager of the National Telephone Co., at Cardiff, has been appointed local manager to the State of Guernsey telephone exchange.

Mr. J. L. Chambers, engineer of the National Telephone Co., at Nottingham, has been appointed outside superintendent to the Glasgow Corporation telephone exchange.

Mr. G. S. Maben, assistant electrical engineer to the Belfast Corporation, has been selected for the post of chief assistant to the superintendent engineer at Bradford Corporation electricity works. The appointment is subject to ratification by the Council.

BUSINESS NOTICES.

Messrs. John Webster and Joshua Ellis (trading as Webster and Co.), electrical engineers, Queen's Arcade, Leeds, have dissolved partnership. Debts by Mr. Webster, who continues under the old title.

Messrs. A. W. Isenthal and C. P. F. M. Potzler, trading as Isenthal, Potzler and Co., electrical engineers, &c., 85, Mortimer-street, London, W., have dissolved partnership. Debts by Mr. Isenthal, who continues as Isenthal and Co.

Messrs. Johnson and Phillips' Electric Cable Works, ask us to state that Mr. T. M. Harvey left their employ on 19th inst.

Messrs. Browett, Lindley and Co. (1899) (Ltd.) have opened London offices at 6, Old Queen-street, Westminster, S.W. Mr. Thos. Browett, joint managing director, is in charge of the London office.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Universal Electrical Advertising Syndicate (Ltd.) is to be wound up voluntarily, and Mr. T. G. Mellors, King John's Chambers, Nottingham, is liquidator.

A second and final dividend (9½d.) will be payable on 30th inst. or any subsequent Wednesday, between ten and one, at Messrs. Pratt, Norton and Co.'s, 9, Old Jewry-chambers, E.C., in the failure of S. G. Trehearne and A. H. Crump (trading as Trehearne, Son and Crump), electrical engineers, &c., 155, Fenchurch-street, London, E.C.

Winding-up Petition.—A petition for the winding-up of the River Plate Electric Light and Traction Co. (Ltd.), will be heard in the High Court on 30th inst.

Businesses for Disposal.—An electric lighting business in a town on the north-east coast is advertised for sale in another column.

An electrical engineering business is advertised for sale in another column. The works are conveniently situated within 10 minutes of London.

For Sale.—A leasehold factory and about four acres of land, situated in Essex, and about 12 miles from London, together with tools and plant and surplus stock, are offered for sale by private tender. Further particulars are set out in an advertisement. Tenders must be sent (by June 19) to Messrs. Sydney Lee, and Co. (Ltd.), 9, Furnival-street, Holborn, London, E.C., from whom forms of tender and conditions of sale may be obtained.

"Simplex" Steel Conduit System.—A neat pamphlet setting out a list of some of the more important electric lighting installations where the Simplex Steel Conduit Co.'s system has been adopted during 1898-1900 is issued, and gives some idea of the extent to which this company's system has been employed in work of a very varying character. The pamphlet chiefly consists of testimonials from those who have installed and those who have used these fittings, and are all of a very satisfactory character.

Electrical Accessories Catalogue.—Messrs. D. H. Bonnella and Son (Ltd.), of 58 and 60, Mortimer-street, London, W., have just issued a useful price list of electric bells and accessories, and sections L and T of their main catalogue of electric light accessories and telephones and accessories respectively. These lists are very fully illustrated, and can be profitably consulted for a large variety of apparatus and sundries for use in electric lighting work, medical electricity, domestic appliances, telephone installations (public and private), &c. Messrs. Bonnella and Son are actual makers, and have old-established works at 43, Kirby-street, Hatton-garden, London.

Telephone and Bell Catalogue.—We have received from the International Electric Co., 55, Redcross-street, E.C., a copy of the fourteenth edition of their catalogue of bell and telephone material. The firm makes a speciality of this class of supplies, and the new edition includes almost every conceivable piece of apparatus from the ordinary push and "baby" bell to multiple telephone switchboards. At the end of the book is an excellent collection of diagrams showing how the various apparatus should be connected.

Westinghouse Plant.—The British Westinghouse Co.'s circular No. 1,027 deals with the Westinghouse incandescent street lighting system, and illustrates the street light shunt coil. Claim is made that the entire system operates with high efficiency, and that the percentage of current required to keep the shunt coils magnetised is very small.

B. T. H. Plant.—Pamphlet No. 63 issued by the British Thomson-Houston Co. describes and illustrates direct-connected continuous-current lighting generators. The L type form of generator is dealt with. Pamphlet No. 64 describes this company's alternating current fan motor, of which several sizes are illustrated.

Dick, Kerr and Co.'s Plant—Circulars Nos. 102 and 103, issued by Messrs. Dick, Kerr and Co. (Ltd.), treat of "Top-seat, single-deck motor cars" and "New rolling stock for the Waterloo and City Railway" respectively. Both pamphlets are well illustrated, No. 102 showing some excellent examples of cars as used on the Liverpool, Bolton, Potteries, Blackpool and Fleetwood, and other lines.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 16 to May 22, with the ports of destination:—

Africa—Alexandria, £35; Cape Town, £4,374 (including £4,103 telegraph material); Chinde, £864 (telegraph material); Durban, £245; East London, £9. *Argentina*—Buenos Ayres, £860. *Australasia*—Christchurch, £11; Lyttleton, £145; Melbourne, £580; Sydney, £514; Wellington, £568 (including £500 telegraph cable). *Azores*—£330,625 (telegraph material and apparatus). *Brazil*—Rio Janeiro, £1,487 (telegraph material). *Canada*—Halifax, £51 (telegraph paper); Montreal, £80. *Ceylon*—Colombo, £10. *Colombia*—Santos, £199 (telegraph material). *France*—Rouen, £50. *Germany*—Hamburg, £335 (telegraph material). *Holland*—Amsterdam, £300; Rotterdam, £45. *Hong Kong*, £21. *India*—Bombay, £40; Calcutta, £216. *Russia*—Riga, £64 (telegraph material); St. Petersburg, £41. *Siam*—Bangkok, £85. *Spain*—Bilbao, £1,330 (telegraph cable); Mazagan, £80; Vigo, £179 (telegraph apparatus). *Straits Settlements*—Singapore, £170 (including £65 telegraph material). Total £343,550 against £11,076 for eight days last year (May 17 to May 24).

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COMPANIES' MEETINGS AND REPORTS.

British Aluminium Co. (Ltd.).

The fifth ordinary general meeting was held yesterday, Mr. R. W. WALLACE, Q.C., presiding.

The CHAIRMAN said that a few years ago aluminium was a curiosity, but it had now become one of the most useful metals in the arts. It had been difficult for the company's travellers to induce manufacturers to use aluminium as fast as the directors would like. During the 2½ years the company had been in a dividend-earning capacity they had had 14,000 different orders. Most of these, however, were only for small quantities of metal for trial purposes. So far the company had not derived any great financial benefit from Government orders. In Germany half the output of the Neubasen Co. went to the Government, and he had no doubt that, in a short time, the same state of things would prevail in this country. Aluminium had been utilised for the balloon equipment in South Africa, and the metal had also been utilised in connection with the field telegraph and field telephone. The Boers had been before us in this matter. A considerable quantity of aluminium was ordered by them from Germany, and had found its way into their equipments. In the navy more had been done as regarded the use of this metal. After complaining that the railway companies insisted on treating aluminium as a precious metal, and charging for its tariff accordingly, he said that so far the company had earned 20 per cent. of the 35 per cent. due to December 31 on the cumulative preference shares. They had been working more for the future than for the present.

Lord KELVIN said that if the same rate of progress that had been made was continued a very great future in the way of practical success would be secured to the company. The question of water-power, in which they were so largely interested, was one of supreme importance now in view of the great increase in the price of coal. The price of coal would it was hoped fall somewhat before long, but that it must go on increasing on the whole from year to year seemed quite certain, when it was considered that the total quantity of coal all over the world was limited.

The directors' report was adopted.

It was afterwards agreed to increase the capital to £400,000 by the creation of 10,000 new cumulative preference shares of £10 each, to rank for dividend in priority to the existing preference shares. Only 5,000 of the new shares will at present be issued.

Callender's Cable and Construction Co. (Ltd.).

The fourth annual general meeting was held yesterday (Thursday) under the presidency of Mr. HENRY DRAKE.

The SECRETARY (Mr. H. A. Manning) having read the notice calling the meeting,

The CHAIRMAN said he hoped the shareholders would consider the statement submitted by the directors satisfactory in view of the difficulties against which the company had had to contend during the past year. There had been a rise in the price of practically all the materials used at the factory, and in the opinion of the directors the result produced reflected great credit on the skill and ability of their managing director. Dealing with the balance-sheet, he said the buildings, machinery and plant now stood—after allowing £5,000 written off for depreciation this year—at £183,000, against £135,000 in the previous balance-sheet. This had been necessitated by the increase in the business. The item of cable-drums stood at £9,800, against £4,800 a year ago, and this increase was also owing to the expansion of the business. The stock in hand amounted to £69,000, against £43,000. The item of "expenditure on contracts in course of execution, including materials and plant," figured for £68,000, against £42,000, and sundry debtors at £290,000, against £172,000. The cash was £11,000, against £21,000, and shares in other companies amounted to £7,500, against £5,000. The directors always endeavoured to keep this item down as low as possible, but now and again they were obliged to take a few shares in order to secure contracts. On the other side the only important items were bills payable £142,955, and trade creditors and other liabilities £80,000 (together £223,000), compared with £119,000 in the previous balance-sheet. Sundry debtors, on the other side of the account, showed an increase of £118,000. In the profit and loss account, the manufacturing profit appeared at £64,000 against £59,000; and after paying all expenses, including the repair and maintenance of the plant and the removal of the machinery to the new factory, a balance was carried down of £41,966, out of which interest on debentures, dividend on preference shares, and interest on new ordinary shares had been paid; £5,000 had been appropriated to depreciation of plant and machinery, and a balance was left of £33,221. Out of this the directors propose to pay a dividend to the holders of the original ordinary shares at the rate of 10 per cent. per annum, clear of tax, or 10s. per share, and a bonus of 5s. a share; and after adding £10,000 to reserve, £8,221 would remain to be carried forward. The reserve fund, with this addition, would stand at £73,881, which was a very satisfactory figure; and the return upon the ordinary shares would be 15 per cent., or the same as was paid in 1898. With reference to the issue of new preference shares, the company's business had increased very largely. Last year the directors issued 10,000 ordinary shares of £5 each at a premium of £5 a share, producing £100,000, and the shareholders might naturally suppose that this would have lasted a considerable time. He would, however, show them where the amount had gone. The increase in the property had been £47,000, on cable drums £5,000, on stock £26,000, in expenditure on contracts £26,000, and in debentures £118,000. These items amounted together to £222,000. On the other hand, there had been a diminution in the cash of £10,000, and the increase in the item of creditors was £104,000, being together £114,000, and leaving a balance of £108,000. They were, therefore, in this way really at the present time £8,000 worse off than they were a year ago. The issue of the new preference shares would be made as soon as the arrangements could be completed, and would be offered *pro rata* to the existing ordinary and preference shareholders. He moved the adoption of the report and balance-sheet.

Lieut.-Col. G. A. ELLIOTT seconded the motion, which was carried unanimously, and the dividend and bonus mentioned were afterwards approved.

Mr. T. O. CALLENDER endorsed the remarks of the Chairman as to the difficulties they had had to contend with during the year, and said that they had had more than their share of the work that was going, and had no reason to complain of the prices obtained under their contracts. They had over 150 contracts in hand, and several of their departments had to be run day and night. He thought the prospects of the company for a continuance of the good business they were at present having were favourable, and he believed that 1900 would turn out to be another excellent year.

A vote of thanks terminated the proceedings.

West India and Panama Telegraph Co. (Ltd.)

The report of the directors for the half-year ended December 31st last states that the amount to credit of revenue is £22,643. 14s. 7d., against £51,937. 16s. 7d. for the corresponding half-year of 1898, and the expenses have been £21,432. 13s. 3d. against £24,443. 15s. 6d., leaving a balance of £1,211. 1s. 4d. The revenue for the corresponding period of 1898 was abnormally large in consequence of the Spanish-American war. Since the conclusion of the war the traffic has resumed its normal character, and owing to its being carried at lower rates than formerly, and there being no compensating increase of business, the company is now feeling the full effects of the reductions made in the message tariffs. Notwithstanding the reduced rates, coupled with the efforts which it was understood Her Majesty's Government were making to stimulate the trade and enterprise of the West Indies, the result of the half-year's working is most discouraging. To this amount of £1,211. 1s. 4d. there is to be added £3,021. 8s. 2d. interest on investments, which has been credited to revenue instead of to reserve as heretofore, making, with £379. 14s. 2d. brought forward, £4,612. 3s. 8d. to credit of revenue. As it requires £11,769. 12s. to pay the half-yearly dividends on the first and second preference shares, the amount available is insufficient by £7,157. 8s. 4d. The directors, therefore, recommend the payment of dividends by drawing on the reserve fund, and also that a dividend of 1s. per share (free of tax) be paid on the ordinary shares. £12,000 has consequently been transferred from reserve, leaving £279. 6s. 8d. to be carried forward.

Notwithstanding the reductions of tariff made by the company, the colony of Barbados has reduced its subsidy from £2,500 to £1,500 for the current year. The directors regretfully express the opinion that low rates for West Indian telegraphic communications cannot be maintained without the financial assistance of the Government. In view of the discouraging circumstances they have, therefore, recently addressed the Secretary of State for the Colonies, pointing out the present position of the company and asking for Imperial aid, without which, it appears to the board, the maintenance of the telegraphic communications of the West Indies, in the interests of commerce of Her Majesty's Government and the Colonies, will be imperilled. A reply from the Colonial Office is anxiously awaited.

Castner-Kellner Alkali Co. (Ltd.).

The report of the directors for the year to March 31, 1900, states that the result of the trading is a gross profit of £59,486. 13s. 5d., out of which £11,273. 6s. 7d. has been expended in repairs, renewals and special improvements of the working plant, which is in a very efficient condition. The net profit is £45,398. 7s. 3d., which, with £5,341. 17s. 1d. brought forward, makes £50,740. 4s. 4d. An interim dividend at the rate of 8 per cent. per annum has been paid for the six months to Sept. 30 last, amounting to £12,000, and debenture and loan interest £6,694. 9s. 2d. has been paid, leaving an available balance of £32,045. 15s. 2d. The directors recommend a further dividend at the rate of 8 per cent. per annum for the six months to March 31, and to write off £6,277. 17s. 6d., the expenses of the debenture issue; to appropriate £10,000 to depreciation reserve; and to carry forward £3,767. 17s. 8d.

The company's process is working very satisfactorily, and experience has enabled it to be improved in important features which strengthen the position of the company, apart from the protection afforded by the patents.

CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)—In moving the adoption of the directors' report at the annual meeting recently, the chairman (Col. A. J Filgate) said the company's progress at first was slow. Owing to various difficulties, chiefly in getting material from England, they could not get their mains laid so fast as they had intended. They were not able to find room for overhead mains in some of the streets occupied by the Government telegraph and telephone wires, and had to change the proposed routes or to place the mains underground. From the date of starting the works to Dec. 31 they had sold 54,897 units of current, but from Jan. 1 to 13th ult. they had sold 74,673 units. The municipality had not yet come to any decision in regard to public lighting, but the matter was under consideration, as was also the question of lighting Fort William. A great demand for electrically-propelled fans had sprung up. The large

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difference which occurred in the sale of electric current between the winter and summer months in the case of electricity undertakings in Great Britain would not occur in Calcutta; indeed, it seemed probable that when the supply of fans came up to the demand the sale of current during summer would equal, if not exceed, that of the winter. The greater proportion of their consumers were located in the European quarter of the city, but they had a demand from native gentlemen, and they would have to keep on extending their mains to a considerable extent within the area of their original concession. They would soon have to provide additional generating plant, and either to increase the size of their station or to construct another in a different locality. The total commitments of the company at present amounted to about £108,000. As the directors contemplated further expenditure at an early date to deal with the extended area and to meet the increasing demand, they had decided to ask the shareholders to sanction an increase of capital from £100,000 to £200,000. Their licence had been extended to 42 years, the municipality having the right to purchase at the end of the 42 years, and at intervals of 10 years thereafter, at its then existing value, and the company were to pay a rent of one rupee a year for every pole erected in Calcutta. As there seemed a probability that a demand for electricity in other large cities and towns in India would shortly arise, the board had commenced negotiations in some quarters with a view of extending the scope of the company's operations. The report was adopted and a resolution passed increasing the capital of the company by the issue of 20,000 additional £5 shares, the new shares to be issued at such times and on such terms and conditions as the directors might think fit.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)—The annual meeting of this company was held recently when the chairman (Mr. J. MacFarlan) said that during the year they had issued £15,000 debenture stock in order to provide for the increased value of the copper stock of the "Metall" Co. caused by the great rise in the price of raw material, and to carry out further extensions at the factory to cope with the greatly increased demand for the products of the company. They also issued preference shares, bringing the total amount to £50,000. Mr. Preschlin, the manager in Germany, had invented a joint for high-pressure copper tubes, and a considerable amount had been expended in testing the joint, in order to prove its value to the Board of Trade in England. These tests, by Messrs. D. Kirkaldy and Co., had given most satisfactory results, and they were now engaged in putting the joint before users in England. They had hoped that the result of the past year would have been sufficiently good to enable them to convert their 8 per cent. debenture stock into 5½ or 6 per cent. stock, but as things had turned out, they would not be justified in making the experiment. The "Metall" Co. had expended £3,500 on additions to land, buildings and water power, and £6,000 was expended on machinery, tools and factory appliances. Unfortunately the great demand in Germany for engineering goods precluded the delivery, until late in the summer, of certain parts which had to be made on the spot, and so they did not obtain the power they anticipated during the dry season. During the year, the sales showed a considerable increase, but both wages and stores increased out of proportion to the trade done. It was estimated that the trading profit would amount to over £21,000 whereas it amounted to £18,200 only. The working of the past year had, notwithstanding the difficulties encountered, given considerable cause for congratulation. The contract with the German Government expired in March last and had been continued for another year at the same prices, and they had all the principal users of copper goods on their books. The actual profit made in 1898 by the "Metall" Co. was £5,193, and in 1899 £6,310, and the current year's working should show a much better profit. They were exhibiting at the Paris Exhibition. It was not at first intended to do so, but they were approached by the Government, who stated that they would be prepared to pay the cost of the site, &c., and that it was their wish that the company should exhibit if possible. The dividend of 3¾ per cent. on the preference shares for the past year was then approved

NEW COMPANIES, STATUTORY RETURNS, &c.

BABCOCK AND WILCOX (LTD.)—This company was registered on April 30, with a capital of £630,000 in £1 shares, to acquire the business of Babcock and Wilcox (Ltd.), and to develop and extend the same, to construct, maintain, and work rail and tram roads, to carry on general business of an electric light and power company, &c. The first directors are J. Dewrance, A. T. Simpson, Sir W. Arrol, W. J. P. Moore, C. A. Knight, J. H. Rosenthal, and F. G. Biurne.

INGLETON WATER POWER CO. (LTD.)—This company was registered on May 14, with a capital of £7,000 in £1 shares, to take over the business of the Ingleton Carbide Co., and to carry on the business of calcium carbide manufacturers, &c.

INTERNATIONAL ELECTRIC TRACTION AND POWER SYNDICATE (LTD.)—This company was registered on May 16, with a capital of £25,000 in £10 shares, to carry on the business of railway and other waggon, carriage, and vehicle manufacturers, electrical and mechanical engineers, suppliers of electricity for motive power and other purposes, &c. The subscribers are R. Le Neve Foster, T. Pollock (engineer), J. P. Bedson, M.I.C.E., W. G. Rhodes, M.I.E.E., C. J. Hall, R. D. Cohen, and T. Harris.

McALPINE'S ELECTRICAL CO. (LTD.)—This company was registered in Edinburgh on May 13, with a capital of £5,000 in £10 shares, to take over the business carried on by H. McAlpine and Co., at 248, Hope-street, Glasgow, and to carry on the business of electrical engineers, &c. The subscribers are:—H. McAlpine, electrical engineer; John Dewar, electrical engineer; J. Paterson, A. McOnish, J. Dewar, printer; A. Macallan, J. Findlay. The first directors are:—Hugh McAlpine and John Dewar.

MIDLAND ELECTRIC CORPORATION (1900) (LTD.)—This company was registered on May 15, with a capital of £200,000 in £1 shares, to enter into an agreement with the British Insulated Wire Co. (Ltd.), to promote the development of the business of the Midland Electric Corporation for Power Distribution (Ltd.), and to carry on the business of electricians, electrical and general engineers, suppliers of electricity for the purposes of light, heat, and motive power, &c. The subscribers are W. M. M. Forwood, A. E. Haptie, C. O. Grindrod, F. W. Lintern, T. M. Watters, J. A. Bland, and E. R. Williams.

MONARCH MOTOR CO. (LTD.)—This company was registered on May 10, with a capital of £250,000 in £1 shares, to carry on business as electricians and electrical engineers, as importers and exporters, manufacturers of and dealers in motors, &c.

NORTH WALES AND DISTRICT LIGHT RAILWAY AND ELECTRIC POWER SYNDICATE (LTD.)—This company was registered on May 2, with a capital of £1,200, in £100 shares, to carry on the business of electrical and general engineers and the business of an electric traction company; to supply electricity for light, heat, and power, and to equip and maintain telephone and telegraph systems, railways, tramways, &c. The subscribers are J. Wolstenholme, J. Royle, E. Hague, F. F. Bennett (engineer), W. T. Pressland (engineer), W. H. Davies, and B. D. Beever.

ST. STEPHEN'S ELECTRICAL SYNDICATE (LTD.)—This company was registered on April 30, with a capital of £8,000, in £1 shares, to acquire the business carried on by Mr. J. E. Taylor at Shepherd's Bush, and to carry on the business of electrical, hydraulic, and general engineers, &c. The subscribers are E. Buchholtz (electrical engineer), J. E. Taylor (electrical engineer), E. S. Templeton (civil engineer), H. G. Well (engineer), G. Richberg (engineer), W. J. Chapman (engineer), and F. Smith.

CITY NOTES.

MEMORANDA.—Bank rate 3½ per cent. (May 24, 1900). Price of silver 27 11/16d. per oz. (May 24). Consols (2¾ per cent.) 101¼—101⅜ for money, 101 7/16—101 7/16 for account; 2½ per cent. 98¼—98½ (May 24). Stock Exchange Settling Day: Consols, June 1; Stocks and Shares Continuation Days, May 29 and June 12; Ticket Days, May 30 and June 13; Pay Days, May 31 and June 14; Mining Share Carry-over Days, May 28 and June 11.

BRITISH ELECTRIC PLANT CO. (LTD.)—Subscriptions have been invited this week to an issue of £75,000 in shares of £10 each in this company, which has been formed with a capital of £100,000. The managing director is Mr. Wilfred L. Spence, and the registered offices of the company 154, St. Vincent-street, Glasgow. The company is formed to carry on works in Scotland for the manufacture of electrical engineering plant of all kinds, and to carry on an electricity bulk supply business worked in conjunction with its own electric lighting and power plant. It is claimed that the district in which the company's operations will be conducted affords exceptional opportunities for the purposes of the company, which holds a provisional contract with the Alloa Commissioners for the supply of electric current in bulk for lighting and other purposes for 14 years, and thereafter for successive periods of seven years. It is stated that the directors of the company, all practical men, have subscribed for one-third of the present issue of shares; that no promotion money is paid; that there are no vendor's shares; and that none of the shares will be underwritten. The agreements entered into are all fully set out in the prospectus, and there is no waiver clause. The list closed on the 23rd inst.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—At a meeting last week the resolutions increasing the capital (*see* our issue of 27th ult.) were confirmed.

HAMPSTEAD ELECTRIC SUPPLY CO. (LTD.)—Investors are again cautioned against responding to the invitation of Sims, Newman and Co., a firm of stock and share pushers who are hawking the shares of the above company, and informing all and sundry that the prospects for these shares are favourable. It will be remembered that at the last meeting of the company the dividend on the 5 per cent. cumulative preference shares was passed, and of course no dividend was paid on the ordinary shares. The shares, both preference and ordinary, may well be left to local purchasers, who are best acquainted with the outlook for this "investment."

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LTD.)—Messrs. Turquand, Youngs and Co. have issued their report on the financial position of this company. They are of opinion that since 1894 dividends, amounting to £15,645, have been paid otherwise than out of profits. Various items debited to capital should properly be charged to revenue, and items credited to revenue are transferred to credit of purchase account. The absence of title to shares valued at £2,000 in the Snaefell Mountain Railway is mentioned; outstanding claims hitherto disputed by the company are also referred to, and criticisms are made on the insufficient accounts kept. On the separate undertaking of the Laxey-Ramsey section the outstanding liabilities are placed at £48,000, and the net revenue account shows a loss of £434 in 1898 and £402 in 1899.

MELDRUM BROS. (LTD.)—Subscriptions are being invited for 50,000 5½ per cent. cumulative £1 preference shares.

OSWESTRY ELECTRIC LIGHTING AND POWER CO. (LTD.)—The annual meeting was held recently. The directors' report stated that the gross

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profit for 1899 amounted to £318. 8s. 2d., which, with £8. 0s. 1d. from 1898, left an available balance of £326. 8s. 3d. Besides providing for depreciation, £60 has been added to reserve, which is being charged with the cost of renewal and extension of battery, and £12. 0s. 4d. has been written off preliminary expenses, leaving a net disposable balance of £254. 7s. 11d. A dividend at the rate of 4 per cent. is recommended, and £20. 9s. 2d. carried forward.

REUTER'S TELEGRAM CO. (LTD.)—The directors' report states that the amount available for distribution for the year ended Dec. 31 last, after payment of current charges, is £8,304. 5s. 3d., including £29. 5s. from last account. An interim dividend of 2½ per cent. was paid in October, and the directors now declare a dividend of 4s. per share (2½ per cent.), making a total distribution, tax free, of 5 per cent. for the year. This will absorb £4,944. 16s. 8d., and after adding £3,000 to reserve the balance (£309. 8s. 7d.) is to be carried forward.

RUSTON, PROCTOR AND CO. (LTD.)—The directors' report for the year to March 31 states that the profit was £48,159. Deducting depreciation of buildings, plant and machinery, &c. (£9,254), directors' remuneration (£1,200), and debenture interest (£10,469), there remains (including £1,479 brought forward) £28,615, and the directors propose a dividend of 14s. per share (7 per cent. for year) £17,500 ; to equalisation of dividends account, £10,000, carried forward £1,115. The directors consider that, in view of the development of the company's business the capital should be increased to £360,000 by the creation of 10,000 additional shares of £10 each.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed the 30th inst. a special settling day in the further issue of £150,000 5 per cent. perpetual debenture stock of the *British Electric Traction Co. (Ltd.)*, and has ordered the same, together with the further issue of 3,000 £10 fully-paid shares (Nos. 12,001 to 15,000) of the *Blackpool and Fleetwood Tramroad Co.* to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in, and to grant a quotation to the provisional certificate for £100,000 5 per cent. second debenture stock of the *Edison and Swan United Electric Light Co. (Ltd.)*.

THAMES IRONWORKS, SHIPBUILDING AND ENGINEERING CO. (LTD.)—During the week this company made an issue of 100,000 "B" 6 per cent. cumulative preference shares.

WESTERN TELEGRAPH CO.—An interim dividend of 3s. per share (at the rate of 6 per cent. per annum), free of tax, for the quarter ended March 31 has been declared payable June 22. The transfer books will be closed from June 15 to June 21 inclusive.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)—At a meeting on Monday the resolutions passed at the meeting on April 11 (reported in our issue of April 13) were confirmed.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	May 19	4,610	+ 426	19	82,169	+ 4,414
Blackpool Corporation...	„ 17	270	+ 49	7	2,462	+ 516
Blackpool and Fleetwood	„ 19	526	+ 202	20	5,110	+ 63
Bradford Corporation...	„ 20	453	+ 118	7	3,143	+ 744
Brisbane Trams	Apl. 4	1,660	+ 310	1	1,660	+ 310
*Bristol Trams & Carriage	May 19	2,764	− 100	20	54,534	+ 1,803
*Buenos Ayres & Belgrano	Apl. 22	2,360	+ 264	16	36,773	+ 5,303
City & South London Ry.	May 20	1,339	+ 260	20	24,963	+ 3,642
Dover Corporation	„ 19	173	+ 13	7	1,325	+ 125
Dublin United	„ 18	3,300	+ 319	20	64,516	+ 13,086
Dublin Southern Dist....	„ 18	759	+ 15	20	15,651	
*Glasgow Corporation ...	„ 19	9,714	+ 1005	...	...	...
*Liverpool Corporation...	„ 12	7,106	+ 493	19	131,467	+ 16,578
Liverpool Overhead Rly.	„ 20	1,476	+ 81	20	28,228	+ 1,205
*Sheffield Tramways	„ 20	2,204	+ 887	20	38,681	+ 13,149
*South Staffs. Trams.....	„ 18	651	+ 55	20	12,929	+ 61

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 16.	Price Wednesday, May 23.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending May 23. Highest	Lowest
			TELEGRAPHS.						
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July.....	100½	...
26,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£833,720	Stock	15/0	Anglo-American	62 65	62 65	5 12 8	Feb., May, Aug., Nov.	...	...
£3,088,640	Stock	30/0	Do. Preferred	114 115	114½ 115¼	5 4 5	„ „	117½	114¾
£3,088,640	Stock	27/0	Do. Deferred	13½ 14	13¾ 14½	9 9 6	„ „	14 1/16	13 1/16
$13,333,200	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	102 104	3 17 0	„ „	103½	102½
16,000	10	6/0	Cuba Submarine Ordinary ..... xd	8½ 9½	7½ 8½	8 4 8	February and August	9⅞	7⅞
6,000	10	10/0	Do. Preference 10 per Cent. ..... xd	18½ 19½	17 18	5 11 1	„ „	17½	17
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	101% 105%	101% 105%	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	11 1/16	11⅛
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101 103	100 103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	150 155	4 10 4	Jan., Apr., July, Oct.	153½	151
£1,236,888	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	99	98
£1,492,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	114	113
250,000	10	6/6	Eastern Extension	15¼ 16¼	15⅜ 16⅜	4 6 2	Jan., Apr., July, Oct.	16⅛	16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	111 116	112 117	3 9 2	February and August	112½	112
£8,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb.,1900 (reg.) ...	100 103	100 103	4 17 1	January and July.....	...	...
£36,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	101⅜	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	100% 103%	103% 103%	3 17 8	May and November ...	101	...
180,237	10	2/6	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11⅝	11½
180,042	10	2/0	Do. 6 per Cent. Preference	15 15⅝	15⅝ 15⅝	3 16 2	„ „	15⅝	15⅝
150,000	10	15/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July.....	34	...
£86,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	100 103	100 103	4 8 0	...	...	...
17,000	25	37/6	Indo-European ..... xd	53 55	53 57	4 7 9	May and November ...	55	52½
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	105⅜	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's	7 8	7½ 8½	4 14 1	April and October.....	7½	...
2,381	£100 Cert.	6%	Submarine Cables Trust	124 128	124 130	4 13 0	„ „	125	...
15,600	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 2	March and September	...	...
30,008	2½	...	West Coast of America.....	⅛ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 15 7	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅜ 1⅛	⅜ 1	...	May and November ...	1	⅜
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9¾	9 9½	6 6 4	„ „	9½	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	105	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	102 105	102 105	3 17 4	June and December ...	...	...
207,980	10	2/0	Western Telegraph (late Brazilian Submarine)	14½ 15	14¾ 15⅛	4 11 10	Mar., June, Oct., Dec.	15⅛	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	103 108	103 108	4 13 10	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	2⅜	...
224,850	10/)	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ⅝	½ ⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
420,000	5	3/0	National	4⅛ 5⅛	4⅛ 5⅛	5 17 1	February and August	5	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	13 15	13 15	4 0 0	„ „	13⅞	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	11 13	11 13	4 12 4	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ..	5 5½	5 5½	4 15 3	„ „	5	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96 99	96 99	3 10 7	June and December ..	98½	97
171,504	1	0/3	Oriental	1 1/16 1 1/8	1 1/16 1 1/8	4 14 1	April and October.....	1	...
58,000	5	2/6	United River Plate	4⅜ 5⅛	4⅜ 5⅛	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4⅜ 5⅛	4⅜ 5⅛	4 15 3	June and December ..	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, May 16.	Price Wednesday, May 23.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 23. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...		...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅝ 12⅜	11⅝ 12⅜	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7 7½	7 7½	...		...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	8⅞ 9⅛	8⅞ 9⅛	4 14 9	February and August	9⅛	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅝ 6	5⅝ 6	3 15 0	,, ,,	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6⅝ 7⅛	6⅝ 7⅛	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	108 111	4 2 2	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	10 11	10 11	4 0 0	February and August	10 5/16	10⅛
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12⅝	...
£100,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½ 10⅛	9½ 10⅛	3 16 2	...	9⅜	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	12⅜	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109 112	109 112	4 0 9	...	111½	111
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13⅜	12⅜ 13⅜	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7⅛	7 7⅛	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅝ 2	1⅝ 2	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4 4⅛	4 4⅛	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13⅜ 14⅜	13⅜ 14⅜	3 9 0	April and October	14⅛	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	93 98	3 11 10	...	93	97
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½ 7	6½ 7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅞ ⅞	⅞ ⅞	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	...	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	170 190	170 190	4 4 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15½	15¼
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4 4½	4 4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½ 15⅝	14½ 15⅝	4 8 10	March and September	11 13/16	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	13/16 1	¾ 1	6 17 2	...	...	...
85,000	1	...	British Electric Works Co. Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	13/16 1 1/16	13/16 1 1/16	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,060	2	1/2⅜	Brush Electrical Engineering	1⅝ 2	1⅝ 2	4 0 0	September	...	...
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cum.	2 2⅛	2 2⅛	5 6 8	,,	2⅛	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103 113	103 113	3 19 8	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 5 9	June and December	103¾	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½ 15½	14½ 15½	4 16 9	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 116	112 116	3 18 5	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅜ 1⅝	1⅜ 1⅝	5 16 5	...	1⅛	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 19 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4⅛	3½ 4⅛	6 13 4	,, ,,	4⅛	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	94½	93½
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜ 5	4⅜ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101 104	101 104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2⅛	2 2⅛	5 6 8	January and July	2⅛	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅞ 3⅛	2⅞ 3⅛	4 6 2	July	...	...
£132,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 103	103 105	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13½ 14½	13½ 14⅜	3 15 10	February and August	14½	13¾
30,000	5	1/6	Do. 4½ per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	3 18 3	,, ,,	5⅜	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	2⅛	...
* £309,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 101	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	34 38	34 38	4 14 6	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	10 11	11⅜ 12⅛	2 16 0	...	12	10⅞
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛ 6	5⅛ 6	4 3 4	...	6⅜	...
30,000	5	7/0	Willans and Robinson Ordinary	11⅛ 12⅛	11⅛ 12⅛	4 16 0	April and October	12 3/16	11⅛
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7⅛	7 7⅛	4 0 7	,, ,,	7	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures xd	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17½ 18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102 104	102 104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½ 23½	22½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£3 paid)	8½ 8⅝	8½ 8⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 8 5	...	...	...
18,000	10	5/0	British Columbia Electric Railway 5% Pref.	9½ 10½	10½ 10⅝	4 13 0	...	1 1/16	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15½ 15⅝	15⅛ 16⅛	3 12 9	...	...	...
15,000	10	...	Do. (Nos. 30,001 to 45,000)	15⅝ 16⅛	15⅛ 16⅛	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 65,000)	12 13	12 13	4 12 4	...	13⅛	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	125½	125
40,000	5	2/8 3/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5 5⅛	5 5⅛	5 14 4	...	...	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104 107	104 107	4 14 10	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk Prov. Certs (£57½% to be p'd.)	37 40	37 40	...	...	...	...
208,940	10	3/0	Central London Ordinary	10 10⅛	10 10⅛	2 17 2	June and December	10 1/16	10 1/16
£355,000	Stock	1½%	City and South London Railway Con. Ordinary	61 64	61 64	2 18 7	January and July	63	...
37,500	10	1/3 1/16	Do. (Nos. 22,501 to 60,000)	5⅛ 6⅛	5⅛ 6⅛	2 5 4	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1884)	140 145	140 145	3 9 0	January and July	...	...
£270,000	Stock	5%	Do. (1893)	132 137	132 137	3 13 8	...	...	...
£214,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture xd	123 123	123 123	3 2 6	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½ 23½	22½ 23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	⅛ ⅜	1/16 ⅜	24 0 0	...	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16 ⅜	1/16 ⅜	16 0 0	...	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅜ 10⅛	9⅜ 10⅛	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8 3/16 9 1/16	9 9⅛	4 1 1	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13⅝	13½ 13⅝	3 14 1	,, ,,	...	...
£ 25,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 15 8	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4	3½ 4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference xd	4¼ 5¼	4⅜ 5¼	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 18	16 18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜ 10⅞	10⅜ 10⅞	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9⅛ 10⅛	9⅛ 10⅛	4 15 3	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100 103	100 103	2 18 8	June and December	101½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,150. [No. 6. Vol. XLV.] FRIDAY, JUNE 1, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 15 cents, or 80fr., or 70pf.

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NOTES.

WE give in another column some account of the lectures and debates on submarine telegraphic communication which have taken place during the past week at the Society of Arts and the Royal United Service Institution. It has always been a favourite method with advocates of reductions in the charges for cable telegrams—as, for instance, Mr. HENNIKER HEATON and Sir EDWARD SASSOON—to add together the internal land tariffs of the different States which would be transited by a land-line message to any given point, and then to base on this total a claim that the rates for submarine transmission are too high. To say nothing of the innocence of the assumption that foreign countries will accept for international communication their internal rates, which frequently involve a loss, a little more knowledge of the subject would show that the great advantages to this country of the submarine cable connections cannot be maintained without pecuniary loss at rates approximating at all to those of land-lines, even when these lines are highly remunerative.

FIRST of all, on a moderate calculation, a land-line system abroad, with one wire, costs only one-fourth or one-fifth as much as a submarine cable of the same length. Then, the maintenance of the former costs much less than the sea route, which requires expensive cable-ships stationed at various points. Again, when duplication of existing cables is necessary, the new section, with constantly rising prices for material, costs more than the original; whereas an additional wire on a land-line would only involve about one-twentieth the cost of the additional under-sea connection. Further, cables are subject electrically to what is known as "retardation"; aerial wires are not, and can therefore be worked at ten times the speed. In the case of long land lines it may be pointed out that, though they are interrupted for shorter periods as a rule than submarine routes, yet short interruptions are very much more frequent, and certainty of communication is one of the elements vital to the growth of telegraphic traffic to its full capacity. It is curious to note that some of those who have urged the great importance of cable routes being "all-British" should have advocated the use of long land lines, which would pass almost entirely through foreign territories.

IN the issue of the *Financial News* for May 18 is a description of the Riecker electrolytic process for extraction of gold from sulphide ores. According to the writer the process consists in agitating the ore in a finely divided state with a solvent containing sodium chloride and potassium cyanide, and at the same time passing a current of electricity through the mass of ore and water by means of iron anodes, and amalgamated copper cathodes over which mercury is kept in constant flow. The coarser particles of pure gold are said to be directly amalgamated, while the finer particles and the chemically combined gold are dissolved by the cyanide, and then electro-chemically deposited upon the cathodes by means of the current passing through the cell. The gold amalgam obtained upon the cathode plates is stated to be exceedingly dense, and able to resist the attrition to which the agitation of a large body of ore suspended in water subjects it. The cost of treatment amounts to 6s. 8d. per ton, and the process is about to receive trial upon an extended scale at the South Kalgurli Mine in Western Australia.

THERE have been so many similar processes for extracting gold invented, tried, and never more heard of, that we wait for further information concerning the trials of the Riecker process at Kalgurli before pronouncing any decision upon it. That some of the gold can be extracted from ores by such a method is well known—that practically all the gold can be extracted at a cost which will compete with the methods now in use, remains to be proved. In view of the closing paragraph of the article in the *Financial News*, which conveys a gentle hint that the shares of the company owning the Riecker patents may prove a splendid speculative investment, we should like to state that there have been several patents for processes

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practically identical with the "Riecker" process granted in past years, and that if the latter process is as successful as its inventors and owners expect, the question of patent validity and priority is certain to arise. For the guidance of those interested in the subject we may name the processes of Edwards (1894), of Danckwardt (1894), and of Hannay (1890), as processes which make use of agitators, crushed ore, amalgamated cathodes, and an electrolyte of potassium cyanide, while the Peletan-Clerici process described by Major-Gen. WEBBER before the Institution of Electrical Engineers in January, 1898, is another process of a similar kind.

THE *Daily Mail's* proposal of a flotilla of electric launches for the Thames river service is eminently feasible. Both from an engineering and from a commercial point of view, its successful accomplishment is well within the bounds of possibility. Indeed, this is a form of locomotion in which the secondary battery has many special advantages in competition with steam. For a river traffic like that on the Thames a frequent and rapid service of boats is essential; it is preferable to have a large number of small boats than a smaller number of larger dimensions, because of the nature of the competition with the parallel road and rail traffic. Small river launches driven by steam are essentially inefficient. Small electric launches, capable of carrying, say, from 100 to 150 passengers, are as efficient as would be electric launches of much larger dimensions, and are far more efficient than steam. They would also be more manageable than electric launches of larger size. The life of storage cells is much greater in river service than in road vehicles, as the injury due to mechanical shocks and vibration is almost if not quite absent. The only vibration the cells might be subjected to would be in moving them into and out of the launches for the charging operations, as it would probably be found impracticable to charge them *in situ*. Trucks of cells, however, could be conveniently wheeled on to the launches at the various stopping places, and the act of placing them in position on board could readily be made to complete their electrical connection, as is done, for example, on the Birmingham battery system. We trust the scheme will receive the attention it merits from the London County Council.

American Institute of Electrical Engineers.—At the annual meeting, held on May 16th, Mr. Carl Hering was elected president of the Institute for the forthcoming year.

German Atlantic Cable.—The laying of the Emden-Fayal section of this cable was completed last Saturday. A Reuter telegram states that the first experiments made on Wednesday between Emden and Horta, Azores, "were satisfactory beyond expectation."

Extension of the City and South London Railway to Clapham.—It is officially announced that on Whit-Sunday the extension of the City and South London Railway, from Stockwell to Clapham Common, will be opened, the first train running from either terminus at noon.

Anglo-German Cable.—The German Reichstag on Friday last passed the third reading of a supplementary estimate providing for the expenditure of 2,000,000 marks on the construction of a new cable between Germany and England. The expense of laying this cable from Borkum to Bacton Norfolk) is to be borne equally by the two nations.

Projected Electrical Exhibition in Vienna.—In commemoration of the twentieth anniversary of the foundation of the Austrian Electro-technischer Verein, in 1908 an electrical exhibition on a large scale has been planned to be held in Vienna. Prof. Karl Schlenk is president of the executive.

Visit of the Institution of Electrical Engineers to Paris.—The Institution of Electrical Engineers will hold an extraordinary general meeting in Paris on Thursday, August 16th—*i.e.*, two days before the opening of the International Electrical Congress. Particulars of the preliminary arrangements may now be obtained from the secretary of the Institution.

Personal.—Dr. J. Erskine-Murray has left the employment of Marconi's Wireless Telegraph Co. (Ltd.).——Major Pringle, R.E., has been appointed Inspector of Railways under the Board of Trade, succeeding the late Col. Sir F. A. Marindin.——The Senate of the Cambridge University have agreed to confer honorary degrees of the University on Prof. H. Poincaré, Prof. S. P. Langley, and the Earl of Rosse, F.R.S.

Wireless Telegraphy in the Navy.—Experiments on wireless telegraphy were carried out last week between the battleships "Jupiter" and "Hannibal." The "Hannibal," which was under way, clearly read the "Jupiter's" messages at 20 miles, while the "Jupiter," which was stationary, distinctly read the "Hannibal's" messages at 32 miles distance in the morning, and at 25 miles in the afternoon.

The Royal Society.—Among the papers down for reading yesterday, were:—"On the Estimation of the Luminosity of Coloured Surfaces used for Colour Discs," by Sir W. de W. Abney, F.R.S.; "The Sensitiveness of Silver and some other Metals to Light," by Major-General Waterhouse, and "The Crystalline Structure of Metals," second paper, by Prof. Ewing, F.R.S., and W. Rosenhain.

Physics at Oxford University.—It is understood that an appointment will shortly be made to the Wykham Professorship of Physics to be endowed by New College. A portion of the Radcliffe Library will be temporarily utilised as a laboratory for the teaching of electricity. Merton College has contributed a sum of £700 towards the cost of fitting up, and £500 towards maintaining for two years the new electrical laboratory.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Paramaribo—Cayenne	Feb. 16, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ..	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Manila—Ilo Ilo...	April 9, 1900 ...	May 29, 1900
San Thomé—Loanda	May 20, 1900 ...	—

Interesting Austrian Electric Railway.—According to the *Engineer*, a funicular railway has been proposed for Trieste, to connect the town, which is in a hollow at the foot of the Karst, with Opcina. At present, to reach Opcina, which is distant from Trieste only 1·28 miles as the crow flies, it is necessary to travel first to Vienna, the line for which makes a long detour, and the journey to Opcina takes from one to one and a half hours. The line will be narrow-gauge, and 3·1 miles long. The steepest portion of the line, the gradient of which is 1 in 4, will be laid down on the rack-and-pinion system. Six stations are to be provided for the present, and the line will be worked on the Abt system by electric power.

The Capacity of Accumulators.—In a recent number of *L'Eclairage Electrique*, M. L. Jumau describes some investigations which he has carried out on the relation between capacity and strength of acid. The experiments were carried out on cells of the Faure type. He found that the capacity increases at first, and then decreases as the strength of the acid is increased, but the concentration which gives a maximum rises with the rate of discharge. The same is true of the positive and negative plates separately; the maxima, however, do not occur at the same values for the concentration, the capacity of the negatives falling off with a strong acid. The greatest capacity would be found in a cell in which the plates were separated, and having strong acid round the positives, and dilute acid round the negatives. This being impossible in practice, the strength of acid should depend on

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the rate of working, and the area of the negative plates should be greater.

Electrical Developments in South America. — A correspondent, writing from Rio de Janeiro, sends us some interesting particulars of the electrical installation of the city of San Paulo, South America. The power is taken from a waterfall, situated about 22 miles from the city, giving a fall of 71·5 ft., and capable of developing 25,000 H.P. Double turbines are used, each of 48in. diameter, and with a capacity of 3,000 H.P., and these are coupled to three dynamos situated at the ends of three totally independent lines running to the city. The price to be charged for each 16 c.p. lamp is at the rate of 48 reis per hour, this rate being about one-half that previously charged for 10 c.p. gas-burners. The city of St. Paulo has about 150,000 inhabitants, and possesses a large and complete tramway system worked by mechanical power. Coal is imported from England. The installation is the work of the San Paulo Railway Light and Power Co., formed some little time ago with a capital of $5,000,000.

Wireless Telegraph Experiments in Germany.—According to the *Frankfürter Zeitung*, successful experiments have recently been made at Bremerhaven with the Schäfer system of wireless telegraphy. An apparatus with a wire 205ft. high has been put up for the North German Lloyd at Kaiserhafen, to effect communication between Bremerhaven, the Rothesand lighthouse, Borkum, and the fireship Borkum-Riff. It is hoped also to signal successfully between Heligoland and Bremen, a distance of nearly 100 miles. The large Lloyd steamers, adds our contemporary, are gradually all to be equipped with Schäfer apparatus, and the steamer "Seeadler" has been fitted up as an instruction ship for the men.—The Berlin correspondent of the *Daily Chronicle* states that the German lightship on the Borkum reef, at the mouth of the river Ems, has been provided with a set of Marconi apparatus, by means of which messages will be exchanged between ships at sea and the land telegraph station on Borkum island. A charge of 10d. is to be made in addition to the ordinary telegraph charges.

Paris Exhibition Literature.—M. E. Hospitalier, editor of *l'Industrie Electrique*, and M. J. A. Montpellier, editor of *l'Electricien*, are, with the collaboration of no less than 33 well-known engineers and writers on electrotechnical subjects, publishing in 12 to 15 numbers a complete account of "l'Electricité à l'Exposition de 1900." The delay in the completion of the exhibition has resulted in only one number having appeared up to the present, but if the remainder attain the same standard of excellence and command of detail as this one, the publication will not be one of the least valuable products of the exhibition. No. 1 is an account of the "Organisation et Service Généraux de l'Exposition," and gives a full account of the arrangements made and regulations for the light and power distribution, transportation, and telegraphic and telephonic service. The statistics and reprints of regulations are brightened with plans and drawings, and the compilation affords an admirable book of reference. Technical details, such as descriptions of the machinery and plant, are reserved for future numbers. The work is being published by the firm of Vve. C. Dunod and the subscription price of the whole is to be 40fr.

The Chicago Electric Traction Co.—The *Railway and Engineering Review*, of Chicago, states that this company has decided, after careful consideration, on changing the system of operation on its lines from the battery to the overhead trolley. The length of line originally under the control of this company amounted to 21 miles of single track; and this during the past year has been increased by six miles. On account of the level nature of the track throughout its whole length, the conditions were exceptionally favourable for the operation of the battery system, and the withdrawal after a three years' trial can be only regarded in the nature of a reverse. The real reason for this change-over is not that the battery system has been found mechanically ineffectual and unsatisfactory, but mainly because careful estimation reveals the fact that even under the most favourable conditions the cost of operation and maintenance is 50 per cent. above that of the trolley system. In addition, the battery system is said to be unsuited for the operation of branch lines such as are at present contemplated on the Chicago system, because all the advantages of a centrally located power station for the recharging of batteries are then unavailable.

An Italian Electric Furnace.—The Stassano electric furnace, which the *Electrical World and Engineer* of New York states has been tested in an experimental plant of 100 H.P. near Rome, is claimed to reduce the cost of producing iron and steel about one-third. The apparatus resembles in appearance a blast furnace of very small size, the heat being supplied by an electric arc between carbons entering opposite openings at the bottom of the furnace and adjusted by hand. Carbonates and oxides are the ores usually treated. The former are first roasted, and it is necessary to powder all the ores and mix them with such proportion of carbon, lime or silica as analysis may show to be necessary for producing the desired quality of metal, and then to form the powdered mixtures into bricks with 5 or 10 per cent. of pitch under hydraulic pressure. The dried bricks are fed into the heated furnace, the treatment then lasting a little more than half-an-hour in a test producing a small ingot. The process is aided by the combustion of the carbon of the mixture, and the electric energy required for each ton of metal is estimated at 3,000 H.P. hours. Further experiments are to be made with three furnaces of about 500 H.P. each, capable of yielding about 4,000 tons of metal annually.

An Electric Lightship.—According to the *Electrical Review* of New York, one of the largest steam-propelled and electric lighted lightships ever built is to be used off Cape Hatteras, for the purpose of lessening the dangers of navigation off that point. For the protection of shipping there is already a lighthouse about 1¼ miles from the extreme point of the cape, whose focal plane is 190ft. above the level of the sea. A few miles from the shore are the dreaded Diamond shoals, on which vain attempts have been made to erect a lighthouse. The lightship, which has been designed to meet the exceptional difficulties, is to be 112ft. long, 28ft. 6in. beam, and a depth of 14ft. 10in. The dynamos and engines for the electric light plant will be located on the main deck, and within the engine and boiler casing. There will be two hollow steel masts, through which the wiring for the masthead flashlights is to run. These lights, three in number on each mast, are to be adapted for electricity or for oil-lamps. The electric plant will be driven by two non-condensing, double cylinder engines, running with 80lb. steam pressure. The vessel will be lighted by 80 16 c.p. 100-volt lamps. The masthead cluster, 59ft. above the water line, will consist of 6 100 c.p. 100-volt lamps, to be controlled by an automatic flashing device. In addition to a steam-whistle, the lightship will be provided with a steam siren, for use in thick and foggy weather.

Obituary.—We regret to announce the death on Saturday last, at the age of 56 years, of Mr. William Johnson, until recently the Corporation electrical engineer and manager of the Sheffield electric supply works. Mr. Johnson had been in ill-health for some time past, but his death will, nevertheless, come as a surprise and be received with regret by all his numerous friends. Under Mr. Johnson's control the system of electric supply at Sheffield was brought to a high state of perfection in the face of innumerable difficulties, firstly under the Sheffield Electric Light and Power Co., as well as after the transference of the undertaking to the Corporation. Mr. Johnson was also prominently associated with the development of the telephone in this country, having been the inventor of a well-known transmitter called after his name, besides being largely connected with the establishment of the telephone system in Sheffield.

We have also to record the death, at his residence, Cottenham Park, on May 7, of Mr. Frederic Wyles, assistant electrical engineer to the London and South Western Railway, Waterloo Station, London, at the early age of 39. Mr. Wyles was an active member of the Institution of Electrical Engineers, and took a deep interest in all matters appertaining to his profession. The London and South Western Railway Co. has sustained a great loss by the death of a most capable officer, and the utmost sympathy is extended to his widow and children. At the interment at Wimbledon New Cemetery nearly 200 railway men of all grades assembled.

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Patent Procedure.—The committee to inquire into the advisability of some reforms in patent procedure has been constituted as follows by the Board of Trade: Sir Edward Fry (chairman); Sir Richard Webster, Bart., G.C.M.G. (Master of the Rolls); Sir Edward Carson, Q.C., M.P. (Solicitor-General); Sir William H. Houldsworth, Bart., M.P.; Mr. F. J. S. Hopwood, C.B., C.M.G.; Mr. S. E. Spring-Rice, C.B.; Mr. J. Fletcher Moulton, Q.C., M.P.; Col. Thomas W. Harding; Mr. Edward Carpmael; and Mr. Herbert Hughes. Mr. Arthur Paget, barrister-at-law, has been appointed secretary to the committee. The reference to the committee is:—

While Her Majesty's Government do not think it desirable and do not propose to establish any general system of examination as to the novelty of inventions in respect of which applications for letters patent are made, and do not require any inquiry into any such system of examination, the committee hereinbefore appointed is to inquire into the working of the Patents Acts with reference to the following questions:—

(1.) Whether any, and, if so, what, additional powers should be given to the Patent Office to (*a*) control, (*b*) impose conditions on, or (*c*) otherwise limit the issue of letters patent in respect of inventions which are obviously old, or which the information recorded in the office shows to have been previously protected by letters patent in this country;

(2.) Whether any, and, if so, what, amendments are necessary in the provisions of Section 22 of the Patents, &c., Act, 1883; and

(3.) Whether the period of seven months' priority allowed by Section 103 of that Act to applicants for letters patent under the International Convention may properly be extended, and, if so, on what conditions.

Buxton Electricity Works.—The electricity works of the Buxton Urban District Council have recently been opened. The provisional order was obtained in 1894, but no steps were taken to give effect to this order until 1898, when Prof. A. B. W. Kennedy was invited to report on the system of electric supply best suited to the conditions and requirements of the district. Prof. Kennedy advised a three-wire low-pressure system of supply, the voltage being about 230 volts. A handsome brick building was erected on a site near the gas works, at a cost of £5,000, while the expenditure to date on machinery, feeders, mains, lamps, posts, &c., amounted to £14,000. The station equipment consists of three Hornsby water-tube boilers, capable of evaporating 4,500lb. of water per hour; four Bellis high-speed engines of a total of 320 H.P. and direct-coupled to six four-pole Mather and Platt continuous-current dynamos, having a total capacity of 198 kw. For the day load a battery of accumulators has been installed, and contains 260 cells of Tudor type, with a capacity of 250 ampere-hours and a maximum discharge rate of 100 amperes. The feeding and distributing mains were supplied by the Callender Cable and Construction Co. and consist of concentric, lead-covered, and armoured cables for the feeders, and triple-concentric cable for the distributors. Mr. Kenneth Watson superintended the erection of the installation on behalf of Prof. Kennedy, and Mr. Edward Calvert is the chief electrical engineer appointed by the District Council.

Municipal Electrical Association.—The following is the programme of the Municipal Electrical Association meeting at Huddersfield from June 20 to June 23 inclusive. First day: Meeting at 10 a.m. at Technical College to hear Mr. A. B. Mountain's Presidential Address; two Papers on "Means for Stimulating the Demand for Electrical Energy," by Ald. W. Potter, of Taunton, and H. C. Bishop, of Wigan; and two Papers on "Electricity Works for Small Towns," by C. S. Vesey-Brown, of Lincoln, and G. M. Harris, of Bray. In the afternoon the Bradford Corporation Electricity and Tramway works will be visited. In the evening a dinner will be given in the Town Hall by Mr. Joseph Hopkinson. Second day: Meeting at 10 a.m. at Technical College; two Papers on "Electric Motors," by T. P. Wilmshurst, of Derby, and C. A. L. Prussmann, of Doncaster; a Paper on "Combined Management of Tramways and Lighting Departments," by R C. Quin, of Blackpool; and a Paper on "Methods of Reducing Light Load Losses," by H. L. P. Boot, of Tunbridge Wells. In the afternoon the mayor gives a garden party; in the evening the Association Dinner at the Town Hall. Third day: Meeting at 10 a.m. at the Albert Hall, Leeds; two Papers on "The Distribution of Electricity in Scattered Areas," by L. Andrews, of Hastings, and G. Wilkinson, of Harrogate; a Paper on "Maintaining Certain Portion of Electrical Distribution Systems at Earth Potential," by C. H. Wordingham, of Manchester; a Paper on "Impressions of Present American Tramway Practice," by A. E. Le Rossignol, of Newcastle-on-Tyne; and a Paper on "Protection of Telegraph and Telephone Lines," by R. C. Quin, of Blackpool. In the afternoon a visit will be paid to the Leeds Electricity Works and Tramway Power Station. Fourth day: The business meeting of the Association. We are asked to state that the Council of the Association cordially invite all who may be interested to attend the meetings; also that copies of the Papers and any further information as to local arrangements may be obtained from the president, Mr. A. B. Mountain, Corporation Electric Supply Works, St. Andrew's-road, Huddersfield.

Physics Congress at the Paris Exhibition. — The International Congress, organised by the French Physical Society, will be held in Paris, August 6th to 12th. The programme has been divided into three parts: (1) Various communications and lectures on some new questions; (2) Visits to the exhibition, laboratories and works; and (3) Papers and discussions on subjects decided upon beforehand. Over seventy papers have already been promised on various subjects by different authors. Among the authors and subjects are the following:—

M. M. ABRAHAM: Determination of *v*. ARRHENIUS: Electrolysis and Ionisation. D'ARSONVAL: Currents of High Frequency in the Organism. BECQUEREL: Uranium Rays. BICHAT and SWYNGEDAUW: Actino-electric Phenomena. BLONDEL: Recording Variable Electric Currents, Oscillographs and Rheographs. BLONDLOT and GUTTON: Speed of Electric Waves. BOUTY: Gaseous Dielectrics. BOYS: The Constant of Gravitation. BRANLY: Variation in the Resistance of Tubes of Filings. BROCA: Transmission of Energy in the Organism. CHRISTIANSEN: Contact Electricity. CORNU: Speed of Light. CURIE (M. et Mdme.): New Radio-active Substances and the Becquerel Rays which they emit. DRUDE: Optical Properties of Metals. DU BOIS: Magnetic Properties of Bodies. EÖTVÖS: Study of Electric and Magnetic Equipotential Surfaces. EXNER: Atmospheric Electricity. PRINCE GALITZINE: The Critical Index. GOUY: Standard of Electromotive Force. GUILLEAUME: International Decisions Concerning Units and Nomenclature; Various Propositions. GRIFFITHS: The Unit of Heat. HURMUZESCU: Electromotive Force of Magnetisation. LORD KELVIN: Conditions of the Formation of Ether Waves by the Displacement of Ponderable Matter; Non-Oscillatory Character of these Waves for Speeds of Displacement less than that of Light. VON LANG: The Electric Arc. LEDUC: Electro-Chemical Equivalent of Silver. LIPPMANN: The Absolute Scale of Temperatures LORENTZ: Magneto-Optics. NAGAOKA: Magneto-Striction. PAULSEN: The Polar Aurora. PELLAT: National Laboratories. H. POINCARÉ: Relations between Experimental Physics and Physical Mathematics. L. POINCARÉ: Theories of the Voltaic Pile. POTIÉR: Polyphase Currents. POYNTING: Theory of the Propagation of Electricity. RIGHI: Hertzian Waves. RUBENS: On Wave Lengths. J. J. THOMSON: Electric Discharges in Gases. VILLARD: Cathode Rays. VILLARI: The Ionisation of Gases. VIOLLE: Speed of Sound. WARBURG: Magnetic Hysteresis. W. WIEN: Temperature and Entropy of Radiation. WITZ: Recent Progress in the Theory of Heat Engines.

Proofs of the majority of these Papers, which will be in French, may be obtained beforehand by those who are going to take part in the Congress. Further particulars may be ascertained from M. Lucien Poincaré, Secretary of the Commission of Organisation, 105 bis, Boulevard Raspail, Paris.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, June 1st.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Sir Henry Roscoe, F.R.S., subject "Bunsen."

THURSDAY, June 7th.

RÖNTGEN SOCIETY.

8 p.m. Ordinary General Meeting in the Electrical Department of St. Bartholomew's Hospital, Smithfield, when: (1) Dr. Lewis Jones will show an influence machine of American design; (2) Mr. James Wimshurst will give a short statement of his work in the design and perfecting of the several forms of his influence machine; (3) Dr. Rémy, of Paris, will show a new localising apparatus.

FRIDAY, June 8th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, when the following Papers will be read: (1) "On the Magnetic Properties of Iron and Aluminium Alloys, Part II.", by Dr. S. W. Richardson; (2) "Note on the Crystallisation Produced in Solid Metal by Pressure," by W. Campbell; (3) "On the Viscosity of Mixtures of Liquids and of Solutions," by Dr. C. H. Lees.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "The Effect of Physical Agents on Bacterial Life," by Allan Macfadyen.

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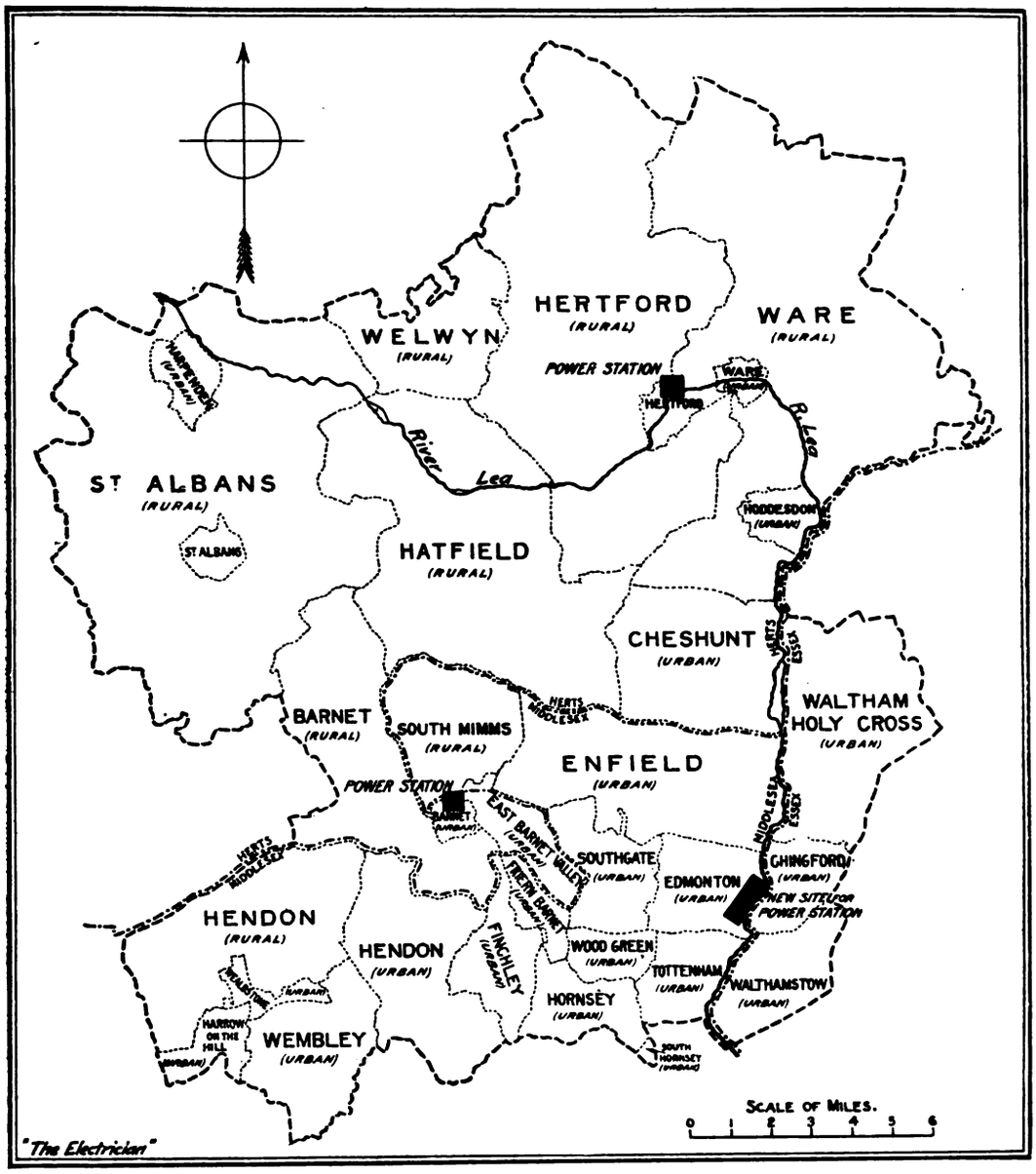
PROJECTED ELECTRICAL POWER SCHEMES.

(*Continued from page 81.*)

5. North Metropolitan Electric Power Scheme.—For the moment we turn from the series of power schemes which is being considered by the Parliamentary Committee, presided over by Sir James Kitson, to deal with a similar scheme of equal importance, which, during the past week, has come before another Committee of the House of Commons, presided over by Mr. H. A. Brown. This is the scheme of the North Metropolitan Electric Power Supply Co., the promoters of which are Messrs. E. Garcke, W. L. Madgen, J. S. Raworth, and R. P. Sellon—the same, in fact, as for the County of Durham scheme, described in our issue of May 4, p. 58. The accompanying map shows the area it is proposed to supply with electric power under this scheme. The capital, to obtain which powers are sought, is £270,000 in £10 shares, with borrowing powers up to £90,000 in debenture stock. Our "Parliamentary Intelligence" columns this week give particulars of the scheme and of the examination of witnesses by the Committee. Meanwhile Sir J. Kitson's hard-working Committee is still considering the Lancashire scheme, of which we have given our readers a full description.

(To be continued.)



MAP OF THE NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.'S PROPOSED AREA OF ELECTRICITY SUPPLY.

PUBLIC ARC LIGHTING IN ST. MARTIN'S PARISH.

The lighting of the streets of London has for long been a subject for complaint, and if the ratio of the number of electrically-lighted to gas-lighted streets were calculated for all our larger towns, it would probably be found that the figure obtained for London was among the smallest. This is due no doubt to the fact that the electric lighting of the main parts of London is in the hands of companies, while in other large cities the corporation owns the electric light works; it is, therefore, a matter for congratulation that another of the metropolitan local authorities has been wise enough to erect arc lamp-posts, and to enter into an agreement with a supply company for the lighting of the principal streets in the parish. In all, 97 10-ampere (1,000 nominal c.p.) open arc lamps have been erected in St. Martin-in-the-Fields, and they are distributed as follows:—

Haymarket, 5 lamps; Panton-street and Whitcomb-street, 5; Leicester-square, 4; Pall Mall East, 2; Cockspur-street, 2; Trafalgar-square, 7; Charing Cross and Whitehall, 5; Horse Guards-avenue, 2; Whitehall-avenue, 2; Whitehall-place, 3; Northumberland-avenue, 6; Strand, 14; Agar-street, 1; King William-street, 1; Chandos-street, 2; Adelaide-street, 1; Duncannon-street, 1; St. Martin's-place, 2; Charing Cross-road, 5; Green-street, 1; St. Martin's-lane, 6; Garrick-street, 2; Cranbourne-street, 2; Upper St. Martin's-lane, 1; Long-acre, 9; Endell-street 1; Villiers-street 5.

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Before deciding to let the contract for street lighting to the Charing Cross and Strand Electricity Supply Corporation, the Vestry instructed their surveyor, Mr. George Green, to report on the advisability of the Vestry erecting its own generating station in combination with a refuse destructor. Mr. Green wisely reported against the latter alternative, and recommended that tenders should be invited from the three supply companies who have mains laid in the parish, with the result that the contract was awarded to the company mentioned above. The

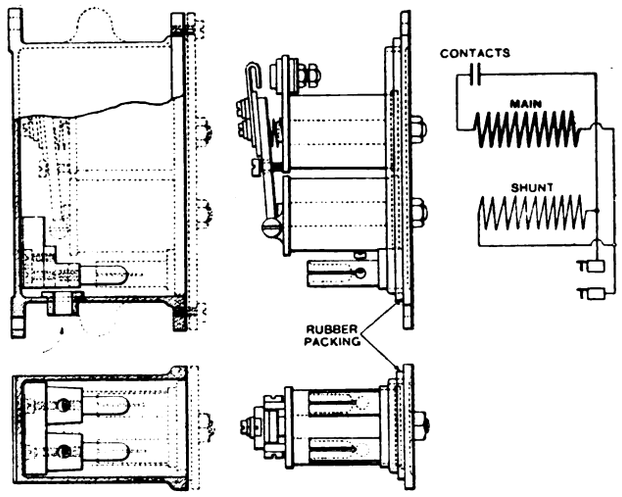

FIG. 3.—AUTOMATIC CUT-OUT. (One-fourth size.)

new street lighting was "inaugurated" on Wednesday last week, in honour of the Queen's birthday.

The lamps are connected in circuits of 20 in series, and are supplied from the Maiden-lane station of the Charing Cross Co. The circuits are connected to a switchboard independent of the main switchboard, and the current at 1,000 volts is

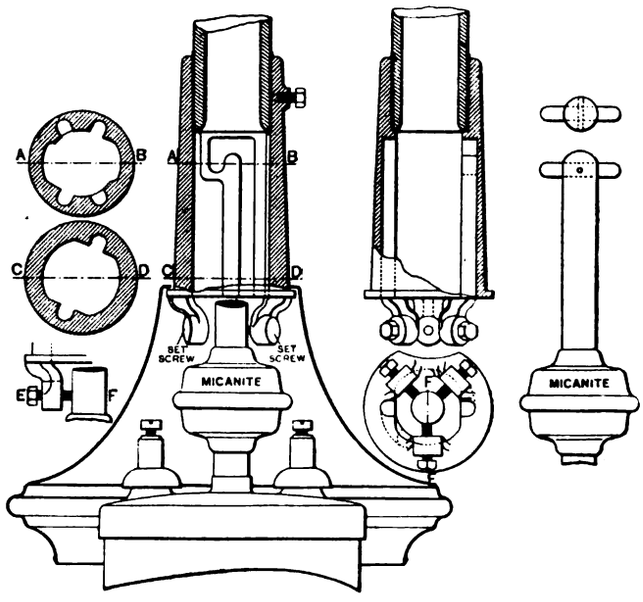

FIG. 4.—DETAILS OF ATTACHMENT FOR CENTRE LAMP AND WEATHER-PROOF HOOD. (One-fifth size.)

supplied by continuous-current converters, whose low pressure side is connected to the low-pressure 'bus bars. Each arc circuit is connected through an ammeter, a double-pole switch, Bates' fuses on each pole, and a series regulating resistance; and a voltmeter is connected across the two poles. As the low-pressure 'bus bars of the Maiden-lane station are supplied chiefly from 1,000-volt continuous-current generators at the company's station in Lambeth through step-down continuous-current converters in the former station, it is seen that the current for the arc circuits undergoes two transformations, although it is supplied to the circuits at practically the pressure at which it is generated. The reason for this is that at present the trunk mains between the two stations are too valuable to allow the arc lighting circuits to be connected to them directly. Probably when the new switchboard at Maiden-lane (to replace the one destroyed in the recent fire) has been completed, an alteration in the connections of the arc circuits will be made.

The cables are all 19/18 S.W.G. single vulcanised bitumen cables (made by Callender's Co.), and they are laid in ordinary Doulton ducts, with three 3in. ways, jointed on cement cradles in the usual manner. Near the station, which is at one corner of the area in question, the go and return cable run together, but in some parts a considerable amount of cable is saved by running them separately. In the case of alternating and rectified current arcs the go and return main cannot be separated in this way on account of induction effects on neighbouring telegraph and telephone circuits, and this

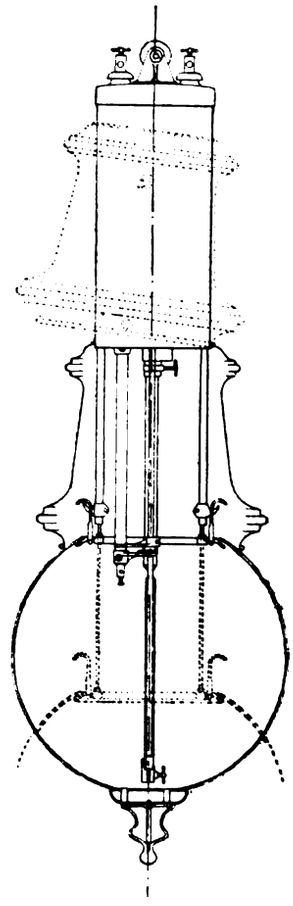

FIG. 5.—METHOD OF LOWERING GLOBE FOR TRIMMING.

advantage of the series-continuous-current method is often overlooked when comparing different systems. Another interesting fact is that no attempt has been made to crowd in more than 20 arcs on the 1,000-volt circuit, although some engineers assert that they have been successful in running nine lamps between 440 and even 400-volt mains. The lamps with their regulating coils take 45 volts each; no steadying resistances other than the series regulating coils themselves are placed between lamps, but all is included in the regulating resistance at the station. With one exception there are no joints in the cables, and the cable is in each case run right up to the switchboard in the lamp pillar and out again. The exception is merely a straight-through joint in the longest length of cable, there being no T joints at all and no surface boxes other than an occasional draw-box to help sharp bends to the lamp posts.

Two patterns of lamp post are employed, the centre type, shown in Fig. 1, placed on refuges in the roadway, and the swan-neck type of Fig. 2. The lamp in the former is reached

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by means of climbing irons, while in the latter case the lamp is lowered for trimming. The posts are by Messrs. Singer and Sons. They are painted a bright cherry red, which is somewhat obtrusive at present, but will no doubt soon get toned down by the effects of weather. The illustrations enable a comparison to be made between the appearance of the electric lamps and the now disused gas lamps.

In the base of each post is a switchboard on which an isolating switch and an automatic cut-out are mounted, and next to it the substitutional resistance. The switch is of the pattern with laminated C-shaped springs, in the jaws of which the rotating contact bar fits. It has, of course, only two positions, one in which the lamp is connected between the two cable ends, and the other in which both terminals of the lamp are isolated and the substitutional resistance is connected in its place. The shape of the key for turning the switch, and of the key-hole cut in the cast-iron cover of the switch, are such that the key cannot be removed when the switch contacts are in an intermediate position. The automatic cut-out is constructed on the usual principle. It is simple and compact—taking up, in fact, less room than the switch—and has the advantage that the whole of the mechanism is attached to the cover, and can be withdrawn easily for examination, the contact being made through the spring thimbles seen in Fig. 3. The two terminals TT are connected in series with the substitutional resistance (not shown in the diagram) and shunted across the lamp. Thus normally the circuit of the upper or "main" coil of the device is open, while the shunt coil is permanently connected across the lamp terminals. When a lamp "hangs up," or if its carbons are burnt down, the current through the shunt coil increases and the armature is attracted against the magnets, closing the two contacts. As soon as this happens, both the substitutional resistance and the "main" coil of the cut-out are in circuit in place of the lamp, and the latter coil being energised draws up the armature tighter and ensures good contact. On the lamp feeding again, as soon as the carbons meet, both coils of the cut-out are shunted by them, and the armature is again released, there being practically no sparking as the coils are short-circuited. The cut-out comes into action when the arc has lengthened sufficiently to require 60 volts. Connection is made between this switchboard and the lamp by means of lead-covered vulcanised rubber cables.

The lamps as well as the auxiliary apparatus already alluded to are made by Messrs. Oliver and Co., of Woolwich, a comparatively new firm of arc lamp manufacturers not yet very well known among central station engineers, as it has chiefly b en occupied in supplying some of the large railway companies. Another sample of its street lighting work may, however, be seen at Leyton. An examination of the lamp shows that the manufacturers' chief aim has been to attain simplicity in construction, and this combined with workmanlike finish and a strict interchangeability of parts is evidently the key to the good working of the lamps, for we understand that the Charing Cross Co. are well satisfied with the way in which they burn. The well known clutch principle (which, we believe, has been tried and again abandoned by some makers) is adopted, and the design of the lamps, which shows evidences of having been most carefully thought out in every detail, is such that any part may be taken out by the removal of two screws, and replaced, without prejudicing the adjustment of any other part. The framework is of a substantial character, to withstand rough usage. To the crown or top plate of the lamp are attached exceptionally strong main and shunt regulating coils, in which annealed iron cores work in the usual manner,

FIG. 1.—LAMP OPPOSITE THE NATIONAL PORTRAIT GALLERY.

FIG. 2.—SIDE-LAMP IN KING WILLIAM STREET, STRAND.

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being pivoted below to a cradle or rocking frame, this directly controlling the working of the clutches. Adjustment for the current and voltage is made by the addition of a weight to either end of the cradle. A large air dash-pot (1½in. diameter) is attached to the latter, the plunger being rigidly held to the base-plate or bottom frame of the lamp, so that the cylinder which works over the plunger is inverted, preventing the accumulation of dirt in it and consequent sticking. By means of attaching the positive rod, on which the clutch works, by a flexible copper cord over a pulley to the negative (not directly, of course, but with the intermission of a mica-insulated washer), the lamp is made focussing. The current is carried to the positive and negative rods inside the case, thus doing away with loose connections in the globe, and the lamp is insulated from the case by little piles of mica, this insulation being used wherever possible.

Among the details deserving notice are the bayonet type of attachment used for holding the centre lamps rigidly, the design of which is evident from Fig. 4, and the method of lowering the globe for trimming, shown in Fig. 5. Another interesting feature is that the top globe ring is inside instead of outside the globe, so that the ring itself and not the wires of the netting bear the weight of the globe. This ring is all in one piece, and at first sight, until two slots at opposite sides of the ring are observed, it is not evident how it has been got within the globe. The side lamps are lowered by means of a winch worked by a key passing through the side of the base of the post. Before being able to lower the lamp it is necessary to open the post in order to release the pawl of the ratchet. The steel wire from the lamp to the winch passes over a pulley through the centre of the weather hood, and then over a second one and through the centre of the post. Contact is made, when the lamp comes up into position, through concentric rings and copper brushes.

In preparing this article much information has been given us by Mr. Oliver, of Messrs. Oliver and Co., and by Mr. Percy Mossop, distributing engineer of the Charing Cross and Strand Co., who has been responsible, under Mr. Patchell, the engineer-in-chief, for putting down the arc lighting system. We wish to tender our thanks to these gentlemen, who have afforded us every facility to inspect the lamps and the details of the system.

THE CENTRAL LONDON RAILWAY.

Introductory.—The Central London Railway is a deep level twin tunnel electric railway running between a point below the roadway in front of the Bank of England and Shepherd's Bush, a distance of 5¾ miles. Besides the two terminal stations, there are 11 intermediate passenger stations. The power house, with the sheds, sidings, yard space, &c., is situated a short distance beyond the Shepherd's Bush terminus. The railway is designed to provide a 2½-minute service of trains. It is probable, however, that the service will ultimately be increased to 2 minutes.

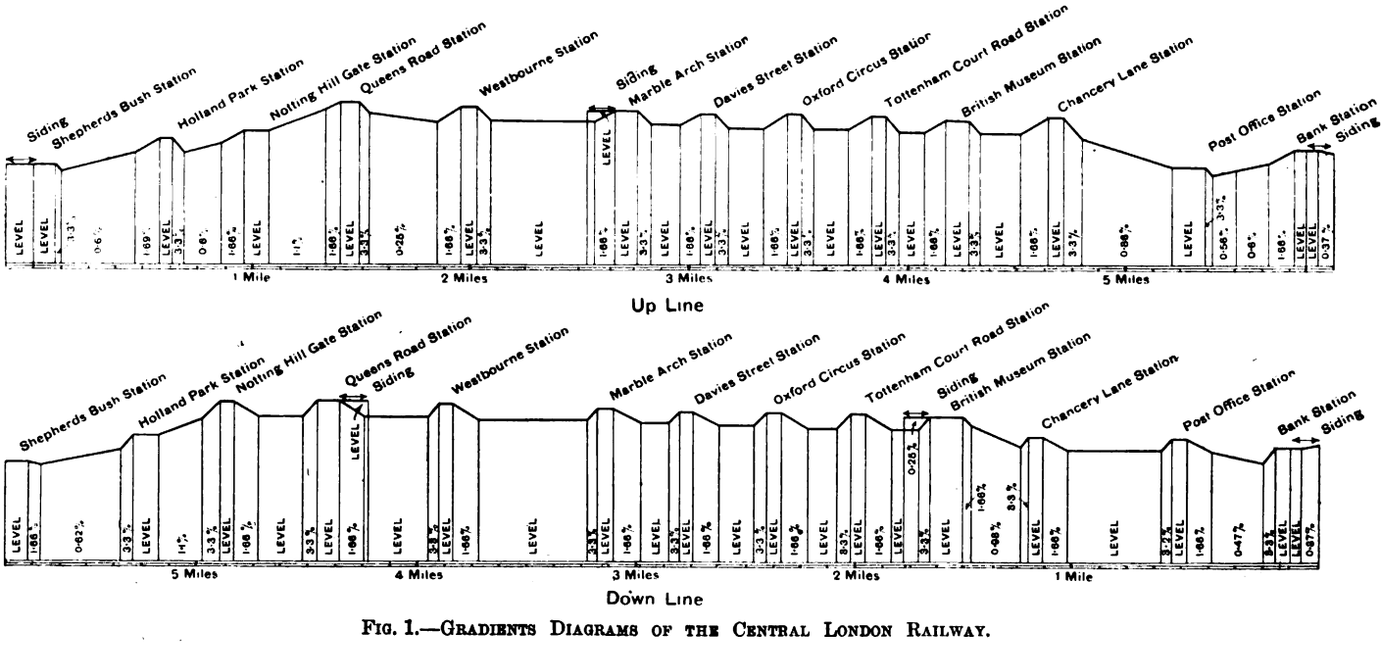

FIG. 1.—GRADIENTS DIAGRAMS OF THE CENTRAL LONDON RAILWAY.

The electrical equipment of this railway is now practically completed, and experimental trains are running frequently with a view to testing the general construction, and also to get the staff practised in the somewhat novel arrangements of the train service. Considerable work, however, remains to be done, principally at the passenger stations, so that some weeks must yet elapse before the line can be opened to the public. The electrical work, however, being completed, the present is an opportune moment for commencing a technical description of this equipment, with some general account of the other features of the railway; as this description must necessarily occupy the space of several articles, we hope to have the series completed before the inauguration of the line takes place.

Before proceeding to consider the engineering features of the line, we will briefly survey the chief events in its development. In 1890 the first Central London Railway Bill was promoted. By this bill it was proposed to construct a deep-level twin-railway on the Greathead system, at a depth of 40ft. or 50ft. below the surface, between Queen's-road, Bayswater, and the King William-street terminus of what was then known as the City and Southwark subway, now called the City and South London Railway. Owing to opposition, however, this bill was rejected. In 1891 a new bill was promoted, and passed, for a line running from Shepherd's Bush to the Bank of England. Trial borings were sunk in November, 1891, in the neighbourhood of Uxbridge-road, these revealing satisfactory conditions as regards excavations. In the following year it was proposed to extend the line to Liverpool-street. This proposal, however, has not yet been carried out. In 1894, powers were obtained to defer the completion of the undertaking until 1900.

The Central London Railway Co. was incorporated on

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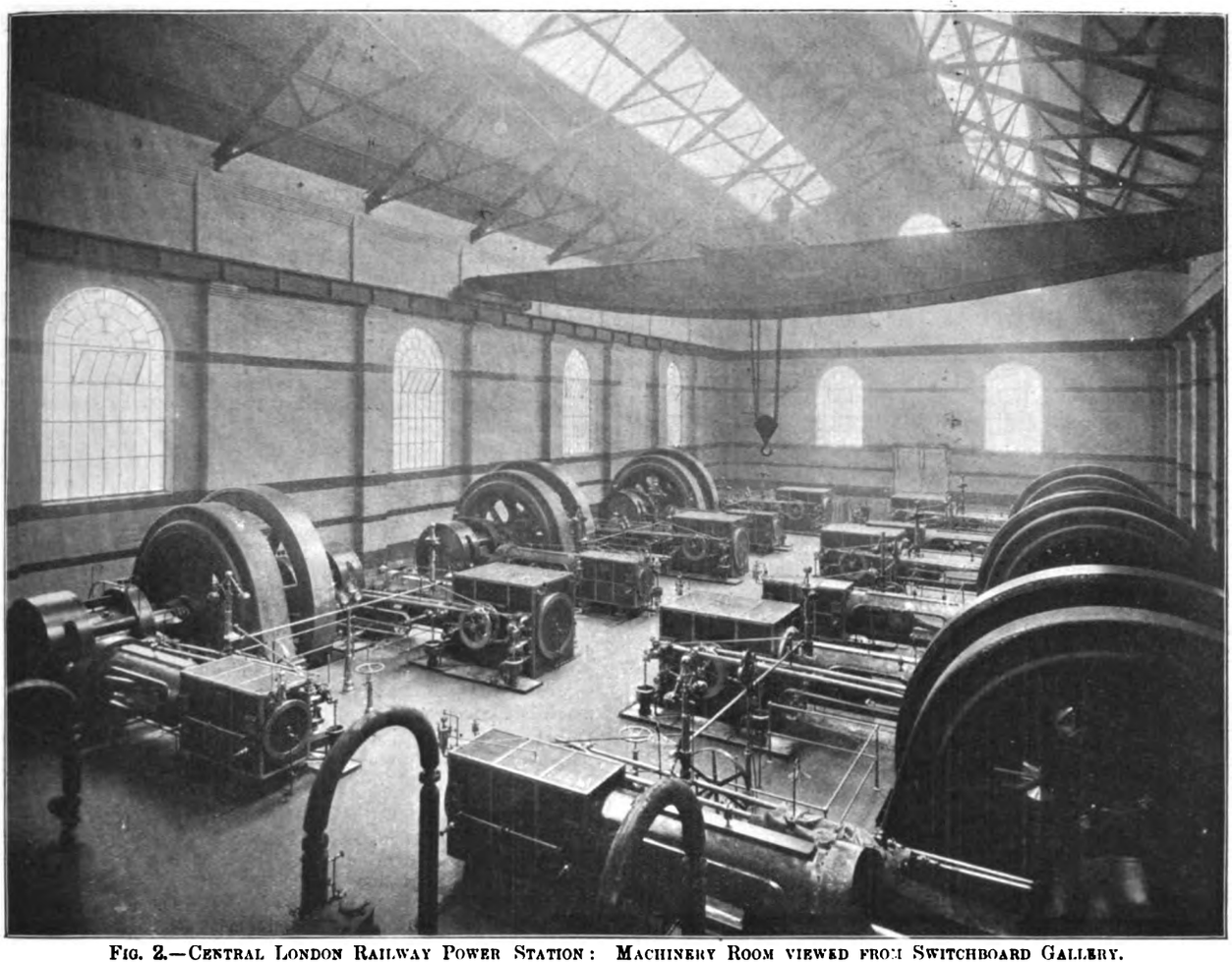

FIG. 2.—CENTRAL LONDON RAILWAY POWER STATION: MACHINERY ROOM VIEWED FROM SWITCHBOARD GALLERY.

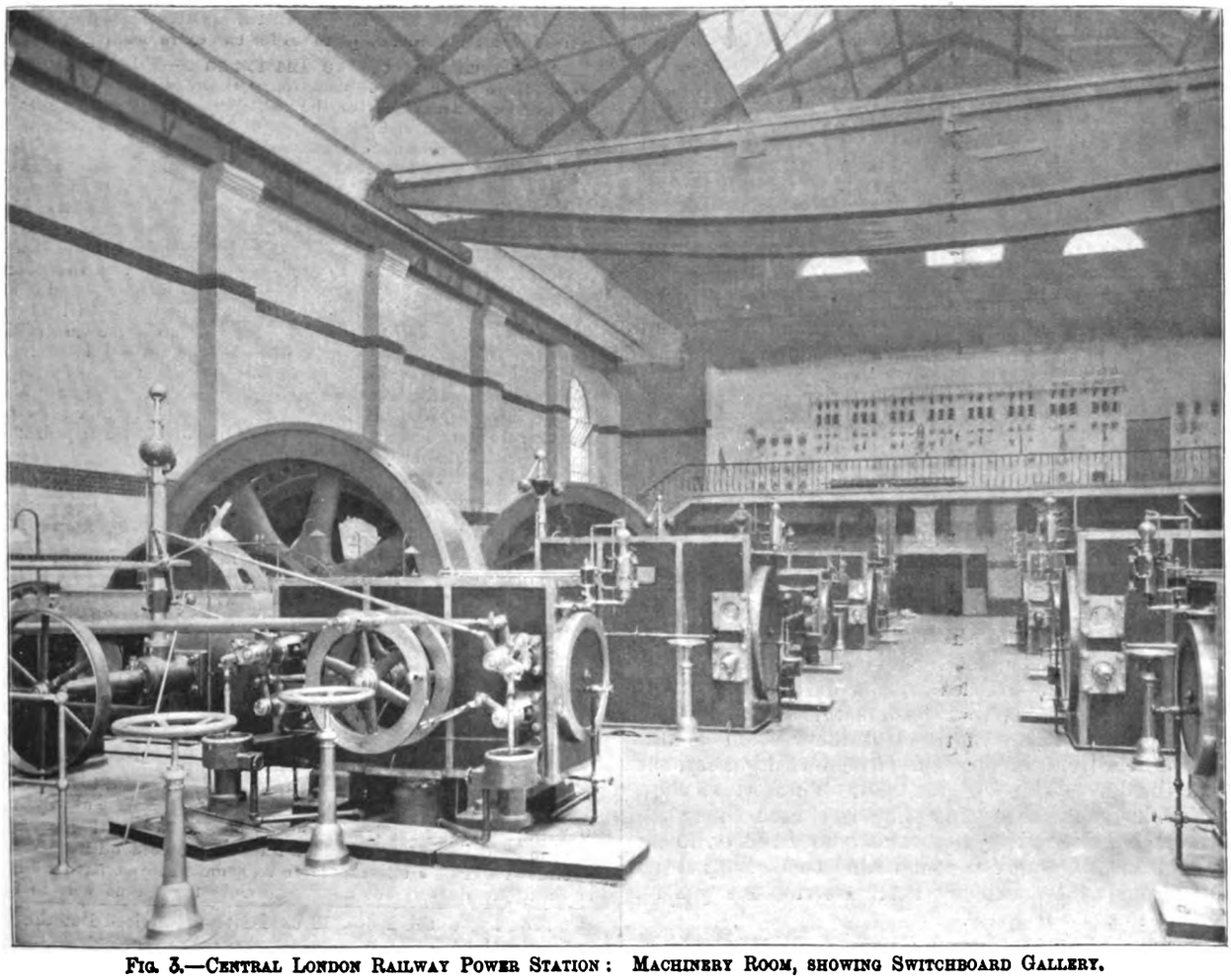

FIG. 3.—CENTRAL LONDON RAILWAY POWER STATION: MACHINERY ROOM, SHOWING SWITCHBOARD GALLERY.

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Aug. 5, 1891, with an authorised share capital of £2,700,000 and £900,000 borrowing powers. In 1894 the capital was increased to £2,850,000, with further borrowing powers of £50,000. It appears that up to the present time the amount of capital received is £2,411,092.

A contract was entered into in June, 1895, between the Central London Railway Co. and the Electric Traction Co. for the acquisition of lands and the construction and equipment of the entire railway for the sum of £3,114,000, payable partly as to £672,000 in 4 per cent. debenture stock and the remainder in cash. The engineers appointed by the company were Sir John Fowler, Sir Benjamin Baker, and Mr. Greathead; but since the decease of Mr. Greathead, Mr. Basil Mott has acted as one of the engineers. In July, 1895, the engineers were instructed to proceed immediately with the construction of the work.

Contracts for the electrical equipment of the power station, sub-stations, track, rolling stock, passenger stations, &c., were placed with the British Thomson-Houston Co. Mr. H. F. Parshall was appointed consulting engineer for the electrical equipment, and under his direction the entire work of constructing the power house and equipping the rolling stock, line, &c., has been ably carried out.

The system adopted for this railway is one which has never before been tried in this country, and, indeed, never on any very extensive scale in any part of the world. It was decided to equip the power station on the three-phase 5,000 volt system and to transmit three-phase currents at the generating

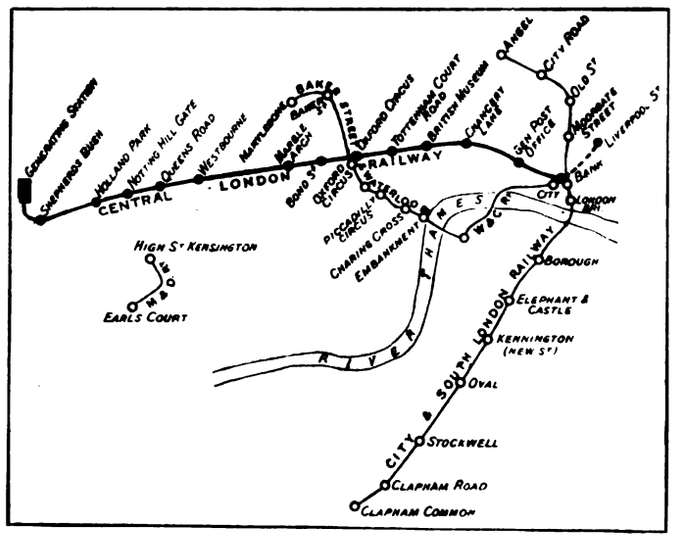

FIG. 4.—SKETCH MAP OF THE CENTRAL LONDON RAILWAY.
——— Central London Railway. ——— Other Electric Railways.

pressure to sub-stations along the line. At these sub-stations the power would be transformed down to the working pressure of 550 volts and from polyphase to continuous current. The continuous current is to be fed at numerous points along the line from distributing cables to a third-rail working conductor placed between the track rails. The return current is carried through the metallic conductor afforded by the track rails. There are at present three sub-stations, viz., at the passenger stations at Notting Hill Gate, Marble Arch and the Post Office.

As already stated, the power station is now quite completed, while many parts of the railway remain as yet unfinished. It will be convenient for this reason, therefore, to commence our series of articles with a description of the power station. We present our readers this week with two recent views of the interior of the machinery room at this station, one taken from the spacious switchboard gallery, the other from the opposite end of the hall. These views show the six 850 kw. polyphase generating sets, each consisting of a G.E. three-phase railway generator built direct on to the shaft of a horizontal cross-compound Allis condensing steam engine. In our next article we shall describe the general equipment of this power house.

(To be continued.)

REPORT OF THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the report of the Council of the Institution of Electrical Engineers for the session which has just closed:

Local Sections.—Active local sections are now in operation in Dublin, Glasgow, the Manchester district, and Newcastle, the Manchester section having taken the place of the late Northern Society of Electrical Engineers now incorporated in this Institution. A local section has also been created in Cape Town. General rules and regulations for the management of local sections at home and abroad have been drawn up, and the organisation of the sections has already assumed a definite form.

Elections and Transfers.—The Council has the pleasure to report that during the twelvemonth ending May 24, 1900, acting in accordance with Article 17 of the Articles of Association, it has elected Mr. Joseph Wilson Swan, F.R.S., the last past-president of the Institution, an honorary member.

Notwithstanding the increased severity of the rules relating to the qualifications for membership, and the strictness with which those rules are enforced, the total of the additions to the register by election at ordinary general meetings during the same period has been 401. This number is much above the average, and is made up as follows:—25 members, 88 associate members, 3 foreign members, 152 associates, and 133 students. Adding to these the honorary members and the new members transferred from the Northern Society of Electrical Engineers at the time of incorporation, the total is 471, comprising one honorary member, 53 members, 113 associate members, three foreign members, 168 associates, and 133 students.* Six associate members, one foreign member, and 12 associates have been transferred to the class of members, whilst 85 associates have been transferred to the class of associate members, and 33 students to that of associates.

Deaths and Resignations.—The Institution has to mourn the loss by death of one past-president, Prof. David E. Hughes; nine members, Mark Bevan T. Buckney, J. D. Doyle, P. B. Elwell, L. Epstein, Frank King, Joseph B. Morgan, Benjamin Smith, and Frederic Wyles; and eight associates, J. Chapman, H. J. Clipperton, H. T. Constable, M. Cooper, W. B. Edgar, J. J. Tough, W. C. Smythe, and L. G. Willmott. Three members, two associate members, one foreign member, 23 associates, and five students have resigned since the date of the last report.

Ordinary General Meetings.—The attendance at the ordinary general meetings has been well maintained. By the kind hospitality of the two societies, the meetings from November to April have been held, as in previous years, in the rooms of the Institution of Civil Engineers, and two of those in May in the rooms of the Society of Arts. The Institution is now further indebted to the Institution of Mechanical Engineers for the privilege of using their new premises for two extra meetings in May.

The Publications of the Institution.—With reference to the *Journal*, the only change of note to be recorded is the alteration in the date of the commencement of the volume, which now runs concurrently with the session. The first number of the current volume, therefore, contained the proceedings of the meetings in November and December, 1899, instead of those in January, 1900, as would have been the case under the old system.

Recognising the great value of *Science Abstracts* to the electrical engineer in placing before him an epitome of most of what is valuable in the current literature of his subject throughout the world, the Council has agreed with the Physical Society for the continuance of the publication under the joint control of the two societies for a further period of at least three years, or of so much longer as may be found mutually agreeable. The scope of the *Abstracts* has now been enlarged, sections relating to steam plant, oil and gas engines, motor cars, and medical electricity having been added, so that the work now appeals to a larger circle of readers than it has done previously, and the growing appreciation in which it is held is indicated by a considerable increase in the proceeds from sales to non-members of the two societies. The number of *Abstracts* published was increased from 1,425 in 1898 to 2,000 in 1899.

The publication of the following papers in the *Journal* as original communications has been ordered:—

In Part 142.—"How Condenser and Choking-Coil Currents Vary with the Shape of the Wave of the Applied E.M.F."	A. Russell, Member.
In Part 144.—"A Two-Phase Rotary Converter and a Note on the Regulation of Rotary Converters"	E. Wilson, Member.
In Part 144.—"The Air-Gap Induction in Continuous-Current Dynamos"	C. C. Hawkins, M.A., Member. R. Wightman, Assoc.
In Part 146.—"Note on Air-Gap and Interpolar Induction."	F. W. Carter M.A., Associate.
In Part 146.—"The Reluctance of the Teeth in a Slotted Armature"	W. B. Hird, Member.
In Part 146.—"On the Absolute Values of Capacity Measurements."	J. Elton Young, Member.

Annual Premiums.—The Council has awarded the following premiums for Papers and communications accepted during the current year. No Paper on a telegraphic or telephonic subject having been read, the Fahie premium is not awarded. Only those that were in type on

* In addition to the above, 19 candidates were elected at the general meeting on May 24.

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May 10 were considered eligible, Papers accepted for publication after that date being reserved for consideration in awarding the premiums in 1901:—

The Institution Premium (value £25) to Mr. C. E. Grove, member, for his Paper on "The Electrical Equipment of Ships of War."

The "Paris Electrical Exhibition Premium" (value £10), to Mr. S. Evershed, associate member, for his Paper on "A Frictionless Motor Meter."

Two Extra Premiums (value £10 each) respectively to Prof. George Forbes, F.R.S., member, for his Paper "On Distant Electric Power Transmission," and to Mr. H. M. Sayers, associate member, for his Paper on "The Calculation of Distributing Systems of Electric Tractions, under British Conditions."

Premiums for Original Communications published in Journal (value £5 each) to Mr. A. Russell, member, for an "Original Communication" entitled "How Condenser and Choking-Coil Currents Vary with the Shape of the Wave of the Applied E.M.F.," and to Messrs. C. C. Hawkins, member, and R. Wightman, associate, for an "Original Communication," entitled "The Air-Gap Induction in Continuous-Current Dynamos."

The First "Students' Premium" (value £10) to Mr. R. P. Howgrave-Graham, student, for his Paper on "Hertz Waves and Wireless Telegraphy."

The Second "Students' Premium" (value £5) to Mr. C. B. Nixon, student, for his Paper on "Switch Gear for the Generation of the Electric Current."

The Third "Students' Premium" (value £5) to Mr. H. J. Humphreys, student, for his Paper on "Permanent Magnets."

Salomons Scholarship.—The Council has awarded a Salomons Scholarship, value £50 to Mr. R. P. Howgrave-Graham, of the Technical College, Finsbury.

Students' Class.—Twelve meetings of the students' section have been held during the session, at ten of which Papers were read by students, the remaining two having been devoted to discussions on electrical subjects. Visits to the following places were arranged for the students by the secretary during the year, and the Council desires to express its thanks to those who, by opening their works for the purposes of these visits, have contributed much to the usefulness of the section:—Bankside station of the City of London Electric Lighting Co., Davies-street station of the Westminster Electric Supply Corporation, London United Tramways, Waterloo and City Railway, and the works of Messrs. Easton, Anderson and Goolden, the Electric Welding Co., the Incandescent Electric Lamp Co., the India-Rubber, Gutta-Percha and Telegraph Works, the Langdon-Davies Electric Motor Co., and Messrs. Siemens Bros. and Co.

Annual Accounts and Financial Position.—The surplus of income over expenditure at the end of 1899, as shown in the annual statement of accounts, demonstrates that, notwithstanding the contribution in respect of *Science Abstracts* and the increased expenditure on premiums, the financial position of the Institution is thoroughly sound.

Building Fund.—The importance of erecting a permanent home for the Institution is recognised by the Council, and they have, accordingly, taken steps to augment the building fund. They have transferred from the general fund the sum of £1,437. 10s. 9d., and they have also invited members to make special contributions to the fund. In response to this appeal £131. 11s. 6d. was paid during the two months of 1899 which remained after the date of issue of the circular. These sums, with the interest on capital previously invested on this account and other payments, have raised the amount standing to the credit of the fund on Dec. 31, 1899, to £7,044. 5s. 11d., as against £5,277. 0s. 6d. at the end of 1899.

Wilde Benevolent Fund.—During the session, Mr. Henry Wilde, F.R.S., an honorary member of the Institution, generously offered to the Council the sum of £1,500 for the purpose of founding a Wilde Benevolent Fund, to be administered in accordance with the following extract from the Declaration of Trust: "The annual income of the trust fund shall, subject as hereinafter provided, be applied in such manner as the said President and Council or Committee of Management shall from time to time think fit for the benefit of members (exclusive of honorary members, associate members, foreign members, associates, or students) for the time being of the Institution, but principally though not exclusively for those who by their discoveries, inventions, or writings shall have advanced the profession of electrical engineering, and for the benefit of the families of any such members and of any such late members being deceased, and for the benefit of any persons who may have been such members and paid their subscriptions for five years consecutively at least, and of the families of such persons—subject, however, in all cases to the following regulations:—

"(*a*) The income may in any year be applied wholly for the benefit of one person or class of persons, or may be applied equally or unequally for the benefit of two or more persons or classes of persons.

"(*b*) The total amount applied for the benefit of any one member or late member or his family during one or more years shall not exceed one year's income of the trust fund.

"(*c*) There shall be no obligation in any year to apply the whole or any part of the income of that year for the benefit of any person or persons. Any income not so applied may, if and so far as permitted by law, be either retained as income to be added to and applied as part of the income of any subsequent year or years, or may be invested and added to the capital of the trust fund."

This trust was gratefully accepted by the Council, and the said sum of £1,500 has been received and invested. It has been decided that, for the present, the fund shall be administered by the Council.

David Hughes Scholarship.—The Council has the further gratification of reporting that the executors of their revered past-president, the late Prof. David E. Hughes, F.R.S., have announced the bequest by him to the Institution of the sum of £2,000, with the object of founding a David Hughes Scholarship, to be awarded under conditions similar to those under which the Salomons Scholarship Fund is administered. Announcement of the date of the first award will be made when the said amount shall have been received by the Institution.

Local Honorary Secretaries.—The return of Mr. A. P. Trotter to England left a vacancy in the local honorary secretaryship for the Cape and South Africa, and looking to the large number of members in the Transvaal, and to the distance of these members from the previous local headquarters at Cape Town, the Council decided to divide the secretariat into two sections, namely, the Cape, Natal and Rhodesia, for which district Mr. John Denham, M.I.E.E., has been appointed local honorary secretary, and the Transvaal, to which district Mr. J. Hubert Davies, M.I.E.E., was appointed. Two new secretariats have been formed—viz., Italy and Sweden, to which Col. F. Pescetto (foreign member) and Mr. John Henrik Hammar (foreign member) have been respectively appointed as local honorary secretaries. The Council has now, by way of experiment, entered into an arrangement for a year with the Société Internationale des Électriciens, under which the treasurer of each society undertakes the collection of the subscriptions of members of the other society resident in his country. The Council desires to record its cordial thanks to Mr. Trotter for his services as local honorary secretary at the Cape, and especially for his share in the organisation of the Cape Town local section of the Institution, which was being carried on informally and unofficially prior to his return to this country.

Visit of the Institution to Switzerland.—In previous years the Institution has three times held meetings away from London—namely, at the Paris Electrical Exhibitions of 1881 and 1889, and at the Edinburgh Electrical Exhibition of 1890, but otherwise no organised visits have been paid to foreign or provincial centres. During the twelvemonth now closing it was decided to arrange a visit to some of the principal electrical works and installations in Switzerland. Thanks to the efforts of the Reception Committee in Switzerland, and of the Organising Committee at home, and to the untiring labours of our secretary, Mr. McMillan, the Council is able to congratulate the Institution on the success of the visit.

The Council has arranged for a joint-meeting of this Institution with the American Institute of Electrical Engineers in Paris on August 16 of this year, immediately before the opening of the International Electrica Congress; and has also accepted an invitation to visit Berlin in 1901.

Common Seal and Diplomas.—During the period under review the engraving of a common seal was completed. The various investments, with the exception of those in respect of the Salomons Scholarship Fund, have now been tranferred from the trustees to the Institution, and are registered under seal. The Council, being also in a position to issue the diplomas for which provision had been made in the new articles of association, has notified members and associate members that they are entitled to apply for diplomas. As a result, a large number of these certificates has now been issued. To meet a certain demand for diplomas on vellum instead of on paper, the Council decided that any member could demand such a diploma on payment of one guinea, the surplus of receipts over expenditure on account of vellum diplomas being regarded as a subscription to the building fund. Fifty-eight of these vellum diplomas were issued up to the end of 1899, and the subscriptions thus accruing to the building fund amounted to £48. 5s. 2d.

Electrical Museum.—Recognising the advantage that would accrue to the profession from the formation of a historical collection of electrical apparatus, and the increasing difficulty in making such a collection representative of earlier work, the Council has appointed a committee, which is now taking active steps to obtain donations or promises of objects or apparatus not now in commercial use, possessing interest in connection with electrical science and its applications.

The Library.—(*The Report of the Secretary.*)—I have to report that the accessions to the library during the year numbered 57; of these nearly all were kindly presented by the authors or publishers. The presentation of specifications and abridgments of specifications relating to electricity and magnetism has been continued by the kindness of H.M. Commissioners of Patents. The number of visitors to the library during the year has been 555, of whom 50 were non-members.

PARIS INTERNATIONAL CONGRESS OF ELECTRICITY.

The following is the complete programme for the International Congress on Electricity, to be held in Paris on August 18th to 25th. The Congress will be opened on Saturday morning, August 18th, at 10 a.m., in the Palais des Congrès, and will consist of five sections under separate presidents.

Section I.

Scientific Methods and Measuring Apparatus.

(i.) *Units and Dimensions.*—Recapitulation and co-ordination of the decisions of previous congresses.

(ii.) *Methods of Measurement.*—The testing of materials, and the proper specification of their qualities. Insulating, conducting, and magnetic materials. The measurement of magnetic fields, and of the power in alternating and polyphase current circuits. The graphical analysis of periodic functions into their simple components.

(iii.) *Measuring Apparatus.*—Recent improvements in measuring instruments. Watt meters. Phase meters. Hysteresis meters. Oscillographs.

(iv.) *Photometry.*—Secondary standards. Photometers.

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Section II.

Generation, Transformation, Transmission and Distribution of Electric Energy. Electric Lighting and Traction.

(i.) *Generation and Transformation.*—Progress in continuous current generators with reference to the fixity of brushes. Standardisation of the methods of testing and of definitions, more especially the definitions of maximum current, normal power, fall of potential, and rise of temperature. Comparison of inductor alternators, and other types. Standardisation of frequency and discussion of best practical frequency having regard to its economy and satisfactory working. Compounding of alternators. Asynchronous generators. Parallelling of alternators and effect on regulation of motors. The size of units. Meters and tariffs.

(ii.) *Transmission and Distribution.*—High-pressure lines. Regulations for high-pressure conductors in public roads. The earthing of conductors. Protection against lightning. Automatic earthing of conductors on accidental rise of pressure. Comparison of synchronous and asynchronous motors. The use of condensers.

(iii.) *Electric Traction.*—Progress in traction motors. Comparison of continuous-current, three-phase current converted into continuous-current at sub-stations, and three-phase current. Comparison between traction on rails, motor cars and trains. Air resistance to motion. Maximum pressure allowed by law for traction on urban and suburban lines on railways and canals. Construction of permanent way. Electrolytic action.

(iv.) *Electric Light.*—Luminous efficiency of the arc. Comparison between continuous and alternating-current arcs, open and enclosed. Connection of arc lamps. New incandescent lamps. The lighting of cars and trains.

Section III.

Electrochemistry.

(i.) *Theoretical Researches.*—Conduction through rarefied gases. Velocity of migration of the ions. Chemical action of spark and brush discharge. Organic compounds produced electrolytically.

(ii) *Apparatus.*—Recent improvements in primary batteries. Standard cells. Dry cells. Accumulators with plates other than lead. Choice of a battery for traction, central station, or regulating. Electric furnaces. Miscellaneous appliances used in large works.

(iii.) *Analysis.*—Qualitative and quantitative analysis of metals. Analytical processes in electro-chemical works.

(iv.) *Electroplating.*—Deposition of chromium, aluminium, and zinc. Statistics of the quantity of silver, copper, and nickel deposited annually in various countries.

(v.) *Electro-metallurgy.*—Electrolytic treatment of ores of copper, zinc, lead and nickel. The treatment of mattes. The commercial separation of copper. Comparison of cost of electro-metallurgical with other metallurgical processes. Statistics relating to the production and consumption of electrolytic copper and nickel in various countries.

(vi.) *Large Works.*—Electrolytic manufacture of chlorine and soda, potassium chlorate and sodium chlorate, calcium carbide, and aluminium.

(vii.) *Miscellaneous Applications.*—The production and analysis of ozone and its applications. Preparation of hydrogen, oxygen, glucinium and its alloys, and calcium phosphide. The treatment of sugar juices. Dyeing and bleaching.

Section IV.

Telegraphy, Telephony, &c.

(i.) *Sources of electrical energy.*—Primary batteries, magnets, dynamos, and accumulators.

(ii.) (*A.*) *Overhead lines.*—Iron and steel wires, copper and bronze wires, bimetallic wires, aluminium wires. Porcelain and glass insulators. Wooden poles and processes for preservation. Metallic poles and supports. Cross-arms. Derricks. Methods of erection.

(*B.*) *Underground Lines.*—Gutta-percha, indiarubber, and paper cables. Armoured and lead-covered cables. Methods of construction.

(*C.*) *Submarine Lines.*—The manufacture of cores. The properties of gutta-percha extracted from leaves. Analysis of gutta-perchas. Cores for high-speed transmission. Electrical tests of cores. Protective coverings and armouring. The employment of high-resistance steels. Light cables for great depths. Heavier cables for shore ends. Cables for telephony. Cables with air insulation. Laying and repairing. Cable-ships, tools, sounding instruments, grapnels, and buoys.

(iii.) *Instruments*—(*A.*) *Telegraphic Instruments.*—Multiple instruments and step-by-step multiple instruments. Multiplex phonic apparatus. Fast-speed apparatus. Photographic registration of messages. Relays for submarine and underground lines. Accessories.

(*B.*) *Telephonic Instruments.*—Transmitters, receivers, and repeaters. Multiple exchange switchboards. {Multiples of indefinite capacity. Central-battery multiple switchboards. Automatic switchboards. Branch exchanges. Systems of calling. Relays. Accessories.

(iv.) *Circuits.*—Overhead, underground, and mixed telephonic circuits. Single and double wire circuits. Non-inductive lines. Long-distance telephony. Simultaneous telegraphy and telephony.

(v.) *Propagation of Currents in Telegraphy and Telephony.*—Lines of small and large capacity. Speed of transmission. The order of magnitude of the currents.

(vi.) *Maintenance of Telegraphic and Telephonic Communication.*—Disturbances due to stray currents. Inductive effects of alternating and rectified currents. Insulating material. Nets. Automatic earthing and cut-outs. Protection of stations. Fuses. Effect of thunderstorms. Lightning protectors. Earth currents.

(vii.) *Wireless Telegraphy.*—Different systems. Oscillators, receivers, coherers, and "antennæ." Syntony. Optical telegraphy. Communication with or between ships.

(viii.) *Clocks.*—Automatic winding-up. Automatic regulation. Employment of telegraph and telephone lines for creating a standard time. Adaptation of electric systems to ordinary clocks.

(ix.) *Miscellaneous Applications.*—Calling and signalling apparatus.

Section V.

Electrophysiology.

(i.) *Production of Electricity by Living Beings.*—So-called "currents at rest" in the tissues, nerves, muscles, glands, &c. "Active currents" or "negative oscillation" in the same tissues. Currents from the special organs of electric fish. Methods and instruments for the study of these currents.

(ii.) *Effect of Electricity on Living Beings.*—Effects of the form of the exciting wave; characteristics of excitation. Electrification by static machine, battery, induced currents, sinusoidal currents, undulatory currents and high-frequency currents. The processes of applying, and the methods of generating these currents.

(iii.) *Measuring Instruments and various Physiological Effects.*

(iv.) *Dangers of Different Forms of Electric Energy.*—Death by electricity. The treatment of persons suffering from shock.

During the Congress, visits will be made to the various electrical installations in Paris, in which only members will be allowed to take part. Names of those desirous of membership should be sent to M. Paul Janet, 14, Rue de Staël, Paris, one of the secretaries of the organising committee, and the subscription (20fr.) should be sent to the treasurer, M. Léon Violet, 20, Rue Delambre, Paris.

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

BY C. E. GROVE.

(*Concluded from page 179*).

Electric Ammunition Hoists.—For serving the 6in. and smaller guns these are in use in many navies. The "Powerful" and "Diadem" classes of cruisers were fitted with them, but the later English ships are fitted only with hand gears. In the United States and Japanese ships they are usually found. The apparatus consists of a quick-running motor of 2 H.P. to 5 H.P. geared in some way to a light whip or chain tackle for lifting small parcels of shot and shell at high speed. The motors must be so controlled that they start, stop, and reverse very quickly, with automatic brakes to hold them as soon as the current is switched off, or else the motions must be effected by clutch gears thrown in and out of connection with a continuously running motor. The latter arrangement is used by Messrs. Armstrongs with friction gears. Fig. 36 shows the arrangement in plan. The motor shaft being in rotation, a vertical lever acting at O along the axis of the shaft puts either of the speed cones A or B into gear with C, thus driving sprocket wheel W1, over which an endless chain runs, passing also over a fixed sheave at the top of the hoist. The cones A and B being out of gear, and therefore running free, the cartridges or projectiles in a bag are hooked on to the chain at the bottom, the friction gear brought into action, and the ammunition rapidly hoisted. Then, while this bag is being unhooked at the top, another round is being hooked on the other side of the chain at the bottom, the cone gears are reversed, and the second charge hoisted, and so on. There is an automatic arrangement for throwing the cones out of gear at the right time for each lift; there is an alternative hand gear working through the sprocket wheel W2, with arrangements for preventing both the hand and power gears being in operation at once, and other details not shown in the sketch.

Summing up the power requirements enumerated in the foregoing paragraphs we get:—

—	Total motor capacity installed, including duplicates.	Maximum demand for power, duplicates excluded.
	E.H.P.	E.H.P.
Ship ventilating fans	40	40
Engine- and boiler-room fans	100	100
Furnace air-blowing engines	200	200
Steering engines	400	200
Forward capstan	120	120
After capstan	50	50
Boat hoists	100	100
Coal hoists	100	100
Ash hoists	20	20
Workshop engine	5	5
Air compressors	200	100
Turret motors	500	300
Ammunition hoists for 6in. and smaller guns	50	50
Totals	1,885	1,385

* Paper read before the Institution of Electrical Engineers, April 26th.

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If these figures err, they err on the large side. In working out details, savings both in power and weight could probably be effected. There are no conceivable circumstances in which the whole of these machines could work simultaneously. The worst conceivable case supposes that in time of action all the gun-working machinery, air compressors, furnace engines, ash hoists, ventilating fans, and steering engine would be at work together. Then the aggregate horse-power demanded would be, according to the above figures, 1,015 E.H.P. input to motors = 760 kw. The lighting of the ship would involve 50 kw., and the searchlights—if it be conceivable that all this mechanism could be employed at night when searchlights were wanted—a further 50 kw. or 60 kw. But, taking into account the fluctuating demands of current made by the motors, and the fact that it is hardly physically possible for everything to be working at the top of its load at precisely the same instant, about 600 kw. output would meet all requirements and cover distributing losses, while 800 to 850 kw. installed in the ship would leave an ample margin of spare plant in all ordinary circumstances. Now this is an equipment not at all unlikely to be called for in the future. It will not come all at once, but it may come sooner than many would allow. What should be the arrangement of plant and system to successfully cope with it?

It seems clear that an installation of 800 kw. is not to be provided by the multiplication of 50 kw. sets. Yet it will always be desirable for battleships to carry a few sets of 50 kw. size—(*a*) for lighting and ventilation when nothing else is doing; (*b*) for working searchlights; (*c*) for regulation of turret and steering motors, should that method not be superseded by something better. But after 200 kw. or 300 kw. are reached, it would be wise to introduce sets of 150 kw. or 200 kw. capacity—the latter for preference. Then for an 800 kw. installation we might well have three sets of 200 kw. each and four sets of 50 kw., there being enough sets of each size to form an efficient reserve. It would be most undesirable to introduce a lot of intermediate sizes.

In regard to the electrical system to be employed for distribution, two questions at once arise—(*a*) whether continuous currents should be employed throughout, or whether polyphase currents should be introduced for the motors; (*b*) whether the existing standard of 80 volts should be retained.

(*a*) In view of the fact that machinery on board ship gets very little attention, it has been urged that polyphase motors should be used on ship-board, because they do away at once with all commutator troubles. But it is to be urged that well-built modern continuous current motors give next to no trouble at the commutator, and that even the polyphase motors would require collecting rings and starting resistances. But the chief objections to the introduction of polyphase machines on board ship are the disadvantage of having two systems of distribution in the ship, and the introduction of the third cable. Possibly the relative advantages and disadvantages are pretty evenly balanced. At any rate, polyphase motors have actually been introduced by the Austrian Navy on their coast defence ships "Buda-Pest," "Wien," and "Monarch," the currents being generated by composite machines which give continuous currents from a commutator on one end and three-phase currents from collecting rings at the other end of the armature.

(*b*) The question of the voltage standard is of greater difficulty. 800 kw. at 80 volts means 10,000 amperes to distribute, which represents a very formidable amount of cable work. If the pressure were doubled, the currents would be at once reduced to 5,000 amperes and the saving in weight and cost of cables would be material. The United States battleships "Kearsage" and "Kentucky" are wired on the three-wire system with 160 volts between the outers. The motors are in general arranged on the 160-volt mains, though a connection is usually taken from the middle wire to provide for changes of speed by switching the motor on to the low-voltage mains. Searchlights and incandescent lamps are arranged on either side of the system to make an approximate balance, as is usual. The results of experience in these ships will be watched with great interest. The author is a little diffident as to the introduction of a three-wire system on board ship, and would rather prefer a direct circuit of 160 volts, for both lamps and motors. Indeed, having got so far, one might as well accept the 200-volt standard at once. Searchlights in such an installation could be operated with very little complication through "series-parallel" switches, which, in the one position, would put two searchlights in series, and in the other position put each searchlight on separate circuit on the mains, with the addition of a resistance capable of absorbing the remaining volts. With automatic lamps, this should be quite feasible, and any difficulty attending the use of so large a resistance as would regulate the arc down from 160 or 200 volts would probably be less than the difficulty of maintaining a balance of voltage on the two sides of the three-wire system when the searchlights worked intermittently, if that system were used. Of course the use of 200 or even 160 volts generally would impose a greater strain on the insulation of the cables and fittings than is now experienced, and would require some improvements in the design of fittings established; but there are no serious difficulties here.

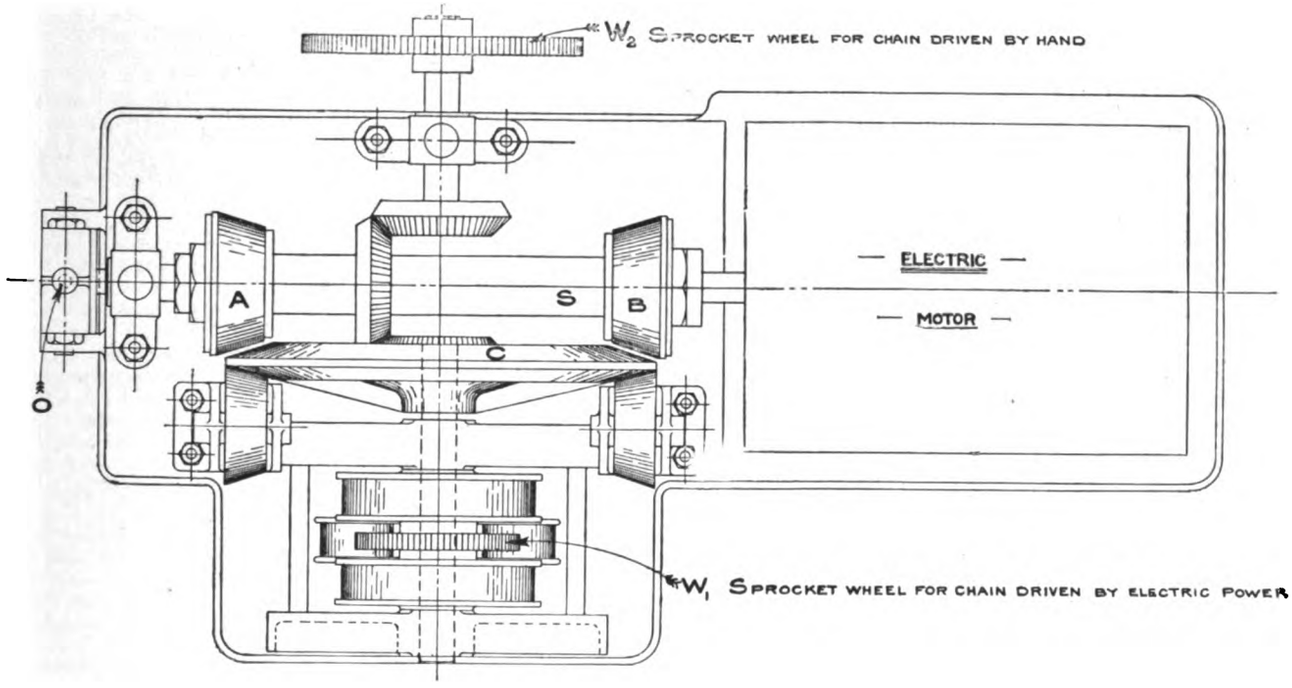

FIG. 36.—Electric Ammunition Hoist Gear (Sir W. G. Armstrong, Whitworth & Co.).

Instead of the Tree system of wiring as at present adopted, all the main cables should be run in rings round the several decks back to the switchboard; through connecting boxes being provided at intervals of 100ft. or so, for rapid disconnection and testing. With such an arrangement a circuit might be injured or shot away in any place without affecting the main supply of current. Separate ring mains for lights, searchlights, and motors should, of course, be used with throw-over switches to connect one to the other on special occasions. It would be desirable to divide the main switchboard into two parts in the machinery room, connected together by switches which would form the closing links of the ring mains, the object being to avoid the possibility of a total breakdown by fire at the main switchboard, which always exists when all the cable connections go through one narrow neck. Of course, all the casings and other woodwork now used about switchboards should be rigorously abolished. The cable distribution should be expressly taken into account and allowed for in the design of the ship, proper trenches or culverts being provided for the cables. At present no such provision is made, and it is often a matter of considerable

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difficulty to find suitable runs, especially where cables have to pass watertight doors and the like.

Returning now to the generators, the question arises as to the possibility of providing the necessary weight and space. 800 kw. in generators of the existing type with double-acting engines, at speeds of about 400 revs. per min., would involve with steam and exhaust connections about 80 tons. This is the only increase in weight, as the motor weights balance out; the additional weights mentioned in the detailed descriptions of the motors above being counterbalanced by the saving which would be effected in the turrets if electrical machinery were substituted for hydraulic for gun working. The weight of the main hydraulic equipment—25 tons—is a credit against the generator weights. There would indeed be a slight saving in the weight of distributing cables and switchboards as compared with the auxiliary steam and exhaust pipes now required for the services in question, but it would not be much. Approximately 55 tons of additional weight, then, has to be carried. In discussing the question of coal consumption, it was shown on the figures there stated that the substitution of electricity for steam for all the auxiliary services would result in the saving of 262 tons of coal for every 25 days' steaming. This figure was calculated upon data assumed to represent the best possible conditions. Some of the engine and boiler-room pumps have been assumed to remain steam-driven, but if electric driving be applied to the services enumerated, and if only one-half or one-third of that estimated saving were realised, there would still exist a strong *primâ facie* case for the adoption of electrical power.

The weight of generators might be materially diminished by the employment of single-acting engines driving dynamos at higher speed, and still more by the adoption of turbine-driven sets; the weight of the units mentioned could be done with Parsons' turbo-generators, including condensers, for about 60 tons. Single-acting engines and turbines have both been used in the Navy; unfortunately both have failed, and, as a consequence, both are at present looked somewhat askance at for the purpose. They require dry steam: hence one of the principal sources of difficulty in the old arrangement, but one that should not occasion much trouble in the new. This consideration, coupled with the very great improvements that have been made in both since the days when they were used in the navy, may bring them into service again.

The space required for the generators for the power mentioned would lie between 800 sq. ft. and 1,000 sq. ft., whichever of the three systems be adopted. It is not easy to find this room in an existing battleship; but on the hypothesis, the main hydraulic engines would not be wanted, and the space occupied by these two rooms would be available. If in consequence of savings on account of efficiency less coal were carried, though a saving of weight would be appreciated, little space would be added for the purpose of generators. Possibly the change to electric driving might be carried out in conjunction with some other change in the disposition of the *matériel* in the ship. For example: there are not wanting critics who consider that it is out of place in these days for ships of the fighting line to carry torpedoes. Should such a view obtain official support, a room equivalent to one of the existing submerged torpedo rooms would make an ideal generating station. Its locality would be, for preference, immediately adjoining the forward boiler-room bulkhead, so that the steam connections might be short and direct.

The electrical equipment of ships of war is the product of many hands and brains. Naval authorities do not as a rule design—they formulate requirements, and the engineering experience of the country is laid under tribute to meet those requirements. Hence it comes about that much of the apparatus employed is of a proprietary kind, and the author has to acknowledge the kindness of many firms and friends who have allowed him to describe their apparatus and inventions. These have already been mentioned by name in the Paper. He is also under obligations of a more general kind, and is pleased to acknowledge here his indebtedness to the Lords of Her Majesty's Admiralty for permission to describe parts of the equipment of H.M.S. "Albion," and to make various references to Admiralty specifications; to the Naval Attaché of the Imperial Japanese Embassy, for permission to refer to the equipment of the battleships recently built in this country for the Japanese Government; to the General Electric Co., of Schenectady, U.S.A., for the photographs illustrating American apparatus; to Messrs Sir W. G. Armstrong, Whitworth, and Co. (Ltd.), for permission to include particulars relating to the electrical side of their naval ordnance work; and to the Directors of the Thames Iron Works Shipbuilding and Engineering Co. (Ltd.) for permission to make general use of the information in their possession.

DISCUSSION.

Capt. CREAK, referring to the question of the effect of the wiring of a ship upon the compasses, said he only knew of one instance in which bad effects had resulted, and this was in connection with the automatic projector in Fig. 18A. In this apparatus the leading wire was connected to one arm and the return to the other. The consequence was they got a deflection on the compasses of 2deg. in one direction and 2deg. in the opposite direction. But this had been easily remedied by leading both wires to one arm of the projector. The greatest sinner on board ship, in the matter of the effect upon the compasses, was the dynamo, and he had often asked dynamo builders and designers to build a dynamo without an external field. With ironclad dynamos he had got a deflection of 2deg. or 2½deg. at a distance of 20ft. away from the machine.

Mr. SYDNEY EVERSHED thought Mr. Grove's Paper gave a very good account of the present position or rather transitional position in which electricity is in the navy; it enabled us to see that our navy was not so very far behind the navies of the rest of the world. There was often a sort of feeling that in the British navy every novelty was passed as a matter of course, but those who had had anything to do with introducing novelties into the British navy could say that this was not the case. It had to pass the ordeal of the three great branches into which the administration of the navy was divided. It was clear, from Mr. Grove's Paper, that the next few years would show an enormous difference in the manner in which electrical work was carried out. At present, if they looked at any warship from an electrical engineer's point of view, they were struck with the rather costly electrical equipment. All the dynamos, engines, cables and everything else were of the best possible quality, but the manner in which they were installed rather suggested that the whole electrical scheme was an after-thought. He was of opinion that the author's suggestion of a power station on board each first-class cruiser or battleship was the right one, and in a few years' time they would see a central electric station properly designed and put into the right part of the ship under the protective deck. It had been very truly stated in the Paper that the development of the electrical equipment of the warship had been the product of many minds and men's work. His own part in the work was chiefly in the direction of establishing communication, and he could confirm what Mr. Grove had said as to the unsatisfactory nature of speaking tubes. It is almost impossible in many parts of the ship to make any use of these pipes. Capt. Creak had referred to the leakage from ironclad dynamos, and at the time it was proposed to use this kind of machine he felt perfectly certain it would be a failure. He even ventured to put his views before the Admiralty in an unofficial way, but he did not think it had much effect. It was tried, and he was not at all surprised to hear that it only diminished the compass error by about half. Although it was possible to shield a dynamo to some extent, they could never entirely get rid of the effect of a coil by putting iron round it, and he was glad to see the Admiralty were introducing the four-pole type of dynamo. This was the true way out of the difficulty, because it made the dynamo astatic.

Mr. R. E. B. CROMPTON said he was going to play the naughty boy again. A previous occasion on which he had done this was in discussing a Paper read some seven or eight years ago before the Mechanical Engineers at Portsmouth by an official of the Admiralty describing electricity in Her Majesty's navy, and in daring to criticise the matter he had so annoyed the officials that he did not get an Admiralty contract for years afterwards. But as he had since been thanked for what he had said he did not mind. He considered the state of the navy with regard to the use of electricity a disgrace to the profession. They were very much indebted to Mr. Grove who had put his Paper in a very readable form, a form which helped him (Mr. Crompton) very much in putting forward criticism for what it might be worth. He would first point out that our Admiralty did not have much to do with the introduction of electric lighting on board ship. This had to be done for them by English contractors for foreign Governments. The first ship fitted throughout was a Brazilian cruiser, and the only reason why the British Admiralty followed suit was that one of their officials was consulting engineer then for the Brazilian Government and he had thus had an opportunity of thoroughly studying the arrangements, which were promptly adopted in Her Majesty's service. Mr. Grove mentioned that even now the electric motor was looked upon with suspicion, but he asked them if it was commoner for an electric motor to break down than for a steam engine, at any rate he had never seen one break down without it had given notice that it was not receiving proper attention, and the cases in which an electric motor broke down without any warning were so rare as to be unknown. With regard to hydraulic power he stated that he had an hydraulic lift in his own house for 10 years and he had known it in the case of a hard frost to be a source of anxiety to the family. He had been telegraphed up to the Midlands on account of three hydraulic fittings splitting one night, and he did not see why, on Her Majesty's ships in extreme latitudes, difficulties of the same kind should not take place. In conclusion he mentioned a statement at the end of the Paper to the effect that both single-acting steam engines and turbines had been tried for driving the generating sets but that both had failed, and as a consequence were looked at askance. While there were others who could speak about the turbines, he could say something about the single-acting engines. Was it not a scandal that the single-acting engine—the greatest friend to the electric light industry—had been kept out of the navy?

Mr. A. E. RICHARDS thought that Mr. Crompton had really got quite outside the Paper at times. Mr. Crompton surely did not mean them to take his statement seriously, that he did not have another Admiralty contract for some time because he had criticised their projector? The Siemens' projector was perfect, and it had been tried in the navy for a long time; but the reason it was not used at present was not because it was inefficient as a projector, but because the people who used it did not consider an automatic projector was required. With regard to the matter of dynamos, he said that of course, a good many years when the Admiralty specification for dynamos was first published it caused a good deal of discussion, the chief thing criticised being the temperature limit; in fact, it had not finished being criticised yet. It was stated in the Paper that the Americans adopted a lower temperature limit; but he might say that during the many years from the first introduction of electricity in the navy, he had never known a dynamo bought

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under the conditions of the British Admiralty specification to fail. Most of the troubles experienced had been on the engine side, and they had some dynamos at present working which had been installed in 1886, and which had outlived the main engines of the ships. This quite agreed with Mr. Crompton that a dynamo or motor never broke down, and it should not, as there was nothing in it to break down. Coming to the question of the electric lighting of ships, he said he did not understand one little clause in the Paper describing the glands for making the bulkheads watertight, and which stated that "they cannot be drawn back." His own idea was to have a cable which never wanted drawing back. In the matter of communication, he said they all knew that voice pipes were not very satisfactory, but until they got telephones in good working order he did not see how Mr. Evershed was going to improve the voice pipe system or any other system.

Mr. A. A. C. SWINTON did not altogether agree with what Mr. Crompton had said. His own view of the matter was that up to a certain point electrical arrangements for the distribution of power on board ship were exceedingly good, but they were not applicable in all cases, and more especially with regard to the training of large guns, hydraulic arrangements were very much better. In training large guns or heavy weights generally, a slow, steady motion was wanted, and this was obtained by hydraulic machines, with extraordinary accuracy and precision, in a way that he did not think would ever be attained by any other kind of machinery in which there were rapidly revolving parts (inevitable in the case of a motor) besides the effects of momentum and a great complication in gear and brakes. His only other point was in connection with the question of turbines which had been mentioned in the Paper, as he had been the first to put one on board ship for the purpose of electric distribution when with Messrs. Armstrong. Mr. Parsons, in conversation with him, had stated that steam turbines were not suited for small power, and that it was very difficult to make small turbines economically, and he thought this was the reason the Admiralty had not continued the use of them. Besides this, at the time of their introduction, the electrical equipment of the ship was a very small part of the whole, and it was very difficult to get the chief engineer to take sufficient pains to learn the details of a new machine which they only considered a very small part of their business. Again, in some cases the turbines were placed transversely across the ship instead of longitudinally, and if they put turbines working at high speeds transversely they got very large strains.

Mr. A. J. LAWSON said that in the description of modern practice, as described in Mr. Grove's Paper, one thing which had struck him was the departure from the "central station" method in the lighting of ships of war. The generating sets were distributed all over the ship, often a long way from the main engine rooms and from each other. Consequently, there was a great length of steam piping, with all its attendant losses, besides complication of the wiring, in which ring mains were a necessity. Again, the Admiralty for very inadequate reasons had adopted a voltage which was used by nobody else—a standardisation of the wrong kind. The sooner they went to 100 volts, or even 200 volts, and got machines which did not have to be specially wound, the better it would be. This increased voltage and the return to "central station" methods on board ship would reduce the massing of cables shown in some of the illustrations, and produce better results in every way.

Mr. C. E. GROVE, in replying, drew attention to Mr. Evershed's remark that he did not think the Admiralty backward in these matters, while Mr. Crompton thought they were disgracefully so, but really the truth lay between these two statements. His Paper certainly did show that in many respects foreigners made electrical applications more elaborately and with more enterprise than was actually done in the British navy, and he thought they were too conservative. There was room in a country like this for more liberality and enterprise in actually trying things. His experience certainly agreed with the remarks that had been made that if there was any difference between the reliability of a steam engine and a dynamo or motor, the advantage was with the electrical machine, but it was extremely difficult to get engineers who were marine or mechanical engineers without electrical training to believe it. One remark of Mr. Richards, he thought, called for answer, and that was that they should build their electrical equipment to suit the ship. He ventured to say this was utterly wrong, and he would even go further than that. Ships were, and have been, and would be built around various objects. Again and again ships were specially designed round guns; the design of the whole ship was made subsidiary to the attainment of certain qualities in gun fire. Within the last few years the British Admiralty had designed and built ships around the Belleville boiler, and if we could only get the British Admiralty to believe they would get better results in efficiency, reliability, economy of coal, and general cleanliness and convenience by the introduction of an electric power station on board, there was no earthly reason why a ship should not be built round the electric power station. He was proud of the simplicity and beauty of hydraulic machines, and the reason why this had been brought to the state of perfection it had in this country was that the principal firm of British gunmakers was Messrs. Armstrong, Whitworth and Co., and they were also our leading firm of hydraulic engineers. The two systems existed in the same company, and nothing was more easy than to develop the two systems together, but if Armstrong's had been an electrical firm the result might have been the reverse. At the same time, on the "Brooklyn," as mentioned in the Paper, the 13in. turrets had been started and stopped electrically very frequently, and with satisfaction, and such results did not stand alone. The Ward-Leonard system of control seemed to lend itself perfectly to the adjustments in minute fractions of degrees, and the momentum effect was almost nil. Mr. Mordey had just told him that some such method of control by the use of generators and motors combined was used over and over again in lifts, and was quite successful where momentum effects had to be dealt with, and where quickness of action was essential.

PARLIAMENTARY INTELLIGENCE.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY.

The Parliamentary inquiry into this electric power scheme, which principally affects the northern suburbs of London and the adjoining outside districts, is proceeding before a Committee of the House of Commons, consisting of Mr. H. A. Brown (Chairman), Mr. Trevelyan, Mr. Rutherford, and Mr. Murnaghan. The first sitting was held on May 24. The opponents of the measure include the District Councils of Wood Green, Hornsey, Walthamstow, Hendon, Edmonton, Tottenham, and Southgate, the County Councils of Hertfordshire and Middlesex, and the Harrow Electric Light and Power Co.

Mr. LITTLER, Q.C., for the promoters, said none of the petitioners raised in the least degree any question of principle with regard to the desirability of supplying electric power, and it was only with regard to the particular circumstances in which the company proposed to supply that any issue was raised. The company promoting the scheme had its origin in the important principle laid down by successive Parliamentary committees in every conceivable class of circumstances that the larger the works supplying a district with electricity and the more varied the demands they had to meet, the better and the cheaper for the consumer; firstly because electrical energy can be more cheaply produced on a large scale than on small scale; and, secondly, because the more varied the purposes to which the current so generated was put, the better for everybody by reason of the reduction of price. In the district proposed to be served under the bill there was already a considerable area devoted to manufacturing purposes. It was proposed to include in the area of supply the eastern half of the county of Middlesex and a considerable portion of the county of Hertford and a small part of Essex. The districts scheduled included Enfield, Waltham Cross, St. Albans, Friern Barnet, Southgate, Hornsey, Wood Green, Finchley, Hendon, Harrow, and Wembley. In some of these places there were light railways and tramways on which it was inevitable that electric traction would be used in the future, and in others there were large establishments, such as small arms factories, powder factories, lunatic asylums, and so on, to which an electrical supply would also be most advantageous. Consequently powers were sought to lay down electric mains in the streets and roads of these districts, and the company undertook to supply all authorities, companies, bodies, or persons entitled to be so supplied with energy for lighting and power. The promoters asked only for power to supply those people who had Parliamentary authority themselves to sell electricity, and not to supply any railway company, tramway company, or other persons who were merely consumers. The first-named bodies would have the whole of the retail distribution in their own hands, and would fix the price to be paid by the consumers; instead of each having their own works, the company would provide the power at the cheapest possible rate. The only compulsory powers over the districts in question sought by the bill was the power to open up the streets and roads. The local authorities might themselves dictate to the company the routes which the cables should take, and might themselves, if they chose, open up the streets and lay the cables, charging the company with the cost of the work. The only difficulty with the company was that they must be subject to some local authority, and there was a difference of opinion as to what authority it should be. If they accepted the views of the Middlesex County Council they would be subject to two authorities, the urban district council and the county council, which would be rather awkward if one required one thing and the other required another. The scheme before the Committee was not in any way a speculative one, and it would be of the greatest possible value to consumers of electricity whether for power or lighting. It was practically permissive in its character, the only compulsory powers sought being those which had been conceded by Parliament over and over again of going through certain districts for the purpose of supplying others.

Mr. S. Z. DE FERRANTI, examined by Mr. Balfour Browne, Q.C., said the essential feature of the scheme before the Committee was the provision of a wholesale supply of electrical energy in place of having a multiplication of small generating stations. There were in existence in certain places large works with ample power during the whole 24 hours, where they probably had such a good load factor that they would not need to come to the Power Co., but there were very few such cases in which consumers would not avail themselves of a public power supply if it was obtainable. In most cases manufacturers only wanted power for a certain time, and it was more economical to get it from a power generating company which had various loads. A number of tramway and light railway companies would no doubt be excellent customers of the power Supply Co., as it would be most advantageous to them to get an electrical supply just wherever it was wanted without having to engage in an electric generating business as well as that of running cars and trams. Supposing that the Power Co. supplied these concerns, they would have a considerable load factor throughout the day, and in the evening also. This would enable them to supply electricity for lighting, say, in Hertford or St. Albans, or other town at a much cheaper rate than they could otherwise supply it, if they had not tramways on their system, without detriment to the supply to the tramways, and also enable them to greatly reduce the cost of supply for electric light purposes. Then having got both these large customers they could supply manufacturers at a very much lower price than the manufacturers could supply themselves, because the Power Co. would have a good load factor. As had been explained, the promoters did not want to compete with the local authorities, but to supply the local authorities with electricity, which they in their turn could supply cheaply to the manufacturers. The Power Co. would merely generate and transmit the power to those who would take it wholesale, namely, the authorised companies and local authorities who would provide both the capital and

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the labour for distributing the current to the individual consumers. Instead of the local authorities and tramway companies each having their generating stations, and distributing electricity to the consumers, they would take a supply from the trunk mains of the Power Co. If both the generating station and the distributing plant were in one hand, the consumers would merely have to pay to one set of persons what he would otherwise pay to two, in fact he would only pay to the distributing authorities.

On what load factor have you been calculating in this case?—On a 25 per cent. load factor derived from tramways, lighting and power. The 6,000 kw. which the company were proposing to lay down in the first instance would by no means meet the demand which would arise in the area of supply. It was simply something to begin upon. For the purpose of arriving at that load factor the company would have to divide the 6,000 kw. as follows:—1,300 kw. for traction, 2,500 kw. for power, 2,200 kw. for lighting. The following were the load factors in each class of demand:—

Estimated maximum demand	6,000 kw.
Capacity of generating plant	8,000 kw.
Capacity of boiler plant	13,000 H.P.

Estimated load factor 25 per cent., made up as he had just stated. The estimated units generated would be 15,300,000, and the estimated units sold 13,000,000.

You can, of course, increase that 6,000 kw. to any extent, but it would be probably always in the same ratio for electric railways and tramways, power and light?—Undoubtedly we can increase it. It would be impossible to say that it would follow exactly the same ratio, but I anticipate that it would never be less favourable.

You put down the capacity of the generating plant at 8,000 kw., allowing 2,000 kw. for a reserve, and a very ample reserve?

The CHAIRMAN: What is the power of 13,000 H.P. reckoned in kilowatts?—10,000 H.P. if you could put it in that way. Boilers only measure horse-power.

Mr. BALFOUR BROWNE: It would rather astonish a boiler to talk to it about kilowatts?—It would, but it would not be unreasonable. £59,800 was the estimated cost of the plant which would transform the steam power into electrical energy. In addition to this there were engines and generators, £80,000, or £10 per kilowatt; switchgear, £16,000; lands, buildings, foundations, chimney, coal stores, and general building work, £40,000; bringing the total up to £195,000. Next came the cost of transmission, which would vary according to circumstances. Mains laid and jointed complete £13,000, and £30,000 for the transformers and transformer chambers, making altogether £355,000, to] which must be added engineering fees, cost of promotion, procuring the capital, and the necessary powers, which he had put down at the round figure of £34,200, making altogether a gross total of £390,000 for the 6,000 kw. The working cost would be £22,000, the cost of coal being estimated at 0·40d. per unit; oil waste and stores, 0·04d.; depreciation, repairs and maintenance, £14,200, being 4 per cent. on the capital expended on plant and machinery; wages of workmen, £5,000, or 0·09d. per unit; rates and taxes, £3,000, or 0·05d. per unit; and management running expenses and directors' fees, £5,800, or 0·11d. per unit. The total expenditure for generation and distribution to the various consumers would be £52,200, or 0·95d. (just under a penny). The very tempting price of 1½d. would bring in a revenue of £81,250 as the result of selling 13,000,000 units, from which would have to be deducted the cost of generation and transmission £52,200, leaving a net profit of £29,050, or 7 per cent. upon the total capital, with a small amount of £1,750 to carry forward. The mode of working proposed under the scheme was the two-phase alternating current. This current would be transformed down to the 500-volt continuous current required for the tramways. The generation would be effected at 10,000 volts pressure. The provision of a third or reserve cable would obviate any fear of part of a district or area being cut off from the supply through failure of the cables. Two cables would be used normally, and the third would take the place of either of the other two in case of accident or repairs, and be laid in solid bitumen. The whole of the materials used in the cables were of the most permanent nature. The insulation was made of paper and oil, both of which were most permanent. He was perfectly certain that cables like these would be as good fifty years hence as when they were first put down.

By the CHAIRMAN: Starting with the copper in the cables for transmitting energy such as would be used in the first instance, there would be no depreciation of that copper from the current-carrying capacity point of view. The conductivity would not decrease, and the insulation would not become less useful.

By Mr. WORSLEY TAYLOR, Q.C.: Each of the cables would be equal to the transmission of 2,000 H.P. As to safety a pressure of 10,000 volts was contemplated. As far back as 1888 the Board of Trade had sanctioned this pressure throughout the streets of London.

By Mr. CLAUDE BAGGALLAY, Q.C. (representing several of the opponents of the Bill): The details of the scheme were the same as in the Durham Bill, modified, of course, by the change of circumstances as between the two districts.

Mr. BARTLEY DENNIS (for the Harrow Electric Light and Power Co.): Where a power has been already established in a district, and is doing well, do you think it right that a powerful syndicate such as yours should be allowed to come in and compete?—We introduce no competition.

Mr. HUTCHINSON (for the Walthamstow Council): Supposing that a tramway company or light railway company, authorised to use electrical energy, obtain a supply from you, could they not use it for the purpose of lighting their own premises?—Certainly; instead of making it for themselves they could buy it from us.

Mr. GEO. CORBLE, clerk to the Lea Conservancy Board, examined by Mr. Littler, Q.C., said the scheme of the bill would be of great benefit in developing the business of the river Lea on the understanding that the powers sought do not include the distribution of electricity to the consumer, but only the supply in bulk to authorised undertakers; that no power is taken to break up streets for the purpose of supply to the consumer or save for the purpose of getting to the point where the supply is given in bulk to the authorised undertaker, or that the street work if required can be done by the authority at the company's expense; that the local authority is to be left to consider the route proposed for the through mains, and that the object of the bill is to reduce the cost of electric energy, and to limit the number of generating stations required in a given area. Every year (said witness) more and more people were looking out for factory land on the borders of the Lea, tempted not only by cheap carriage, but by the comparative cheapness of the ground. To these places an efficient supply of electricity would be a great advantage, and he also had in mind that some day barges might be propelled by electricity if power could be obtained cheaply.

Mr. J. W. SWAN, F.R.S., examined by Mr. Worsley Taylor, said that year by year there had been very great development and progress in the direction of increasing the area of economic supply of electricity, mainly owing to the increase in the district over which it had been found by gradual experience that electrical energy could be transmitted economically. For instance, in 1877, by the Jablochkoff system, 20 or 30 lamps could be run from one dynamo. Shortly after that the Swan incandescent lamp was invented, and in about the year 1880 it was found possible to distribute electricity for something like a mile and a half from the generating station. Even Sir Wm. Siemens was at one time of opinion that for the electric lighting of London a separate generating station would be required for every square mile proposed to be lighted, but now it was agreed by all electrical engineers that the position was entirely changed, first of all by the fact that by means of the high-tension dynamos and cables described by Mr. Ferranti it was possible to transmit energy economically, having generated it at a central station, over a large number of miles. He agreed that electricity could be transmitted at such high pressures as were contemplated in the scheme before the Committee with perfect safety. Very great advantage would arise from the fact that a day use for power purposes and traction as well as a night use for lighting could be found and arrangements could be made for facilitating that combination of uses. It would be a much better arrangement to have one generating station and to distribute the power generated at that station to the neighbouring districts, rather than to have a number of small stations distributing within their own small areas. He was not sure that the proposals in the bill would be of any direct advantage to the Edison and Swan Co., except that, being large employers of labour, it would be a much pleasanter thing for their workpeople if electric light was supplied in their district. There was also a remote possibility that they might themselves take an outside supply of electricity for driving machinery if they ran short and there was a neighbouring electrical station supplying electricity very cheaply.

Cross-examined by Mr. FORBES LANKESTER (for the Wood Green District Council): Do you agree that 5,000 kw. is a fair economical unit?—I do not think that rule could be stated without reservation. I should not call a station generating 5,000 kw. a very small station. It would not make much difference in point of economy of generation whether the electricity was generated by a combination of local authorities or by a single company. At the same time it was rather difficult to imagine a small local authority extending its operations over a wide area when a company was proposing to do the same thing.

By Mr. HUTCHINSON: An alternating current of 10,000 volts pressure is not the most advantageous current for driving motors, is it?—It would have to be transformed.

Light railways and tramways generally take their current at about 400 volts, do they not?—Yes.

And they prefer to have it continuous, and not alternating?—Yes. It is part of the scheme before the Committee to supply electricity at such a pressure for traction purposes.

Further general evidence in favour of the scheme having been given,

Mr. J. S. RAWORTH said he had been paying great attention to the subject of electrical transmission of power cheaply and effectively, and had come to the conclusion that the scheme before the Committee would throw open a considerable area in the neighbourhood of London suitable for the erection of works both for electrical and for manufacturing purposes. If arrangements could be made whereby power could be acquired from a large supply company or works it would be almost a living profit to some manufacturers—that is, the saving in power would be so great as almost to keep the manufacturer in food and board and lodging. He was satisfied that small local authorities, if they could take their power from large works such as those proposed, and distribute the power themselves, would be able to supply customers much more cheaply, and get a very much more extended sale for electricity and make a satisfactory profit for themselves.

Have you found that if generation is carried on on a large scale the saving of cost is in itself more than sufficient to pay the whole capital cost of distribution?—The saving in capital cost of the installation is enough to provide for distribution.

What is the cost of distribution? Is it very small when the distance does not exceed 6 miles?—Very small indeed, if properly used.

You estimate that where the load factor exceeds 25 per cent, and the distance is not more than 6 miles it may be even less than $\frac{1}{10}$d. per unit?—Yes.

It has been suggested that if you have a main from your generating station at Enfield to St. Albans you cannot take off any electricity on the route; is that so?—No, you can take it off.

Is the scale of maximum charges so worked out that, as near as possible, the consumer shall pay a price based on the cost of generating his own particular supply?—It is made with the intention that a man taking an expensive supply pays a higher price than a man taking a cheaper supply.

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Obviously, if you have a uniform tariff, the effect will be that the consumer with a low load factor would be supplied at a loss, while the man with a high load factor would be unduly taxed to make up the loss?—That is the defect under which no great expansion of electrical energy takes place.

Cross-examined by Mr. BARTLEY DENNIS: If the lighting and the trams are about the same in the Durham case as in the Middlesex, but the power to be taken in the Durham case is more than twice that in Middlesex, the load factor in Durham must be higher than in Middlesex?—We have not taken that basis. We have taken the load factor for light as better in Middlesex than in Durham.

The three factors coal, load factor, and quantity, are the ruling factors in the cheapness of the price at which you can sell—that being so, is it not the fact that all three are more favourable in the case of Durham than in Middlesex?—We do not know what they will be yet. We know that coal is more favourable in Durham.

Witness was briefly cross-examined on behalf of the various other local authorities, and the Committee then adjourned until Tuesday, June 19.

CHRISTCHURCH, BOURNEMOUTH, AND WINTON TRAMWAYS BILL.

On Friday last the Select Committee of the House of Commons, presided over by Mr. W. H. Holland, took the Christchurch, Bournemouth, and Winton Tramways Bill and the Bournemouth Corporation Tramways Provisional Order. The promoters of the first-named bill were the Poole and District Electric Traction Co.

Mr. BALFOUR BROWNE, Q.C., for the promoting company, said the bill was one to authorise the Poole and District Electric Traction Co. to construct tramways from the middle of Christchurch into Bournemouth, to be worked by electricity. There were two bills before the Committee, the one he was opening and one promoted by means of a provisional order by the Corporation of Bournemouth, who were proposing to construct lines in Bournemouth running partly over the same route as that proposed by the company, but with ramifications to streets which the company did not proposed to touch. A light railway was already authorised and in course of construction by the company promoting the present Bill, which would connect Poole with the County Gate at Bournemouth, and this line would be very important. Only the Bournemouth portion of the present scheme was opposed. On former occasions attempts had been made to obtain power to construct lines in Bournemouth, but the Corporation opposed on the ground that the introduction of lines along any of the roads of the town would drive away the wealthier class of visitors, who brought with them their own carriages and horses, and upon whom the prosperity of the town in the main depended; and the schemes were rejected. But last autumn when the promoters wrote to the Bournemouth Corporation giving notice of their intention to apply for power to run tramways into Bournemouth, the Corporation, immediately they received the letter, and forgetting all they had said before, promoted a scheme of tramways on their own behalf. Counsel thought in these circumstances the company had been very badly treated. He would not oppose the Corporation bill for the making of the trams, but he asked the Committee to say that if the Corporation scheme were sanctioned the company should have running powers over the Corporation line, so that people could travel from Christchurch to Bournemouth, and then on without change to Poole on the other side of the town; and thus avoid, as might be possible if the company did not possess these running powers, having to change on reaching Bournemouth, enter a Corporation car, change again on reaching the other side of Bournemouth, and proceed thence in a car of the company to Poole. If these running powers were granted the company would give the Corporation running powers over the company's lines. It was absolutely essential that there should be through communication. The only question really between the Corporation and the company was as to who should make the line on the road in the borough in regard to which both sought powers.

Mr. MARSHALL, ex-mayor of Christchurch, said the district through which the trams would run to Bournemouth was rapidly developing, and the trams would materially assist that development. Local feeling was strongly in favour of the company's scheme. In the event of the Corporation being allowed to construct the tramways in Bournemouth the company should have power to run over those lines, and should either party be unreasonable as to terms, there should be power to call in a third party to decide between them.

Mr. PAGE, Q.C., for Bournemouth Corporation, said he admitted the importance in the public interest of through communication, and he should not question the engineering or financial aspects of the scheme of the company. He could not agree, however, that in the event of the company and Corporation differing as to the means by which the through communication should be established a third party should be called in.

Mr. TUCKER, another ex-Mayor of Christchurch, said local opinion was strongly favourable to the establishment of an electric tramway between Christchurch and Poole, and to a through system—not one which should be dislocated at the borough boundaries.

The CHAIRMAN said the Committee were convinced of the desirability of there being a through service.

Mr. W. E. BURT, clerk of the Pokesdown District Council supported the company's bill.

This closed the case for the bill.

Mr. PAGE, Q.C., said if their bill were passed the Corporation would honestly carry out what they proposed. The only question was who should make the tramway in the borough, and he contended that the Corporation were the proper body, as was suggested in the Tramways Act of 1870. The Corporation objected to the compulsory running powers sought by the company with regard to the Corporation lines; it was not in accordance with the practice of Parliament to give such powers.

Mr. WEBBER, mayor of Bournemouth, said he saw no reason why a portion of the system should be severed and handed over to a company. As to running powers the Corporation and the company should be free to make their own bargain. He thought they could agree, and he objected to a third party, even the Board of Trade, being called in to decide between them in case of difference.

Other evidence having been given for the Corporation,

Mr. MOON, for the company, suggested that, having regard to the past history of the Corporation, and the strongly-expressed desires of the inhabitants, it would be well that there should be some security for the construction of the line for through communication. If the Corporation did not construct the tramway between the borough boundary and the centre of the town within two years, the company should have the power. Through communication was the essense of the scheme, and it ought not to be left to the Corporation to determine the terms upon which the company should use the line in the borough. The company should be given compulsory running powers, or else the Board of Trade should appoint an arbitrator to decide the terms upon which the company should be allowed to use the Corporation line. The company were willing to give the Corporation running powers over the company's line to Christchurch and Poole.

The CHAIRMAN asked Mr. Page whether he would agree to the insertion of a clause providing that if the Corporation did not construct this particular line within two years, the company should have power to do it.

Mr. PAGE said he would not object to that clause provided compulsory running powers were not granted.

Eventually the Committee passed the preamble of both measures, inserting the clause referred to, and granting running powers to the company under the terms of the Tramways Act of 1870, and reciprocal running powers to the Corporation with regard to the company's lines.

The bill was then ordered to be reported to the House.

THE ELECTRIC POWER BILLS.

The Special Committee of the House of Commons on Electric Power Bills took further evidence with reference to the Lancashire Electric Power Co.'s measure on Friday last. Sir J. Kitson again presided.

Mr. W. P. J. FAWCUS supported Mr. Gripper's evidence, given in our last issue, as to the cost of carrying out the scheme and the price at which it was hoped to supply electric power. He said the promoters expected that they would have to meet an enormous demand in the Manchester district and elsewhere. The duty of laying the mains ought, he thought, to be in the hands of the company, and not in those of the local authorities.

Prof. S. P. THOMPSON spoke of the advantages of supplying very large areas, and thereby reducing the price of electric energy to the consumer. He said that there were cases abroad in which electric mains extended over much greater distances than were proposed to be covered by the Lancashire Co.'s mains. It had been proved that a power of 100 volts could be carried 100 miles. He declined to assent to a suggestion which was made to him in cross-examination, that the cost of producing power by means of water, as in Italy and the United States, was lower than that of producing it by means of coal, and said that, though nothing had to be paid for the water, enormous sums had to be expended on engineering and hydraulic apparatus. In answer to a remark of a member of the Committee, witness said that the loss of power due to the transmission of electricity for a certain distance was the same in the case of overhead as in that of underground cables.

Mr. J. S. RAWORTH said the promoters of the bill had based their estimates on the requirements of the Board of Trade, and if the Board allowed the use of larger cables than those at present authorised a saving would be effected by the company. Such a saving might run into hundreds of thousands of pounds. He regarded the scheme as thoroughly feasible, and as one that could be worked to the financial advantage of the company.

Mr. G. CALDWELL, mining engineer, and one of the promoters of the bill, said that the collieries in the Ince and Wigan districts with which he was associated would be glad to see the scheme passed.

This closed the promoters' case, and the opposition of 15 district councils, represented by Mr. Wedderburn, Q.C., and Mr. Moon, was then proceeded with.

Mr. WEDDERBURN declared that the bill was an experiment that would result in failure, and hinder the natural development of electricity supply. As the roads were to be interfered with, he urged that the local authorities should have the power of supervising the laying of the cables.

Mr. ASPINALL, clerk of the District Council of Abram, gave evidence that representatives of all the collieries in the district were on the Council, which had petitioned against the measure.

Mr. ROBERT HAMMOND said that in the past provisional orders and licences had been granted in a larger number of cases to local authorities than to companies. The total capital invested under the Electric Lighting Act was about £20,000,000, of which £12,000,000 had been invested by local authorities. In Manchester the Corporation had lately extended greatly their lines of outlet, but the cost of the works had not gone down as in some places by an aggregation of outlet. While he should be delighted to see the whole country covered with power distributing undertakings, he considered that the *quid pro quo* offered by this company to the local authorities was by no means tempting. What was offered was not as good a condition of things as the local authorities could create for themselves.

The Committee adjourned till June 18th.

(Parliamentary Intelligence continued on page 226.)

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THE THOMSON METER CASE.

FOR some reason not precisely defined, disputes as to priority of invention always arouse interest in a large number of people not directly, and sometimes not even indirectly, concerned with the matter. Whether the issue be the enunciation of a new physical theory or principle, the new application of a scientific fact to a practical purpose, with a prospect of commercial importance, or whether it be an industrial matter pure and simple, each side has its partisans, and it is rare that the controversy ends by the mere statements of the claims of the inventors, or even that its discussion is confined within the four walls of a court of law. This being the general rule, it is no wonder that the action of CHAMBERLAIN and HOOKHAM *v.* THE BRADFORD CORPORATION, of which we publish the judgment in this week's issue, should have given rise to much comment, for although it may nominally concern only one firm of meter manufacturers and one local authority supplying electrical energy, actually if the decision had been in favour of the plaintiffs a large number of undertakers of electrical supply by continuous currents would have been affected; and, besides the maker of the meter alleged to be infringing, at least one other prospective meter maker might have had his ardour damped. The defendants having won the action, the position is practically "As you were," except perhaps that the importance of the Hookham patent has been considerably lessened, and that it appears no longer to be the master patent some may have thought it after the decision in the Perry meter case (CHAMBERLAIN and HOOKHAM *v.* JOHNSON and PHILLIPS) three years ago.

The action was brought against the Bradford Corporation as users of the Thomson meter, which, it was alleged, infringed the meter or meters described in Hookham's specification, No. 4,225, of 1887. The actual Hookham and Thomson meters, as built at present, are both motor meters with Foucault brakes—and there the resemblance apparently ends. While on the one hand the Hookham instrument measures ampere-hours, and its motor has a permanent magnet field, the main current being led through the armature by means of mercury contacts to the commutator, the Thomson meter, on the other hand, is an energy meter in which the main current passes through the field and a shunt current is led to the armature through silver brushes resting against an ordinary divided commutator. However, the question was not between the two meters, but whether the Thomson meter,

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as used at Bradford, could be deemed to have been made in accordance with the Hookham specification. The qualification, "as used at Bradford," is added advisedly, for the plaintiffs' advisers evidently saw that the meter *per se* was no infringement. Hookham's specification was for a quantity meter and a quantity meter only, and the Thomson meter is essentially an energy meter. But, said the plaintiffs, the Bradford Corporation is employing their meters on constant pressure mains, and we give the Corporation engineers the credit of keeping the pressure at their consumers' terminals absolutely constant, and then their energy meter does no more than measure ampere-hours just as our does. The judge did not take this view. He held that the fact that the defendants at Bradford had hitherto supplied electricity at a constant uniform pressure, did not render it unnecessary to have a meter capable of measuring whether they do or do not keep up such uniformity; to say that the defendants had not proved that they had deviated in the past from the Board of Trade regulations was an attempt "to turn their virtue against them in a manner quite unwarrantable." No doubt several of the principles underlying the Thomson meter are enunciated in Hookham's specification. For instance, it explains that either a permanent magnet field or an electromagnet field can be employed, and that the motor can be constructed with the main current passing through the field and the shunt current through the armature or vice versâ. But it has now been abundantly proved, if it had not previously been proved in the Hookham-Perry case, that the principles underlying the motor meter and Foucault brake had been set forth before, and were therefore "common knowledge" at the time of the specification. Ayrton and Perry's historical specification describing both their "erg-meter" (the precursor of the Aron meter) and the motor meter with disc brake—without, however, sufficient detail in the latter case to enable an efficient meter to be constructed—was again brought forward in evidence; but to this was added an article by Marcel Deprez in the *Lumière Electrique*, of January, 1884, describing the Siemens' energy measurer, which was a motor meter with a paddle brake, and pointing out how this instrument might be improved by adapting to it a magnet and disc brake which he had previously employed in an electro-magnetic speed indicator, and also an article by Uppenborn in the *Centralblatt für Electrotechnik* repeating, and to some extent enlarging on M. Deprez's conclusions. Incidentally it may be remarked that this case emphasises more than ever the value of technical journals and the importance of studying them. Mr. Ferranti, in his evidence, stated that, had he read M. Deprez's article at the time, he could have constructed a properly working motor meter in accordance with the instructions, and a motor meter resembling the Thomson meter. Yet, until over three years later, when Mr. Hookham succeeded with the first pattern of his meter, we believe that no really practically working meter of this type had been put on the market, although a demand for electricity meters existed. To return to the present lawsuit, however. The principle of the motor meter with a Foucault brake being "common knowledge" previous to the date of Hookham's specification, it only remained to show that Hookham and Thomson had employed different means of applying this commonly-known principle practically. This the judge stated had been done to his satisfaction. From his judgment it will be seen that he had attained a thorough grasp of the case in spite of all its intricate technicalities, and the same can be said of all the counsel employed. Yet considerable time has always to be spent in all such cases in educating the legal fraternity up to the required standard, and it is doubtful whether it would not have been more useful to appoint a committee to consider the question of reform in the methods of patent litigation rather than one to consider the few points in patent law included in the reference to Sir Edward Fry's committee—the text of which reference will be found in another column of this issue. It is surely of more importance that the means of testing the validity of patents, and of suing with regard to infringements should be cheapened, than that help should be afforded to the slovenly inventor who is too lazy or not sufficiently educated to ascertain for himself whether his invention has been anticipated.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Electric Dispersion of Ice.—By means of the method used for comparing the rates of propagation of electric waves through bitumen with and without wires, C. Gutton has determined the dielectric constant and electromagnetic dispersion of ice. The refractive index was found to be 1·76, which would give a dielectric constant of 3·1. The ice was perfectly limpid and dry, and was examined at a temperature a little below zero. It did not perceptibly absorb the electric waves. The value found for the dielectric constant is much higher than that obtained by Blondlot by a different method, and the author therefore suspected that ice would show considerable dispersion for different wave-lengths. The original method not being available for great wave-lengths, he used that devised by Blondlot, in which the wave-length proper to the same resonator is measured first in air and then in the medium under investigation. The refractive indices thus obtained cover wave-lengths ranging from 14 to 2,000 cm. For the smallest wave-length the refractive index is 1·76, as already stated. This becomes 1·73 for a wave-length of 25cm., and so it goes on decreasing with increasing wave-lengths until it reaches 1·50 at a wave-length of 2,088cm. This gives a dielectric constant of 2·25, which is not far from Blondlot's value of 2·0 found in still greater wave-lengths. Within the region investigated the dispersion of ice is normal. But it yet remains to connect it with the optical dispersion, which is characterised by even smaller refractive indices.

[C. Gutton, *Comptes Rendus*, April 23, 1900.]

Armoured Galvanometers.—The protection of magnetic observatories, necessitated by the development of electric traction, involves the absence of any magnetic other than that of the earth from the observatory grounds. Protection of the instruments from all external action would eliminate the very field it is desired to study. The same difficulty does not occur in the protection of galvanometers, where an artificial field is created and measured, and the total absence of any other field is the best possible condition of working. The protection of galvanometers by suitable "armour" is therefore a problem well within the sphere of practical electricity. Such armoured galvanometers have been constructed in various patterns by du Bois and Rubens. Theoretically, the best form of magnetic shielding is by a spherical shield, but there appear to be technical difficulties in the way of providing a suitable material for such a shield. The authors have, however, at length overcome this difficulty by the preparation of a special cast steel capable of taking a thin spherical surface. This cast steel, which is prepared by a process the details of which have not as yet been published, has a high initial permeability and very small coercive force. It is not only used for the two hemispheres of the outer armour, but also for a special armouring of the coils themselves. The planes dividing the outer and the inner hemispheres respectively, make an angle of 90deg. between them, and the combined system gives a production amounting to a hundredfold reduction of the disturbance. Usually a cylindrical outside armour is added, which makes the protection a thousandfold one. Quartz fibres are used for suspension.

Du Bois and Rubens, *Zeitschrift für Instrumentenkunde*, March, 1900.]

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Effect of Heat on Vacuum Discharges.—The distribution of the waste of energy in vacuum tubes has been measured by determining the quantities of heat given out at different points, or by studying the potential gradient. The dissipation of energy is, of course, greatest where the gradient is steepest, and so both methods yield substantially the same data. But the measurements, with the exception of those of Pandolfi, have hitherto been confined to ordinary temperatures, and Pandolfi confined himself to finding the total difference of potential rather than the gradient in various parts of the tube. G. C. Schmidt has, therefore, examined the potential gradient at different temperatures, ranging from 15°C. to 300°C., paying special attention to the differences in behaviour between the positive light column and the dark cathode space, which, as we know from the researches of Wiedemann and Wehnelt, acts virtually as a dielectric, freely transmitting electric oscillations, and breaking down under heavy dielectric stress much as would a layer of petroleum. The method used was that of probes, platinum electrodes being fused into the gas at various intervals. The most striking effect of heating was that the continuous positive light was split up into stratifications, which on further heating were gradually displaced towards the cathode, so that eventually a dark discharge was produced. At the same time, the potential gradient at the cathode was found to be unaffected by a change of temperature, until a point was reached at which the cathode was entirely covered with glow light, or heated to a white heat. After that the gradient would become steeper. In every case, when the discharge became non-luminous it was found that the gradient was steepest at the anode, and that its steepness was in fact proportional to the distance from the cathode. This relation is very suggestive from the point of view of the ionic theory. [G. C. Schmidt, *Ann. der Phys.*, No. 4, 1900.]

Dielectric Hysteresis and Viscosity.—Since the work of Arno, it is well-known that a dielectric placed in an alternating electrostatic field gets heated, and that the heating is proportional to some power of the E.M.F. Similarly, Janet has proved that with increasing potentials the charge of a condenser is feebler than it is when the potentials are decreasing. This lag is due either to viscosity or to hysteresis. Arno supports the latter alternative. In that case the dissipation of energy should be independent of the rate at which a cycle is completed. The experiments of F. Beaulard, however, point to the opposite conclusion. He charged a condenser to the same potential during various time intervals ranging from 4 seconds to 600 seconds, and compared the charges by sending them through a ballistic galvanometer. He found that the loss of energy in the condenser decreased as the time increased, and that if the process of charging the condenser was extended over an interval of 15 minutes the loss was nil. He, therefore, concludes that the effect is due to viscosity rather than hysteresis.

[F. Beaulard, *Comptes Rendus*, April 30, 1900.]

International Observation of Magnetic Storms.—The characteristics of "magnetic storms" point towards local processes as their proximate causes, which, though producing simultaneous disturbances over the entire earth, confine their strong influence to a limited area. Since these local processes are probably electric currents in the higher strata of the atmosphere or in the earth's crust, they may be of the nature of wandering current vortices. Whether these are situated in the atmosphere and the terrestrial phenomena are effects of induction, can only be determined by simultaneous observations extending over thousands of miles. The only such area at present adequately supplied with magnetic observatories for such a purpose is Europe and even there the number of Northern observatories, which are specially important for this object, is somewhat small. A. Schmidt gives some general principles which should govern the action of an international combination of observatories organised for this study. Absolute measurements are not indispensable. It suffices to have the values of the elements compared with those laid down on the existing charts. The apparatus of the different stations should be at least approximately of the same sensitiveness, but that sensitiveness need not be very high, as it is a question of comparing considerable variations. In the declination, for instance, accuracy up to one minute of arc suffices. The needles should be strongly damped. The epochs should not be too numerous, so as to avoid overworking the staff. The observations should be handed in fully reduced, and the prompt publication of the results should be ensured.

[A. Schmidt, *Terr. Magnetism*, March, 1900.]

CORRESPONDENCE.

THE ABSORPTION OF ELECTRIC WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Having recently constructed an apparatus for the production and detection of electric waves having a wave-length of only a few inches, I have been interested to find how easy it is, when certain precautions are taken, to exhibit experimentally with this apparatus, of quite moderate dimensions, the chief properties of electric waves and the electro-optic qualities of bodies. With these appliances, which I shall describe later on, the transparency and refractive power of insulators, opacity and reflective power of conductors, and polarisation effects are most readily and strikingly shown. The apparatus is especially adapted for testing qualitatively the absorptive powers of various substances for electric waves. It is accordingly found that paraffin oil, benzol, turpentine, and all insulating liquids of low dielectric constant prove to be exceeding transparent, but water, and many liquids of high dielectric constant, are very absorptive. The waves I have been employing (of about 8in. wave length) pass easily through a wood board an inch thick, a dozen sheets of window glass, a dozen thicknesses of dry washleather, a thick slab of ebonite, but are stopped almost completely by a couple of wet cloths, or $\frac{1}{8}$in. thickness of water, and by any substance which is very moist. Ice on the other hand, if *dry* on the surface, is transparent to them. Constructing a large ice prism I have readily refracted these rays by it, and measured approximately the refractive index of ice for them. It proves to be a number near to 1·7 or 1·8. The human hand and body are very opaque to these particular electric rays. I have also found they are absorbed by some vapours. The red nitrous fumes produced by the action of nitric acid on copper appears to absorb them to some extent even if only a few inches in depth, although they will pass easily through a slab of ice some 4in. in thickness. They are easily reflected from a surface of glass, and a very striking experiment may be shown by reflecting them at 45deg. from the palm of the hand. By splitting an electric beam into two parts, and sending the two portions along two zinc tubes, which can be varied in length, the interference of two electric rays is most easily shown, and the wave length measured. Any substance which has conductivity or large dielectric constant in one direction only is very absorptive of these rays when that direction is placed parallel to the electric force of the ray falling upon it. Thus a paper of pins stops the rays when the pins are held with their length parallel to the direction of the electric force, but not when they are held normal to it. The strongly absorptive character of distilled water or alcohol shows that in these cases it is not so much conductivity as large dielectric constant which seems a determining factor. As the experiments have not proceeded very far it is necessary to refrain from generalisation, but it appears very much as if all substances which contain in their chemical molecule either hydroxyl (HO) or nitryl (NO_2) are in the liquid, and perhaps in the gaseous, form very opaque to electric radiation, the wave length of which is not more than a few inches.

In the case of water it would seem that the absorption band known to exist in the ultra red water spectrum extends as far as wave lengths, 200,000 or 300,000 times as long. The electric refractive index I have found for ice is in very fair agreement with the square root of the dielectric constant for high frequency reversals of electric force.—Yours, &c.

J. A. Fleming.

Pender Electrical Laboratory, University College,
London, May 30.

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LONG DISTANCE TRANSMISSION OF POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your leading article on May 18, you refer to my remarks on the recent Paper of Prof. Forbes. I would explain that I thought the Paper a practical joke. I could not praise the Paper, so the author became angry, and suggested many times that when I read his Paper more carefully I might change my opinions. I was indeed a little disconcerted, nevertheless I beg to ask for a careful consideration of what I said, as I think that it was, and is, and will be, of great importance. Furthermore, I said that I had not had time to examine the figures of the Paper, and I hereby declare that I had no intention of condemning those figures until I was bullied into doing so. I had no doubt whatever about the wrongness of his figures, but as he had described six quite different systems on which he was in the habit of making calculations, as I suspected that they were all wrong systems, I knew that if I chose any one of these systems and proved his numbers to be wrong, he had five lines of retreat.

Allow me now to show you how the thing appeared to me at the time. In our old 1886 Paper, so reviled as nonsensical at the time by Prof. Forbes and commended by him now, we proved that the efficiency in an ordinary transmission system (no boosters) could not be less than 50 per cent. What we meant will become quite clear from the following arithmetical example:—Take any case one pleases of power transmission where the efficiency seems as if it might be less than 50 per cent. For example: Generator voltage 1,000 volts, current 200 amperes, resistance between generator and motor 3 ohms. The voltage at motor is 400 volts. The power delivered is 80 kw. The efficiency of transmission 40 per cent. Now notice that, if such a case could by accident exist, it could only continue to exist by some careful and curious way of governing the speed of the motor. If the motor is allowed to run up in speed so that it may work at 600 volts, it will receive 133⅓ amperes through the same resistance, and therefore the same power, 80 kw., will be delivered, the efficiency of transmission now being 60 per cent. It is in this sense that I affirmed the non-existence of any case of transmission where there is an efficiency of less than 50 per cent.

Now, surely I may take it that this is clear even to the man most scornful of science, and especially of elementary algebra.

To apply my result in the present case: Consider in Table II. his total efficiency 0·12. In whatever way he worked he would certainly get his best result by having the same efficiency $\sqrt{0{\cdot}12}$, or 0·3464, in each of the two sections. If he did not have them equal, one would be less than this. This statement applies to any of his six systems of calculating. But I have proved that if he, using only arithmetic and domestic mathematics, gets an efficiency 0·3464 or less, for a section, then I know that with the very same conductor and same generator voltage I can deliver the same power with an efficiency of 0·6536 or more, through that section. This was my rough and ready way of looking at the matter at the time, but I did not like to put it forward, for it certainly understates my case. Nevertheless it is useful as giving condemnation of the published figures.

The following result is more exact: Prof. Forbes puts it that, with a certain conductor and given generator voltage, to deliver 1 H.P. at the distance of 100 miles, using boosters, it is necessary to waste 7⅓ H.P. in overcoming ohmic resistance. I affirm that, with the same generator voltage, and same conductor, he can deliver 1 H.P. at the same place at the same voltage, his total ohmic loss being only 0·28 H.P., and he need not use anything like such large boosters. I also say that, if he starts working in his own uneconomical way, taking no precautions to maintain this want of economy, his boosters will quickly alter things so that the transmission of energy will proceed, not in his way, but in my way.

I was very much understating my case when I said that in no section of a boosted system can the efficiency be less than 50 per cent. In fact, there can be no total efficiency in the system of Table II. less than 33 per cent., and no efficiency in either of the two sections of that system less than 57⅓ per cent. Also, there can be no total efficiency in the system of Table III. less than 25 per cent., and no efficiency in any section of such a system less than 63 per cent. Thus, for example, in Table III., where he gives 11 per cent. I find that the total efficiency need not be less than 44, and where he gives 13 per cent. the efficiency need not be less than 40.

The proof of these and no end of other interesting statements is quite easy, but I must confess that it needs elementary algebra, so that it is quite hopeless to convince Mr. Swinburne. I had not known that he was interested in power transmission, else by many concrete examples I might have endeavoured to give to him the information which my simple formula expresses.

You will recollect that I called attention to the possibly great extra cost of the power transformed by the boosters, neglected by Prof. Forbes. In his Table II. (his line of two sections) when his efficiency is 0·12, his boosters generate 2·5 H.P. for every horse-power delivered; even by my figures the boosters generate 0·5 H.P. for every horse-power delivered. I do not see why Prof. Forbes should have been so angry when I ventured to suggest that there was really no practical need for boosters to keep up the voltage.

I must say that I am still of that opinion and I think that Prof. Elihu Thomson, who patented this booster system of Prof. Forbes, many years ago, is of the same opinion.—

Yours, &c., JOHN PEERY.

May 17, 1900.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Professor Elihu Thomson's well-known use of boosters in power transmission, may I put before your readers the result of a calculation. In deference to the wishes of those who want to know facts and do not care for reasons, I forbear to give the simple algebra on which the calculation is based, but any of the younger electrical engineers can get it out for himself. I have assumed the same current density throughout. It is easy to extend the reasoning so as to have less current density at greater distances from the generator. I take the case of a generator at $v_1 = 10{,}000$ volts; I receive $P_0 = 5{,}000$ kw. at the voltage v_0 at the distance of $\frac{1}{2}n$ miles or 100 miles from the generator. I assume the costs of power and of copper to be such that by the simple Kelvin law there ought to be 500 amperes per sq. in. in the copper (or $t = 20$ in the Ayrton-Perry Paper of 1886). Practically this means that the cost per annum of one ton of copper is 1 kw. at the generator. All values are reckoned in watts. In calculating column 5, I assume that the transformation of power by a booster costs three times as much as the original generation of the power; it is easy to change the numbers if this ratio is objected to.

Instead of making many tables—one for a few boosters, another and others for more and more, taking many cases—I have assumed that the current is continually boosted—an infinite number of infinitely small boosters, because the results are much the same and the algebraic expressions are simpler to think about.

I. $v_1 - v_0$ is the total drop of voltage on the line, and I use the letter m for $\frac{v_1}{v_0}$. Let there be everywhere A amperes per square inch in the copper. Let n miles be the whole length of the conductor. Use the letter μ for

$$m^{\frac{m}{m-1}\cdot\frac{0{\cdot}04A}{v_1}} - 1,$$

then ohmic loss $= P_0\mu$ kilowatts.

Loss because of cost, &c., of copper $= P\left(\frac{t}{0{\cdot}04A}\right)\mu$ kilowatts, where $t = 20$.

Energy transformed by the boosters $= P_0\mu\left(1 - \frac{v_1 - v_0}{0{\cdot}04An}\right)$.

II. When v_0 is equal to v_1 and the boosters maintain a constant potential,

Let $\gamma = \frac{0{\cdot}04A}{v_1}n$; then, if C_0 is the received current of 500 amperes, ohmic loss $= C_0 v_1 (\epsilon^\gamma - 1)$ watts.

Loss because of cost, &c., of copper $= C_0 v_1 (\epsilon^\gamma - 1)\left(\frac{t}{0{\cdot}04A}\right)^2$ watts.

Energy transformed by booster $= C_0 v_1 (\epsilon^\gamma - 1)$ watts.

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Delivering 5,000 kilowatts at a distance of 100 miles by direct current from a generator at 10,000 volts :—

—	Amperes per square inch.	Percentage drop of potential in 100 miles.	Kilowatts ohmic loss.	Kw. loss because of cost of copper.	Three times the power tr'nsformed by boosters.	Total loss in kw. ohmic + copper + boosters.	Total tons of copper.	Power delivered / Power at generator
Simple Kelvin rule...	500	0·20	1,250	1,250	0	2,500	1,203	0·8
Ayrton-Perry rule...	409	4 16	979	1,461	0	2,440	1,496	0·836
Ditto.	205	8·19	446	2,662	0	3,108	2,561	0·918
Boosters	300	8·19	665	1,848	633	3,146	1,747	0·885
	400	8·19	910	1,421	1,332	3,663	1,310	0·848
	500	8·19	1,234	1,234	2,186	4,654	1,189	0·802
	100	0	205	5,125	615	5,945	4,930	0·962
	200	0	415	2,594	1,245	4,254	2,494	0·926
	250	0	525	2,100	1,575	4,200	2,022	0·905
	300	0	635	1,764	1,905	4,304	1,697	0·893
	400	0	880	1,374	2,640	4,894	1,322	0·850
	500	0	1,110	1,110	3,330	5,550	1,061	0·820
	600	0	1,360	945	4,080	6,385	909	0·786
	800	0	1,870	732	5,610	8,212	709	0·729
	1,000	0	2,455	614	7,365	10,434	591	0·671
	2,000	0	6,125	383	18,375	24,883	368	0·450

As I take it, the most economical figures here for each of these drops of potential are :—

—	Amperes per square inch.	Total loss on line.	Percentage drop of potential.	Tons of copper.
A.-P. rule (no boosters)	409	2,440	16·4	1,496
Ditto.	205	3,108	8·19	2,561
Boosters	250	4,200	0	2,022

If we do not mind having a drop of 16·4 per cent., it is evident that the old Ayrton-Perry rule without boosters is the best. I take this as my standard. If we may have 8·19 per cent. drop, still the Ayrton-Perry rule without boosters is the best: there is a total loss of 27 per cent. more than in the standard case. If, however, we may have no drop of potential, then the use of boosters with 250 amperes per square inch in the conductor is the best, but we have a total loss of 72 per cent. more than in the standard case.

I said in a recent discussion that I know of no reasons why, with the above voltage and for such a distance, it should be at all necessary to use boosters, for a drop of 8 per cent. is not important and the saving in not using boosters is very great. When no boosters are used it is easy to show that the most economical result as to ohmic loss and price of copper is obtained with a conductor of the same section throughout.

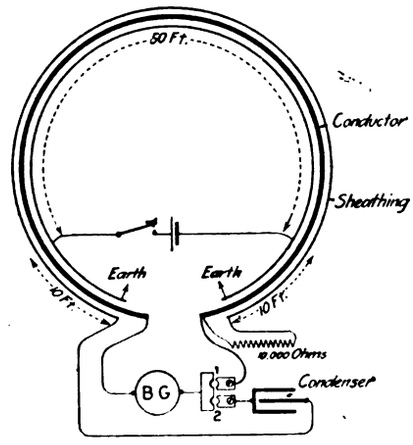
If the price of copper is so great that the simple Kelvin rule would give 1,000 amperes per square inch, it is necessary to divide all the numbers of the column headed "Loss because of cost of copper" by 4.—Yours, &c,

May 17, 1900. JOHN PERRY.

ELECTRIC TRACTION CURRENTS AND SUBMARINE CABLE WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is only recently that I have been able to act on Mr. McWhirter's suggestion (see his letter in *The Electrician*, Vol. XLIV., p. 868), and to repeat the experiment recorded in the discussion on Prof. Jamieson's Paper on this subject, and illustrated by his Fig. 12. This figure, according to the advocates of the electromagnetic induction theory, correctly represents the actual working conditions at Cape Town. The figure which I append is practically identical with Fig. 12 in the discussion when the key is placed in the hole 2 of the two-way plug. But I have introduced an additional connection by means of which, when the plug is in hole 1, the galvanometer is simply connected across the two ends of the core, and thus subject to electromagnetic induction pure and simple. In order to make the object of this arrangement quite clear, I cannot do better than quote the following two sentences from the discussion :—"Mr. Sayers said that . . . these effects were not produced from induction solely, for he thought that the battery current split at the point of attachment to the sheathing. *If it did, the portion of the current which came from this attachment along the sheathing to the telephone was opposed to the induced current from the central core, and so it was in the case of the Cape cable*" (the italics are mine). From this it follows that a simple determination of the *direction* of the disturbing current will finally settle the point at issue. For this reason, I substituted a Crompton "Midget" ballistic galvanometer for the telephone, which cannot be used for giving the direction of a current. When the plug was in hole 1, so that the most favourable conditions for electromagnetic induction were produced, the galvanometer gave a throw of 15 scale divisions to the *right* when the battery circuit was *made*. On transferring the plug to hole 2 (corresponding to actual conditions at Cape Town), a throw of 11



scale divisions to the *left* was obtained when the battery circuit was *made*, the capacity of the condenser being 1 microfarad. With 4 microfarads 42 scale divisions were obtained.

The results hardly require much comment, and clearly show how utterly insignificant the effects of electromagnetic induction are in the case considered.—Yours, &c.,

Liverpool, May 26, 1900. ALFRED HAY.

GUARINI'S WIRELESS TELEGRAPH REPEATER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—Reading, rather late, the issue of April 20th of your esteemed journal, to which I have subscribed for a long time, I find on p. 932 a review of a pamphlet by M. Guarini on the wireless transmission of electricity, and in it an allusion to the use which the author has made of my name. I have the honour to send you herewith the *Bulletin* of the Société Belge d'Electriciens, reproducing my lecture of November, 1899, entitled "Some Advances in Wireless Telegraphy." In it a brief description of the repeater devised by M. Guarini (a kind of telegraphic relay) follows a summary of the principles and the most remarkable results of wireless telegraphy. Desirous of putting my colleagues *au courant* with interesting novelties, and fulfilling, at the same time, a duty of hospitality towards a young foreign inventor, I have not considered myself able, however, to carry further the exposition of his ideas.—Yours,&c.

E. GÉRARD.

Office of the Minister of Railways, Posts, and Telegraphs, Brussels, May 26.

[In the report of the lecture enclosed with his letter M. Gérard explains that, in treating of things in which he is little versed, he does so in order to carry out the recommendation that every member of the Society should relate at its meetings any novelty he has come across, and because the inventor did not know enough French to explain his invention himself. After a brief explanation of the principles of wireless telegraphy and a historical retrospect, he proceeds to describe M. Guarini's apparatus, leaving it to M. Guarini himself, if he desires it, to give an exposition of the complete theory on which the efficiency of the essential parts of the system depends. M. Gérard concludes as follows: "Such [various suggested wireless telegraphic possibilities] are the ideas of M. Guarini, which do not appear to me incapable of realisation by the progress which his invention promises. I conclude here, leaving M. Guarini to explain his theory of metallic screens and curvilineal 'antennæ,' on which depends the action of his successive repeaters. Let us congratulate M. Guarini, and let us congratulate ourselves on being able to count him among our new colleagues."—ED. *E.*]

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IMPERIAL TELEGRAPHIC COMMUNICATION.

Before the Foreign and Colonial Section of the Society of Arts, on Monday, Sir E. A. Sassoon, M.P., read a Paper on "Imperial Telegraphic Communication." The Paper traversed practically the same course as that covered by the discussion in the House of Commons (fully reported in our last issue), except that Mr. Hanbury's reply to the attacks of Sir E. A. Sassoon upon the cable companies had tempered the hon. gentleman's remarks, and consequently the Paper fell somewhat flat. The remarks of the President (Sir H. H. Fowler, M.P.), were, however, more to the point. He said: "This question of submarine telegraphy was a very difficult one. In this country the Government never begins anything. It is left to private entetprise and private capital, especially where any risk is involved. Now telegraphic inventions were from the first in private hands and the Government did not favour its development in past times. The telegraph system had been allowed to grow up, and he was quite sure that it could not be disturbed or settled without a great deal of inquiry and consideration, so as to secure what was right both to those who had risked their money in the concern, and the wider public beyond who might have arrived, and he thought would arrive, at the ultimate conclusion that this was not a matter which should be left in private hands. He regarded the submarine cable enterprise from a threefold point of view. It had a commercial aspect, but it was something more than a commercial enterprise. It had a social and personal character. We were seeking to knit all the subjects of the Queen in various parts of Her Majesty's dominions into one undivided empire, feeling the impulse from the centre, and at the same time developing to the fullest extent that local self-government which they had carried out and could carry on with the greatest advantage to themselves and to the Empire at large. Now we wanted to bring our colonial fellow-subjects into the closest possible communication with us day by day. That could not be done unless the means of communication were facilitated to the utmost of our power, and reduced to the lowest possible cost. He maintained that in a great colonial empire like ours it was worth our while paying money not commercially remunerative to secure free cable communication with the various parts of the empire. This was to be regarded as a great national service, irrespective of commercial considerations, which did not enter into our telegraphic system at home, where 10 millions o capital did not yield a shilling interest. Yet no Government would venture to increase the telegraphic rates at home. Then, on every ground it was of supreme importance to the interests of this country that our communications with India of every kind—in the transit of goods and passengers and in the facility and economy of telegraphic messages—should be in daily touch with the mother country. Then there was the military aspect of the question. A great empire like ours, with colonies in every part of the globe, with great possessions in Asia, Africa, America and Australasia, ought to have a communication of its own, under the control of its own Government, independent of all private companies and foreign nations, which would be a powerful element in its equipment for defence against whatever happened. He held that the time had arrived when there should be an inquiry by independent, impartial, competent men into the past history of the case, into the present position of all these cable enterprises, and into the wisest and best course to be adopted for the future. That Committee, while careful of all fair and legitimate interests involved, would point out to Parliament, the Government, and the nation at large whether any, and if any, what changes should be effected in so potent an instrument between the home Government, its Indian Empire, and the Colonial Empire, in which instrument he thought there were at present many weak spots and possible dangers, against which we ought to guard."

Sir PATRICK PLAYFAIR said the unfairness from which India had suffered in the matter of telegraphic rates was perhaps partly due to the reluctance shown by the Government to guarantee any loss of income that might temporarily ensue on the reduction of rates to the extent of 50 per cent. or 75 per cent. of existing rates, the opinion being held, he understood, by some of the officials of the Indian Government that it would be unfair to make the general taxpayer meet any part of a deficit, however temporary, that might follow upon a reduction of charges between England and India, as the benefit would be received by a small section only of the community, and be largely for the benefit of the European as distinguished from the Indian community.

The Hon. GEORGE PEEL said the broad issue which faced them in connection with this question was whether submarine cable enterprise was to be in the hands of private persons, or in those of the State. There would shortly be 190,000 miles of submarine cables laid in the sea, of which 20,000 only were owned by different States, and what was more these 20,000 miles were laid almost entirely in territorial or inland waters. It might, therefore, be said that the whole of the great international traffic of the world was conducted by cables in the hands of private companies. It had been truly said that Governments did not care to embark their capital and credit in these enterprises, and the public functionaries were not the proper persons to be creators of international trade. He (the speaker) would therefore look with a close and careful eye on the proposals made to abandon the experience of the past. He then passed in review various proposals made in the Paper read by Sir E. A. Sassoon and in the statements made in the House of Commons during the recent debate on the question, subjecting many of these statements to severe criticism.

Sir John Leng, M.P., Sir M. M. Bhownaggree, M.P., Mr. R. K. Gray, and Mr. Chas. Bright also took part in the discussion.

At the Royal United Service Institute, London, on Monday, Sir John Colomb, M.P., presided at the reading of a Paper by Lieut. C. W. Bellairs on "The Routes of Submarine Cables." Lieut. Bellairs took as a test case the proposed "all-British" Pacific cable, and contrasted the proposed line with another laid and worked by British capital but touching foreign territory. He said that, so far from finding it a disadvantage to land the cable on territory belonging to a strong neutral Power like the United States, it was a positive gain. The principal objections to the proposed all-British cable were that by international law, as the cable would not touch neutral territory, a belligerent would be at liberty to cut it anywhere along the 8,000 miles, and the landing stations, not being on neutral territory, would have to be protected. The proposed cable entailed a span of 3,560 nautical miles, the longest in the world by over 350 nautical miles. It would mean the loss to Canada, Australasia and our shipping trade of direct communication with Hawaii. The Americans were about to lay a cable from San Francisco to Hawaii, and if we did not connect Australasia with this system others would probably connect New Caledonia. If connected with Hawaii Australasia would obtain a fresh line to the East by the projected American cables to the Philippines. The risk of being cut in time of war would be much greater to an all-British cable than to one following a natural route to friendly neutral territory. The natural route, too, was always the cheaper to lay and maintain, while it opened up the largest market for commerce. In time of war it would be a very easy thing to lay special strategic cables for naval use. For the rest naval requirements were the same as those of commerce—a multiplicity of routes—so that if a cable were lost in one direction the message could be sent by another route.

In the course of the discussion which followed Col. Sir George S. Clarke said the lecturer had fairly pricked the bubble of the all-British cable, which was threatening to extend in a most harmful way. There was something unwholesomely fascinating about the word "strategic." After all, strategy was merely a question of applying common sense, and Lieut. Bellairs had applied common sense and pricked the bubble of an all-British cable. There was no international agreement about the cutting of cables in time of war. The only question was the difficulty of doing so. When it came to war belligerents would do anything they could unless it was a thing likely to shock the world, and the cutting of cables would not shock the world. The most important strategy for the British empire was the strategy of commerce. The cheaper and more certain telegraphic communication was made the better it would be for this country in peace or in war. Our policy should be to discourage monopolies and to encourage cheapness of communication and an increase in the number of lines for purely commercial purposes.

Sir John Colomb in the course of a few concluding remarks, said he held very strongly the conclusions of the lecturer. The commercial argument for all-British cables had proved weak, and therefore the strategic argument was used as a crutch to help up the cause.

PARLIAMENTARY INTELLIGENCE.

(*Continued from page 219.*)

GLASGOW DISTRICT TRAMWAYS BILL.

A Select Committee of the House of Lords, under the chairmanship of Lord Herries, considered this bill last week. The promoters seek to incorporate a company to construct electric tramways in and around the burgh of Paisley.

Mr. PEMBROKE STEPHENS, Q.C., for the promoters, explained that the original proposals for the construction of new tramways on the north side of the Clyde had been dropped, but from the termination of the Glasgow Corporation Tramways and Balloch Bridge eight sections of tramways remained. No. 1 started in Johnstone, and connected with existing lines of the Paisley tramways; No. 2 occupied the site of the Paisley tramways; No. 3 was a tramway running out of Paisley and going as far as Abbotsinch on the road to Inchinnan; No. 4 was a tramway running through Paisley, connecting with the Glenfield Scouring Works and the opening to the Braes of Gleniffer; No. 5 was a short line in Renfrew; No. 6 was a continuation of No. 5 running from Renfrew to Paisley, and completing a through route; No. 7 was a line from Renfrew to Govan; Nos. 8 and 9 were small subsidiary lines. The Govan section would be about 2 miles in length. The gauge would be 4ft. 7½in., so that if desired afterwards there would be difficulty in making a physical connection. All the tramways would be worked by electricity, and be constructed on the overhead system. The tramways would have to go over or under bridges crossing lines of railway, but the promoters did not interfere with railway works. Local feeling had been expressed in favour of the proposed lines, and the undertaking came up with the assent and approval of the Town Council of Renfrew, the Police Commissioners of Johnstone, and the County Council of Renfrewshire, and the Upper Ward District Committee of that Council, and with the support and assent of the burgh of Paisley, who had two agreements with the promoters scheduled to the bill. The petitions against the measure were those of Glasgow Corporation, Lanarkshire County Council, Clyde Trustees and the Glasgow and South-Western, the Caledonian, the Glasgow and Paisley Joint Line, the Paisley and Barrhead District, and the Glasgow and Renfrew District Railway Companies. So far as Glasgow was concerned, the opposition was a matter of clauses. The petition of the Clyde Trustees proceeded on the misapprehension that there would be a tramway ferry and an electric cable across the Clyde, which would interfere with the navigation of the river. There would be no such cable, and a ferry had never been thought of. The County Council's opposition was in the nature of a legal objection to the laying of the Govan line. The objection of the railway companies was on the ground of competition.

Mr. WILLIAM BARRINGTON, C.E., the engineer under the bill, said the period for the completion of the whole scheme was five years, but tramway No. 7 would take only seven or eight months to build. It had never been intended to have a tramway ferry across the Clyde. At one

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time it was in contemplation to put the main electric cable under the Clyde, so as to connect the trams on the north with those on the south side, but that was only to be done if the Clyde Trustees consented, and now that Dumbarton was out of the bill altogether there was no necessity for the cable. There was nothing in the objection that the tramways would interfere with the electrical signalling apparatus on the railway. The bill contained the ordinary parcels clause. It was not intended to carry goods, and the promoters were willing to give a clause prohibiting them doing so. The tramways would not be railways on the public road. The carriages would not be railway carriages. They were departing from the general law allowing the local authority the option to purchase at 21 years, because it was now usual to make a departure from the Tramways Act. He did not know whether it was proposed to supply outsiders with electricity in bulk. The promoters were seeking to reconstruct the Paisley tramways. At present their trams were single lines, and it was proposed to double them throughout. The total estimated cost of the lines proposed was about £180,000.

A mass of local of evidence in favour of the bill was then taken, after which Mr. WM. M. MURPHY, chairman of the Dublin United Tramways Co., and one of the promoters, stated that the Dublin tramways were the largest system of electric tramways in the United Kingdom. They were worked from a single generating station, which was (he asserted) the largest in this country and one of the best equipped in the world. He was a director of tramway undertakings in London, Belfast, Cork, and other places. At present he was engaged in the construction of tramways at Margate, Ramsgate, and Broadstairs. If necessary he would find the whole of the capital without any appeal to public subscriptions, but if the local people wished an opportunity of investing in the undertaking he would give it to them. The circumstances at Cork were not unlike those of Paisley, and the system he had constructed in Cork in the first year of working carried 5,000,000 passengers and earned £20,000. It had been found in the new conditions of tramway enterprise impossible to undertake services on the terms of the Tramways Act, 1870, and in consequence it had been necessary to arrange special terms, especially as to wayleaves and conditions of purchase. In the Isle of Thanet he gave the local authorities power to purchase at 42 years on paying the value under the Act of 1870 with 25 per cent. added for the goodwill of the concern. In the case of the Hastings tramways there was a right of purchase at 25 years, the price to be the value of the undertaking as a fair going concern. The agreement with Renfrew and the other local authorities was that they should be entitled to buy what was in their own districts without going to Parliament; the distinction in the case of Paisley was that they were to have the power of purchasing the whole undertaking, but Paisley must go to Parliament and show that there was a public case in the purchase, and, of course, it would be open to any of the other local authorities to oppose the bill. He was the sole promoter of the present undertaking. The Renfrew agreement provided that the Corporation might purchase the tramway within the burgh as a going concern at a fair market value at 25 years; while the Paisley agreement provided for purchase at the original cost.

Mr. ERSKINE POLLOCK, for the Glasgow and Renfrew District Railway Co., submitted that their case was a particularly hard one, because their railway had only been sanctioned in 1897, and was not yet completed. The railway was designed for suburban pick-up traffic, just the class of traffic which the tramway was designed to serve. In these circumstances, he submitted that Parliament, having sanctioned the railway, should not subject it to this competition until it had had an opportunity of proving its usefulness.

Evidence on behalf of the other opposing railway companies was then heard, Mr. WORSLEY TAYLOR, for the Caledonian Co. and the Clyde Navigation Trustees, contending that if tramways were to be made, they should be made by the Corporation of Glasgow. Evidence for the Corporation of Glasgow was then taken and Mr. PEMBROKE STEPHENS said the promoters would be prepared to give the Corporation of Glasgow running power over tramway No. 7 from Govan to Renfrew if, upon corresponding conditions, the Corporation gave the promoters running powers over their system to Glasgow.

Evidence on behalf of the Glasgow Corporation, the Lanark County Council, and other opponents having been given, the CHAIRMAN intimated that the Committee had decided that tramway No. 7 (Renfrew to Govan) must come out of the bill. With this exception the preamble of the bill was passed, the clauses adjusted and the bill ordered for report to the House.

S.E. AND CHATHAM RAILWAY AND FOLKESTONE, SANDGATE AND HYTHE TRAMROADS BILLS.

On May 21, the House of Lords Committee, presided over by Lord Brougham, considered the Omnibus Bill of the S.E. and Chatham Railway Co., which relates to the construction of a junction railway line from New Romney to Hythe. The proposal was opposed by the Sandgate and Hythe Electric Co. (Ltd.), who have a bill before the same Committee seeking powers to construct tramroads from New Romney to Folkestone to be worked by electricity.

Mr. LITTLER, Q.C., for the railway company, said the proposed line would be 8¾ miles in length, would run from New Romney to Hythe, and would enable passengers travelling between those places by rail to save the present long detour of 35 miles viâ Ashford. The line would be worked by steam locomotives up to a point about three-quarters of a mile from Hythe, where it would form a junction with the company's own tramways, from which point it would be worked by electricity on the conduit system as far as the commencement of a short line to be constructed connecting the tramway with Hythe station. The only opposition came from the Sandgate and Hythe Electric Co., who sought by their bill to form in connection with their existing tramways a communication between Romney and Hythe. But then tramways would run, if authorised, along the highway inconveniencing the traffic on the high road, especially as it was proposed to carry goods as well as passengers. There was, he contended, no justification for their scheme, when there was a railway company prepared to give a properly constructed railway off the high road.

Mr. ALFRED WILLIS, manager of the S.E. and Chatham Railway, explained the proposals of the bill. He said that for many years the railway companies had proposed schemes to connect Hythe, Folkestone, Newchurch, and Dymchurch, the general idea being to connect the lines of the two companies, and have a through service from Ramsgate to Portsmouth. At a point outside Hythe, on the new line, there would be exchange stations, where the steam locomotive would be removed, and an electric motor put on, and the train taken over the tramway to Hythe station. The advantage the War Office would get by having connection between Shorncliffe and Lydd for heavy traffic would be important.

Mr. TEMPEST, engineer to the railway company and to the scheme, said the proposed line presented no engineering difficulties, and its cost would be £62,800. Electric traction was more suitable for the heavy gradient from Hythe station to the existing tramways. By the construction of the proposed line all the towns on this coast would be put in communication on the same gauge from Hastings to Margate and even along the Thames. The company's rolling stock could run over the tramway rails. It was possible that different trains might have to be used from the point where electricity was substituted for steam, but in cases of emergency any stock might be used.

After local evidence had been taken in favour of the new railway, the Committee decided to hear the case for the Folkestone, Sandgate, and Hythe Electric Tramroads Bill before deciding upon the proposals of the Railway Co.'s bill.

Mr. MOON, for the Sandgate and Hythe Electric Co., submitted that the scheme of the railway company was a hurriedly conceived one, and was not anything like so well calculated to meet the requirements of the district as the tramways scheme, which would give through communication from Folkestone to Hythe, Sandgate and New Romney. The tramway service would afford far better facilities for the purpose of Shorncliffe Camp, and would much better serve all the needs of the War Office. The trams were to be constructed along the public road, and all the local authorities, with the exception of the Folkestone Corporation, were in their favour.

Evidence was then given in support of the Electric Company's bill, and a number of local witnesses, including the Vicar of Sandgate and the Mayor of Hythe, expressed themselves in favour of the tramways.

Mr. S. P. SELLON, engineer to the scheme, said the tramways would be worked by electricity on the overhead trolley system. In Dover, where he had constructed tramways, the whole population was carried 60 times in each year. The length of the proposed tramways would be 17 miles. The generating station would be erected between Hythe and Dymchurch. He had ascertained the views of the local authorities as to the communications necessary for the district. They were very anxious that the tramways should form a continuous route throughout the district. A clause had been arranged by which any contract with the local authority for the purchase of any portion of the undertaking would contain provisions to secure the future working of the tramways as a continuous system. His company would take over the electric lighting order that Sandgate was promoting, as it was important from the point of view of the consumers that the company which supplied the energy for the tramways should supply the electric lighting. Sandgate had been offered by his company terms for electric lighting which could not have been offered apart from the tramways scheme. The electric cars would be exceedingly well supplied with brake power, and could be stopped when running at 8 miles an hour within their own length. The cost of the scheme would be for permanent way and general construction £131,518, with an additional sum for equipment. In trying to enter Folkestone they were seeking to carry out the wishes of all the other districts. If Folkestone would agree to give his company running powers into the town they would be prepared to hand over that portion of the scheme to the Corporation so that they might construct their own tramways and connect them up with theirs.

Sir CHARLES RIVERS WILSON, Chairman of the Sandgate and Hythe Electric Co. (Ltd.) said he was also the Chairman of the British Electric Traction Co. The relations between the Sandgate and British Cos. were that the Sandgate Co. was the child of the British Co., and was called into existence by it, and whatever present or future liabilities it might have will entirely fall upon the British Co. The British had about 40 affiliated companies now working tramways and light railways. The reason why these companies were not carried on in the name of the British Co. was purely one of administrative convenience. The British Co. exercised general supervision over the affiliated companies by means of their officers. The British Co. were in the present instance under agreement to provide the capital necessary for the promotion of the present bill, and the carrying out of the scheme if authorised. All the money required by the promoting company would be found for them by the British Co., the capital of which was £1,200,000 ordinary and preference shares, and £600,000 in debentures. That was the authorised capital, and of that £450,000 had been raised by ordinary shares, £500,000 by preference shares, and £350,000 by debentures, making a total of £1,300,000, leaving unexhausted means of about half a million. The British Co.'s £10 shares had been as high as £17, they were about £14 now. The debenture stock stood at £125, and the preference shares at a considerable premium. The shares of one of the affiliated companies—the Potteries Co.—had risen to as high as 100 per cent. premium. There was no doubt about the necessary capital being raised for the present undertaking if the bill passed. Only six of the British Co.'s affiliated undertakings had as yet been electrically equipped, but some 80 per cent. of them were working,

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although the work of reconstructing and electically equipping the tramroads had not been completed.

After hearing witnesses and counsel in opposition to the tramway scheme, Mr. CARPENTER, mayor of Folkestone, said there was a balance of opinion in Folkestone favourable to tramways, but the town was virtually unanimous in favour of municipal tramways. The Corporation had pledged themselues to construct tramways in the future. In regard to the gap between Folkestone and Sandgate, the Town Council would co-operate with the outside authorities to fill it up. They would rather deal with the S.E. Railway or the outside authorities than with the promoting company. The Corporation had formed a sub-committee to bring up a tramway scheme, and a rough plan (produced) had been drawn up. The plan might be similar to that of the company, but they were at present trying to keep this outside company away. He pledged himself as Mayor, which was as far as he could go, to come to Parliament with plans next October.

Mr. MOON said all the Electric Co. asked for was that the tramways should not be blocked at the entrance of Folkestone; that running facilities should be given either by lease or Board of Trade intervention.

Re-examined, Mr. CARPENTER said the ratepayers would willingly pay more to have the conduit system of electric traction rather than have the overhead system.

Mr. BAKER, the chairman of the Public Works committee of the Corporation, said they ought not to have the overhead system in Folkestone. The goods terminus proposed by the Tramway Co. was within 100 yards of his property, which it would considerably depreciate.

Mr. POPE, Q.C., for the Railway Co., said the tramways could not pay unless the views of the principal local authority within the area were outraged by the company being enabled to construct tramways within Folkestone. To meet the objections raised, the Electric Co. had said, let the Corporation make their own tramways, but bind them to lease them to no one but us. The scheme was a bad one in a financial sense. There would be no traffic over the outside lines in the winter, and he could quite understand why the British Electric Co. were anxious that these tramways should be constructed not by themselves but by an affiliated company. He asked the Committe to reject the tramway scheme.

Mr. MOON, in replying for the Tramway Co, said in regard to the Folkestone opposition it was admitted that tramways were required, and that the tramways the Corporation had in mind were similar to those proposed by the company. The only question was who should construct the tramways. His company were willing to take their bill up to the boundaries of Folkestone. In the present state of feeling there they ought not to be so limited, but the public ought on fair terms to the Corporation of Folkestone and to the company to get the tramways. If the Corporation chose they could construct the lines in Folkestone on the conduit system, and the company could use the overhead system up to the boundaries of the borough. Cars could be run from the one system to the other, and passengers need not change cars.

The Committee decided to sanction the railway from New Romney to Hythe, provided it were constructed as a continuous railway throughout, so that no change of carriage would be required, the period for construction, as the line presented no engineering difficulties, to be three years in place of five, as asked for in the bill. The Committee further decided that the preamble of the bill of the Hythe and Sandgate Electric Co. for the construction of tramways from New Romney to Folkestone was not proved.

MUNICIPAL TRADING.

The Houses of Lords and Commons Joint Committee on Municipal Trading met again on Friday last, the Earl of Crewe presiding.

Mr. ALBERT GRAY, counsel of the Chairman of Committees in the House of Lords, stated that during the past two sessions every proposal on the part of a local authority or company to manufacture gas fittings had been struck out of the bills containing them. In this respect, therefore, the practice of Parliament had tended to check municipal trading. With regard to electric lighting, the power to supply outside the local authority's district had been given ever since the passing of the Electric Lighting Act of 1882. Manchester supplied electric light to nearly all its suburbs, and he believed that the Corporation of that city was going to run tramways both in the city and the neighbouring townships. If a local authority was in possession of electric lighting plant it might compel a company to take its electric energy from it. This, of course, meant a saving, and there was no reason why there should be a double electric plant in a town where one would do.

The CHAIRMAN: The local authority would in that case be more likely to purchase the company's undertaking?—They might be.

The power to manufacture electric fittings has recently been struck out of electric lighting bills also?—Yes. Witness added that the veto which a local authority had over a tramway scheme promoted by a company appeared to him at the present day to work very badly. He thought it was the intention of Parliament that the consent of the local authority should be what might be called a "clean" consent. There had, however, unfortunately sprung up a practice of demanding conditions, and in some cases a demand was made that the local authority should share the profits of the undertaking during the term of the company's tenure. It was obvious that when such a demand was made a company was in a cleft stick. The clauses introduced into private bills under this system were very frequently of great length, varying inversely to the size and importance of the local authority. No complaint could be made of the conduct of the great municipalities in this matter, but the smaller municipalities seemed to think that they were entitled to get as much as they could out of the companies. A provision for the payment of an annual rent to a local authority was not regarded by Parliament as a proper one, and was invariably struck out. Tramway companies were sometimes compelled to allow the use of their electric wire poles for electric lighting, for sewer ventilation, and for advertisements. One tramways bill, introduced in the present session, contained a clause providing that free passes over the tramways should be given to officials of the corporation, while another provided that a tramway company should pay a corporation, as an annual rent for the use of the streets, £10 a year per mile for 10 years, and £20 per mile in subsequent years.

The Committee then adjourned to June 15.

WEST BROMWICH CORPORATION BILL.

The Omnibus Bill of the West Bromwich Corporation, which seeks powers for the construction of electric tramways and for additional electric lighting powers, &c., was considered by a Select Committee of the House of Commons last week.

Mr. FITZGERALD (for the promoters) said that at present the Corporation did not own the tramways within the borough. The South Staffordshire Tramways Co. had never been a successful company, and the lines had been for many years past in a bad state of repair, and the whole track required to be taken up and relaid. The line within the borough was worked by steam, and the Board of Trade had never granted a licence for more than six months at a time. The lease of the trams expires in February, 1903, and the Corporation had decided to exercise their option of purchase. At the present they had no power to work tramways, and now sought these powers, and to work by agreement tramways situated outside the borough which could be best and most economically worked as a part of the whole system. By clause 7 it was proposed to authorise the Corporation to purchase by agreement any authorised tramway outside the borough which formed a continuation of the tramways within the borough; and clause 8 enabled the Corporation, when the local authorities decided not to purchase and work the lines, to do so as a part of the whole West Bromwich system.

Mr. SYDNEY MORSE, solicitor for the South Staffordshire Tramways (Lessee) Co., objected to the Corporation spending money for working the tramway systems of the local authorities against the South Staffordshire Co., who were working merely on money raised by shares in the ordinary course.

The CHAIRMAN pointed out that the promoters brought no specific scheme before the Committee in this connection, but proposed to take general powers ranging all over the place.

Mr. FITZGERALD said he would be willing to have the powers restricted to Wednesbury, Tipton, Oldbury, Smethwick, and Handsworth in the case of their being able to come to an agreement with those local authorities in the event of their acquiring the tramways in their district.

Mr. MORSE urged that no special circumstances had been proved for the special powers asked for. On the other hand, the South Staffordshire Co. had good ground for asking for good terms as against the Corporation of West Bromwich. It was difficult to make horse or steam tramways pay, but it was proposed to work the system electrically, and the company had made arrangements with those fully able, financially and from an engineering point of view, to carry out all that was required in the district.

After deliberation the CHAIRMAN said the Committee would permit the Corporation to go outside their boundaries for such parts as had been specially named, viz., small lines in Handsworth, Wednesbury, Tipton and Oldbury. In dealing with the electricity clause, the chairman called attention to the report of the Local Government Board on the clause, which said: "Under the provisions of this clause the Corporation would be empowered to supply electrical energy for the working of tramways and light railways an indefinite distance from the boundaries of the borough, and to construct such works as may be necessary for the purpose. The Board suggest that before approving of the clause the Committee should require evidence of the grounds on which those powers are sought by the Corporation."

Mr. A. D. GREATOREX, borough surveyor, said the Corporation had an electric light undertaking, and were building a generating station, the site of which had been selected, with the object of supplying electricity both for traction and lighting.

Mr. FITZGERALD undertook to amend the clause by introducing the suggested limiting words.

LEGAL INTELLIGENCE.

Chamberlain and Hookham v. The Corporation of Bradford.

Mr. Justice Farwell delivered judgment in this case on Friday last. The hearing of the case was reported in our issues of May 11, p. 99, and May 18, p. 137.

JUDGMENT.

Mr. Justice FARWELL said: The plaintiffs seek for an injunction to restrain infringement of this patent, No. 4,225, of 1887, for improvements in electricity meters,* parts of which improvements are applicable to dynamo-electro generators and motors. The defence is a denial of the infringement, and a plea of the invalidity of the patent. The plaintiffs' patent has been before the court in another action, tried before Mr. Justice Wills, in February, 1897,† when, on the evidence before him, he granted the relief asked for against Johnson, the defendant in the action, and gave the usual certificate that the validity of the patent had come in question. I propose to adopt the judgment of Mr. Justice Wills on all questions of

* An abstract of this patent is given in *The Electrician* of May 11, 1900, p. 101.

† See *The Electrician*, Vol. XXXVIII., pp. 622, 665. (*Judgment*) 839.

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law determined by him in that action. The plaintiffs' complaints in the present action are confined to claims 1 and 3 in their specification. With respect to the first claim, Mr. Justice Wills has held, and both sides agree, that this is a claim for a combination, that is to say, that the invention consists in the combination in the plaintiffs' meter of a number of appliances either for the purpose of producing a new result or for the purpose of producing an old result by new means. The appliances combined may be either new or old, or partly new and partly old, and the patent may, if aptly framed, effectually claim protection for such of the appliances as are novel as subordinate integers, in addition to the invention contained in the combination and protected by the patent. It is contended in the present case that the third claim is not merely a branch of the combination, but is also an independent integral claim. It is also contended by the plaintiffs that they introduced for practical purposes a new principle or idea in the construction of meters. It is, of course, well settled that a mere idea or principle cannot be the subject matter of a patent; there must be some concrete form to which the principle is applied; and that concrete form must be defined and limited, for if the claim is in general terms for every mode of carrying the principle into effect it becomes a claim to the principle itself, and fails.

I propose to apply these propositions in determining this action. The first question that I have to consider is that stated by Lord Justice Cotton in "Proctor *v.* Bennis," 31 Chancery Division, p. 754: "Has the plaintiffs' combination in substance been taken; have the defendants though not taking exactly the whole combination patented, taken by slight variations or mechanical equivalents, the substance of it, so as to produce the same result by practically the same means." In answering this question, I have to bear in mind the distinction pointed out by Vice-Chancellor Wood, in "Curtis *v.* Platt" (3 Chancery Division, 135) that "Where the invention is for the production of a result already known and attained the protection afforded by the patent is confined to the particular means pointed out by the specification, and the same result may be attained without infringement by another person by the use of mechanical equivalents." In other words, the invention of a combination of processes leading to a known result does not prevent other persons from arriving at the same result by a combination of other processes; but if the result is novel in that it produces a new instrument or involves the practical application of a new principle, the defendant infringes by substituting known equivalents. To use Lord Bowen's words (36 Chancery Division 764) "When there is really an ingenious novelty, the idea that the combination will produce a new result, that novelty in the dea is part of the merit of the very combination."

Now in this case the object to be produced is an electricity meter for lighting and motor purposes; such meters were not new in 1887. Electricity as a mode of lighting was well known, certainly before 1882, when the first general Act relating to electric lighting was passed, and meters for the purpose of measuring the article supplied were a necessary adjunct for the commercial success of any system of lighting. Mr. Ferranti made meters in 1884, and Edison at or before the same time. These meters were, of course, of a different type to the plaintiffs, but they were not the less instruments for measuring electricity. But then it is said that the plaintiff discovered and applied for the purpose of his meter a novel principle—namely, that magnets could be at the same time permanent and powerful. He stated that before 1887, although permanent magnets had been known and used as constant with a weak field, yet when magnetised so as to become powerful their constancy was not only unknown, but not believed in. He said in effect that permanent magnets were really considered inapplicable for the purposes of a meter by reason of incompatibility of power and constancy, a fallacy which he considers he exploded. This is material from the point of view of the principles which have already been stated, for if this idea was really novel it would form part of the invention found in the combination within the meaning of the words of Lord Bowen quoted above. But on the evidence I find the contrary to be the fact. I think I do no injustice to the plaintiffs if I look at their own specification to assist me in judging of the probability of the reality of this alleged discovery. One would expect to find there a statement of the new principle, and not the less because it was destructive of an old fallacy. If a patentee had really discovered for the first time that power and constancy were compatible, and knew that all other electricians believed them incompatible, he would never direct the construction of an instrument with very powerful and very constant permanent magnets without calling attention to the fact that the existing belief with reference thereto was fallacious. He would surely know that the expert, uninstructed as to this, would at once cast aside his specification as that of an impracticable dreamer. I have, further than this, the oral evidence of witnesses of experience and standing entirely contradicting the plaintiffs' statement. Further than this the specification really states no tangible principle at all. All magnets necessarily have some constancy and some strength; to say that magnets are to be used which are both powerful and constant is imply to state that you must make your magnet as powerful as is consistent with its constancy; it becomes a mere question of degree, and no principle is involved, and no practical direction given in the specification. Further, it is clear on the evidence, that before 1887 the practice of ageing powerful magnets and thereby making them constant was well known. There was nothing to prevent the defendants from rendering their magnets constant by artificial ageing, and from using two or three if one was found insufficient; and the defendants, in fact, used formerly three and now use two comparatively weak magnets which have been rendered constant by a very special process of ageing described by one of the witnesses. I conclude, therefore, that there is neither novelty of object aimed at nor of idea or principle involved, and I approach the consideration of Claim 1 as a combination patent pure and simple.

Now, the object aimed at by the plaintiffs and defendants are different in this respect. Both make a meter; but the plaintiffs' is a current meter, the defendants' is an energy meter. The distinction is, to my mind material. The current meter measures current only, and is incapable of measuring anything else. The energy meter measures the energy—that is, both the pressure and the quantity. The Board of Trade unit is energy, not current. Mr. Ferranti stated the essential difference to be that in an energy meter the two parts of the motor—namely, the armature and the field—must be connected, the one in circuit with the lamps to be measured, the other across the circuit so as to receive the voltage of the circuit. The current meter deals only with the main current of the circuit flowing to the lamps. Further, it is essential to a current meter, and is so stated in the specification, that there must of necessity be an electromotor with a constant or nearly constant field. In an energy meter such a constant field would be destructive. Further, the energy meter will not directly measure current at all. It is true that if you have, in fact, a constant potential, you can calculate from your energy meter, and the amount of energy shows thereby what amount of current has passed. Mr. Moulton founded an ingenious argument on this. He said that by Act of Parliament the potential was allowed to vary only to the extent of 3 or 4 per cent., so that it must be practically constant; and that at Bradford the defendants' supply was so good and regular that the potential was practically constant; and, further, that the defendants knew and intended that their meter would measure current, in effect, because of the use by the defendants of a compound winding for the purpose of starting. This was originally the second claim in the patent, but was struck out, and is admitted to be old. It is said, however, that this compound winding involves, as a necessary consequence, the existence of a constant potential—constant that is in the sense that a meter supplied with this and adapted for a circuit of 100 volts could not be used on a circuit of 200 volts. All these contentions appear to me to be fallacious. The fact that the defendants at Bradford have hitherto supplied electricity at a constant uniform pressure does not render it unnecessary to have a meter capable of measuring whether they do or do not keep up such uniformity. To hear is not necessarily to obey, even between an electric lighting company and the Board of Trade, and to say that the defendants have not proved that they have deviated in the past from the Board of Trade regulations is to attempt to turn their virtue against them in a way quite unwarrantable. The point as to the compound winding also comes to nothing. It is usual to have currents of either 100 volts or 200 volts, and it is not usual to vary the voltage more than a small percentage. The use of an old appliance for a circuit of a particular voltage is in no way inconsistent with the measurement of the variations of energy possible within the range of fluctuation usual in such a circuit. It is, perhaps, not immaterial to add that in the case before Mr. Justice Wills the defendant used a current meter, and the present plaintiff in that case relied, and in part succeeded on the distinction between energy and current meters, and further, the plaintiff told me that he himself gave evidence as to the distinction, and accepted his counsel's statement that he had taken the simpler problem. Further, the plaintiff, at about the same time that he took out his present patent, obtained another patent for an energy meter, and accurately described his energy meter as combining the parts of electro motors of the kinds described, whereby the driving force acting on its armature is proportional both to the quantity of the current to be metered and to its electromotive force.

Further, I hold on the evidence that the defendants' meter will work with alternating currents, and that a meter made according to the plaintiffs' specification would not, so that the defendants' meter not only measures that which the plaintiffs' will not, namely, energy, but is also appropriate to currents to which the plaintiffs' is not. The plaintiff is in this dilemma—if he claims that his patent extends to alternating currents he has given no directions by which an instrument could be made to work therewith, and his patent would therefore be void. If, on the other hand, he does not claim that it is within his patent, he admits that the defendants' meter performs an important function that his cannot. It is not necessary for me to determine on which horn of the dilemma the plaintiff is impaled, but I will assume the latter as being more favourable to him. and I do this the more readily as the defendant does not press me to hold the plaintiff's patent bad unless it is absolutely necessary to his case. It appeared in evidence that in 1887 alternating currents were little used in a manner which required to be metered, and that no machine for alternating currents has, in fact, ever been made or attempted to be made in accordance with the plaintiffs' specification. I hold, therefore, that the object aimed at and attained by the defendants' meter is both more extensive and more practically useful than that attained by the plaintiffs'.

Then it is said by the plaintiffs that the defendants have taken the material part of their combination, and have used the governing idea suggested by the inventor. Both the meters necessarily have a motor to supply the driving power and a magnet to supply the braking power and a commutator. The great practical difficulty experienced by inventors in devising a form of motor that would work was static friction. As Mr. Hookham put it, "The forces at our disposal that act for us are so extremely small that I should say that static friction which obeys the wrong law is our principal difficulty." In order to obviate this difficulty Mr. Hookham commences by enlarging and making as powerful as possible the forces which act in the right way. As he put it, "It is the exaggeration of the electrical forces which is as important as the diminution of the static friction." This diminution is effected partly by the mechanical contrivance of bars or anti-friction rollers, and (which he regarded as more important) by a commutator which acted by means of mercury cups instead of ordinary solid brushes. His complaint is, in fact, that the central idea—namely, the exaggeration of the electrical forces—is his idea, and is taken by the defendants. He admits that the defendants' commutator and other mechanical anti-friction contrivances are entirely different from his own; but so far as the combination claim is concerned (having regard to what I have already

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decided as to the knowledge of the possibility of the co-existence of power and constancy in magnets), any argument in support of claim 1 must rest on the novelty of the use to which the idea of this exaggeration of forces is applied. The substance of the argument, as I understand it, was put thus by Mr. Moulton: The two things that Hookham found out were these:—(1) That he could have his brake so powerful in the way adopted by him that he could afford to have a large driving power, and (2) that he could made a commutator so frictionless that with that brake power he could get practical accuracy; and he says that the combination of these two steps was Hookham's invention, and ensured success. But I find as a fact that it was known before 1887 that you could, by the exaggeration of the electrical forces, render the amount of friction with which you had to deal less important. In addition to the oral evidence, I refer to Uppenborn's Paper of February, 1884,* Marcel Deprez's Paper, January, 1884,* and Ayrton and Perry's patent.* There always remained a residium of friction, too great to be got over by mechanical appliances, if any commutation that was known prior to 1887 was used in the meter. The new step taken by Hookham in his meter was that he invented a form of commutator with an ingenious arrangement of mercury cups whereby he avoided the friction produced (and then supposed to be necessarily produced) by brushes altogether. The real step in advance that Hookham took, as compared with Ayrton and Perry, was the addition of this commutator to the means for exaggerating the electrical forces which were then well known. Both Ayrton and Perry, Marcel Deprez, Siemens and the plaintiffs exaggerated their magnetic forces, but this exaggeration was not sufficient to ensure success for any of them. But the defendant uses a commutator of an absolutely different nature from the plaintiffs. They have solved another problem, and have shown that brushes can be successfully used if they are silver tipped, and if silver is used in other respects, as pointed out by the witnesses. This is not the case of a mere mechanical equivalent, but of a new appliance. The plaintiffs' case on claim 1 in my judgment fails entirely.

There remains claim 3, and as to that Mr. Moulton says that claim 3 is not a combination, but a subordinate integer, and he claims that his clients are entitled to an electricity meter, to a monopoly for permanent magnets, rendered permanent and constant by their special form, used to form either the brake or the armature field. Now, the plaintiffs' magnet is what has been called a compound or built-up magnet, and is absolutely dissimilar in form to the defendants'. The plaintiffs' is of a very special form. The defendants' is the common horseshoe, and the witnesses say that that form is a material circumstance in considering a magnet. If Mr. Moulton were claiming as his subordinate integer the particular form of magnet described in his specification and drawings, and no other, he might possibly rely upon Mr. Justice Wills's judgment as a decision in his favour. His Lordship says that Hookham did invent a form of permanent magnet with great splayed ends, where the continuity was broken. I understand this to mean a magnet such as is described in the specification as having very large polar surfaces closely fronting each other, so as to form a narrow slit in which the disc armature revolves. In the case before Mr. Justice Wills, the defendant used a magnet similar to the plaintiffs' magnet, and was restrained; but this will not be sufficient for the plaintiffs in the present case, and Mr. Moulton, in fact, claims a monopoly of all magnets with large polar surfaces close together. I have very great doubt whether such a claim could even be sustained. It is exceedingly difficult to say what is large in respect to surface and what is close together; and while I feel convinced that Mr. Justice Wills did not decide this point in any way that amounts to plaintiffs' contention, I am not quite sure that he meant to decide that the particular form of magnet was well claimed as an independent subordinate integer. I should myself read the third claim as subsidiary to the first, so that the novel form of magnet is claimed as one portion of a combination, and not as a separate invention. But however this may be, I am of opinion that the defendants' magnet does not come within any fair interpretation of the plaintiffs' description of permanent magnets with very large polar surfaces. Further than this, in my opinion permanent magnets with polar surfaces closely fronting each other so as to form a narrow slit in which the disc armature revolves were known before 1887, and there is no novelty in anything that the plaintiffs claim in claim 3 unless it be the particular form of their magnet. As Mr. Justice Wills puts it in his judgment, the idea of using the Foucault currents for producing braking action, is clearly not new. Nor is the idea, in a general way, at least, of applying this braking action to an electricity meter. He points out that it is described in definite terms in Ayrton and Perry's specification—the revolution of magnets in front of a disc being indistinguishable in principle from the revolution of a disc in front of the magnets. In addition to the evidence before Mr. Justice Wills, I have Siemens' energy measurer with Marcel Deprez's Paper thereon in 1884. Siemens' instrument had an axis with wings revolving in paraffin. Marcel Deprez suggested in 1884 an improvement upon this, by substituting for it a copper disc revolving between the poles of a permanent magnet, and he continues: "The rotation of the disc between the poles of the magnet will have the effect of developing in the interior of the disc induced currents following a well-known law which I formerly applied in my magnetic speed indicator, exercising on the magnet a magnetic force proportional to the first power of the speed." This accurately describes the defendants' machine. It is true that it does not describe any particular form of magnet, but ordinary horse-shoe magnets, with polar surfaces close to each other, were well known, and the magnetic speed indicator to which the writer referred, is described in a Paper dated 1881, which contains drawings of magnets, two of which (Figs. 5 and 7) are practically indistinguishable from the defendants' magnets. As a matter of construction of Marcel Deprez's Paper of 1884, I should say that the magnet that would be naturally taken by the reader in the absence of specific directions, would be one of the magnets shown in the drawings relating to the speed indicator therein mentioned. For these reasons I come to the conclusion that the plaintiff has failed to show any infringement of his patent, and it is therefore unnecessary for me to express any opinion as to the validity of the patent. I dismiss the action with costs, and I see no reason for making any distinction between the costs of the action so far as it relates to the validity of the patent.

The action was accordingly dismissed.

* See *The Electrician* of May 11, 1900, pp. 103 and 104.

Crompton and Co. (Ltd.) re Electrical Power Syndicato (Ltd.).

This case came before Mr. Justice Wright and a special jury yesterday.

Mr. BRAY, Q.C., said plaintiffs were the well-known firm of electrical engineers and contractors, and defendant syndicate was at present in liquidation, but the jury must not think it was insolvent, for the shareholders had had all their money returned with a dividend of 100 per cent., and there were assets which would be sufficient to pay a further dividend of some 250 per cent. It was a company that had done its work and was being wound-up because it had done its work, and plaintiffs claimed to have a title to some of its assets. The plaintiffs claimed that having rendered large services in the promotion, and after the promotion of the syndicate there was an agreement made by which plaintiffs and other companies which had rendered similar services, should have the right to be contractors to the syndicate for such electrical plant and machinery as they would in the ordinary course require. They had refused these contracts, the syndicate had repudiated all liability, and plaintiffs asked for damages, which would represent the profits they would have made on their share of the contracts. Alternatively they said they were entitled to be paid for services rendered. In 1896 Mr. Addenbrooke, of Wolverhampton, was proposing a scheme for establishing an electricity supply station in Staffordshire to supply electric energy to towns near Birmingham, where there were many manufacturing establishments. There was an enormous demand for power in this district. Mr. Addenbrooke, in order to carry out his scheme had to look out for some person of high standing in the electrical engineering profession, and under these circumstances he applied to Mr. Crompton. Interviews took place between Mr. Crompton and Mr. Addenbrooke and Mr. Albright (a co-director at the time with Mr. Crompton) who agreed to enter into the formation of a syndicate to carry out the idea. The company was incorporated on June 10, 1897, and after the scheme was gone into in great detail, it was arranged that Messrs. Crompton and Co., the Callender and Co., and Messrs. Thomas Parker should be contractors to the syndicate. They were to have the contracts which, had they been carried out, would have amounted to about £150,000 between them. Another syndicate was subsequently promoted, called the Midland Electric Corporation for Power Distribution (Ltd.), Mr. Crompton rendering some service. Subsequently resolutions were passed by the directors of the pioneer syndicate, referring to the three firms as being contractors for the syndicate, and offering them compensation in the event of the syndicate disposing of its rights. Plaintiffs, however, complained that no contracts had been given to them, and brought the present action.

The evidence of Mr. Crompton was read, to the effect that he, as managing director of Messrs. Crompton and Co., had many meetings with Mr. Addenbrooke, when details of the scheme were discussed.

In answer to one of the jurors, Mr. BRAY stated that plaintiffs had received nothing from the syndicate.

Mr. T. TERRELL, Q.C., for the defence, said there was no foundation in law for the action. The contract alleged a verbal arrangement made before the syndicate, which was sought to be charged with the contract, was registered. He submitted it was a contract outside the powers of the memorandum of association and could not be accepted afterwards by the syndicate as it was *ultra vires*.

In the result the parties came to terms, Mr. Terrell announcing that his clients would pay £750, without costs.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Deutsche Kabelwerken." By Dr. Thomas Lenschau. (Berlin: Mittler and Son.) 1m. 20.

"Leçons d'Electrotechnique Générale." By P. Janet. (Paris: Gauthier-Villars.) 20fr.

"Municipal Finance and Municipal Enterprise." Being the Annual Address of the Right Hon. Sir H. H. Fowler, M.P., to the Statistical Society. (London: P. S. King and Son.)

"A Handbook of Electrical Testing." By H. R. Kempe. Sixth Edition. (London: E. and F. N. Spon.) 18s.

"Science Abstracts." May, 1900. (London: E. and F. N. Spon.) 2s.

"Journal of the Institution of Electrical Engineers." May, 1900. Edited by W. G. McMillan. (London: E. and F. N. Spon.) 4s. 6d.

"Bibliografia Voltiana." By F. Fossati. (Milan: Ulrico Hoepli.)

"The Official Gazette of the United States Patent Office." No. 7, Vol. XCI. (Washington: Government Printing Office.)

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MUNICIPAL, FOREIGN & GENERAL NOTES.

Abercarn.—At a special meeting, last week, the District Council, who are opposing the Electrical Power Distribution Co.'s bill, agreed to appoint a committee to consider the question of themselves undertaking to establish electricity works, or joining with other local authorities in promoting a scheme of supply for the western valleys of Monmouthshire.

Adelaide (South Australia).—In connection with a note appearing in our last issue (page 193), we have received the following:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the current *Electrician* is a paragraph stating that "Mr. W. G. Bingham has obtained a concession from the Adelaide City Council for the construction of electric tramways." All Mr. Bingham has obtained is a promise from the Adelaide Corporation to support and assist him in the promotion of a bill through the South Australian Parliament, to enable the compulsory purchase of the present 54 miles of horse tramways, 18 of which are in the city and 36 outside its boundaries, and which belong to some half dozen companies. Prior to the agreement between Mr. Bingham and the Corporation coming to light, the British Westinghouse Co. and the Callender Co. had effected agreements with the greater number of the present tramway companies for the purchase of their lines (as has, I think, been mentioned in *The Electrician*), and a bill is to be brought before Parliament this next session to enable them to convert the lines for electric traction. As it seems that the suburban councils support these companies, and will oppose Mr. Bingham's bill, the latters so-called "concession" from the Corporation of Adelaide, is a rather doubtful commodity.—Yours, &c.,

ADELAIDE KIAN.

Arbroath.—Mr. M. Buchan has been appointed consulting electrical engineer at a fee of £52. 10s., plus expenses (not to exceed £10), to prepare a report on the proposal to establish electricity supply works.

Bath.—It has been decided, owing to the increase in the price of coal, to postpone for the present the reduction in the charge for electric energy, which was to have come into force on June 24.

Beira.—In connection with the tenders recently called for in London, Lisbon and Paris for the erection and equipment of an electric generating station at Beira for lighting, traction and power supply, it is stated that the expense of hardening the roads to permit of the laying of a tramway track will prove to be very heavy and of a difficult nature, owing to the total absence of stone in the vicinity. The roads are at present entirely composed of soft sea sand. It will, therefore, be some time before the work is started.

Blackpool.—The electric tramway extension through Claremont Park to the Gynn is now open for traffic. The line was officially inspected by the Board of Trade last week.

The profit on the electricity department for the year ended March 31 is £1,170. The borough electrical engineer (Mr. R. C. Quin) estimates that the advance in the price of coal has reduced the profit from his original estimate of £2,300. A gross profit of £9,660, with a net profit of £2,185, is estimated on next year's working. On the Tramways department's working a profit of £12,000 is anticipated.

Board of Trade Intelligence Branch.—A committee has been appointed for advising the Board of Trade on the work of the Intelligence Branch of the Commercial, Labour and Statistical Departments. The committee will consist of Sir Courtenay Boyle (chairman), Sir Alfred Bateman (deputy-chairman), Lord Avebury, Sir F. Abel, Sir H. G. Bergne, Sir C. E. Bernard, Mr. F. Brittain, Mr. T. Craig Brown, Prof. Wyndham Dunstan, F.R.S., Mr. C. A. Harris, C.M.G., Sir Alfred Hickman, M.P., Mr. W. H. Holland, M.P., Sir Albert K. Rollit, M.P., and Mr. G. W. Wolff, M.P. The committee is appointed for five years, and Mr. G. J. Stanley, of the Commercial Department of the Board of Trade, who acted as secretary to the departmental committee on Commercial Intelligence, has been appointed secretary of the advisory committee. The first meeting of the new committee has been summoned for June 14.

Burnley.—The Council has come to terms with the whole of the opponents to their electric tramway scheme, and on Wednesday resolved to reconstruct and electrically equip the tramways within the borough on a gauge of 4ft. as soon as practicable after their acquisition by the Corporation. The borough surveyor (Mr. G. H. Pickles) and the electrical engineer (Mr. R. Birkett) have been instructed to prepare preliminary plans and specifications for the work, and in conjunction with the town clerk (Mr. A. Steele Sheldon) to make inquiries with a view to retaining the services of a consulting engineer.

"**Cassier's Magazine**."—The June issue contains articles on "Trade Possibilities in South Africa," "Sixty Years in British Iron Works," "Engineering Graduates from Universities," and "The Cost of Machine Work."

County Councils and Electric Lighting.—The Middlesex County Council have decided to oppose the bill confirming the Twickenham and Uxbridge electric lighting orders.

Court of Common Council.—At yesterday's meeting the Streets committee presented a report on the subject of the communication from the London County Council, asking the views of the Corporation on proposals for the construction of tramways from Farringdon-road to Ludgate-circus, from near the Mansion House to Putney-bridge viâ Queen Victoria-street, Victoria Embankment, &c.; and recommending that the Council be informed that the Corporation is not prepared to give its consent to the construction of such tramways within the City boundaries.—The recommendation was agreed to.

The committee also reported relative to an application from the Postmaster-General to take up the roadway pavement at the southern end of St. Bride-street and at Holborn-circus, for the purpose of forming a connection with the St. Bride-street, Shoe-lane, and St. Andrew's-street subways, erecting and maintaining throughout an iron and wood frame staging to support lead-covered telegraph wire cables; and recommended that no objection be offered to the proposed works, subject to the same being carried out to the satisfaction of the engineer, and to the Postmaster-General agreeing to pay such fees in respect thereof as may hereafter be prescribed for similar easements in the City subways.—The recommendation was agreed to.

Customs Duties.—The Argentine Customs law of 1900 imposes a duty of 5 per cent. *ad valorem* upon imported machinery and mains for electric lighting and upon automobiles of all kinds and spare parts thereof except car bodies. The duty on incandescent lamps has been decreased from 3·00 to 2·80 pesos, and has been increased on insulated wires and cables for electrical purposes up to 5mm. from 0·60 to 0·70 pesos. Amongst the goods entering Argentina free of duty are iron or steel fish-plates, transoms, &c., for electric tramway tracks, and all plant destined for the construction and working of electric tramways.

Darlington.—The Corporation have fixed the charges for electric current at 5d. per unit up to 1,000 units, 4½d. up to 3,000, and 4d. over 3,000, and a maximum of 2d. per unit for power, with special discounts to large consumers. A proposal that the Corporation should undertake to pay for the wiring of private houses and recoup themselves upon a gradual payment system has been referred to Prof. A. B. W. Kennedy for report.

East London Provisional Orders.—The Board of Trade have forwarded copies of the provisional orders for Limehouse, Mile End Old Town, and St. George-in-the-East, to the various local authorities, and have intimated that it is proposed to insert in the confirmatory bill a clause providing for the treatment of the three undertakings as one with that authorised by the Whitechapel Electric Lighting Order on the establishment of the new borough of Stepney.

Electric Light and Traction Bills.—Royal assent has been given to Electric Lighting Orders Confirmation (No. 2) Act (1900), the City and South London Railway Act (1900), and the Charing Cross, Euston, and Hampstead Railway Act (1900).

Electric Light Fixtures.—Section F of the catalogue published by Messrs. D. H. Bonella and Son (Ltd.), 58 and 60, Mortimer-street, Cavendish-square, London, W., is now ready, and deals with electric light fixtures for both indoor and outdoor work. An infinite variety of designs in bracket, pedestal, and suspension lights, and the accessories therefor, are shown.

Electric Power Scheme for West Yorks.—The Yorkshire Electric Power Co. have prepared a scheme for the supply of electricity in bulk for lighting and power in the manufacturing districts of West Yorkshire. Todmorden Council has decided to oppose the scheme, while Golcar has refused to pass any resolution on the subject.

Electrical Enterprise in Italy.—The great development of the applications of electricity to industrial purposes continues, and has caused increased imports of the requisite plant and the creation of fresh works for its production. The imported plant comes chiefly from Germany and Switzerland, and foreign capital from these two countries enters largely into the companies which have been formed under Italian names. A New York company is about to establish in Milan a factory for manufacturing plant and material required for electric traction on railways and tramways, which has hitherto nearly all been imported. A new industry which has now assumed considerable importance in Italy is the manufacture of calcium carbide, used chiefly for making acetylene gas. The United States and France occupy first and second places respectively as producers of carbide, Italy coming next. The Edison works at Paderno derives 13,000 H.P. from the river Adda, employed for generating electric current, which is taken by overhead cable to Manzo and Milan. Another similar enterprise, but on a larger scale, is on the point of completion.

The price charged for current varies according to the quantity of energy required, but the average at which the whole has been contracted for is £4. 4s. per kw. per annum for use during 12 hours per day, firms working 24 hours per day paying a slight increase. Current is to be transmitted by overhead cables. This enterprise is claimed to be the most important of its kind in Europe. The plans are due to the initiative of Italian engineers, and were made as far back as 1887, but their execution must be attributed in a large

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measure to the assistance of a German, firm which has subscribed a considerable part of the capital of the company.

The experiments in electric traction recently made by the Mediterranean Railway Co. on its line from Milan to Monza, with accumulators, revealed certain defects, necessitating some considerable changes, and a partial and temporary suspension of the service. It is, however, believed that the modifications now in course of application will prove efficacious, and that the use of accumulators will prove best adapted to the short-distance journeys. The same company is about to try an experiment on a much larger scale on its line from Milan to Gallarate, on to Varese, Lavens, and Arona, about 73 miles of track. Water power for generating electric current will be obtained from the river Ticino, at Tornavento, where the necessary works are to be commenced immediately. The third-rail system is to be adopted. Orders for the electrical plant and apparatus required for this experiment have been placed, and are due for delivery in April next year. The cars will be built at the Mediterranean Co.'s own works.

At the same time, the Adriatic Railway Co. will adopt the trolley system on its line from Lecco to Chiavenna and Sondrio, 66 miles of track, power being obtained from the river Adda, near Morbegno. In this case the electrical plant and apparatus will be supplied by Messrs. Ganz and Co., and is due for delivery about April next.

The Officine e Cantieri Liguri-Anconitani, a metal-working undertaking established at Ancona, employing nearly 1,000 hands and occupying a works' space of 14½ acres, is using electric power to a large extent. Electric motors of an aggregate of 150 H.P. are employed, three large generating machines being installed, and an extensive battery of accumulators. The company is engaged in shipbuilding, the manufacture of railway plant, bridges, iron roofs, and similar enterprise.

La Societa per le Forze Idrauliche delle Liguaria has been formed in Genoa with a capital of £32,000 to acquire and exploit concessions for the utilisation of water power in the province of Liguria.

A concession has been granted by the Italian Government for the utilisation of the water power of the Caffaro between Ponte Caffaro and Bagolino. The electrical energy is to be employed for working the projected electric railway between Caffaro, Nave, and Brescia.

Electrical Enterprise in Poland.—In February last tenders were received by the municipality of Warsaw for the erection and equipment of electricity generating works, and the concession was granted to a German firm whose tender was the lowest of eight sent in. All the public streets are to be lighted electrically, and the horse tramway service converted to electric lines and considerably extended. No British firm tendered.

A German firm has secured the concession for the supply of electric current for private lighting, power and traction at Lodz in the same district, where the present mileage of the tramway is to be largely extended.

A Belgium firm is seeking a concession for converting the horse tram lines at Vilna into electric traction.

A concession for the construction and working of electric tramways at Lublin has been granted to a German firm.

The town of Czenstochan is being provided with an electric tramway service.

Electrical Inkless Printing—While the printing trade generally is sceptical as to the future of the process known as electrical inkless printing, and while those who look upon the process with some favour and anticipate for it some measure of success regard with misgivings the policy of the Electrical Inkless Printing Syndicate (Ltd.) in keeping the technical details of their process a secret, we think it right that the views of those who look upon the process as having been perfected and become demonstrably a real success should be given every publicity. The issue of Barnett's *Printing Trades Gazette* for May 9 contains the following leading article, setting out the merits of electrical inkless printing:—

To begin with, there is a very tangible economy, represented exactly by the difference in cost between the ink at present consumed and the current of electricity which will be consumed under the new method. We do not attempt to fix the saving in this respect, varying as it must do with the relative cost of ink and electrical supply. Black ink varies according to circumstances from 2½d. a pound in export quantities to two or three shillings for "cut" blacks; similarly, current from the mains ranges from 3d. per unit to 7d. or 8d. in different localities. [This should be 1½d. to 5d.—ED. *E*.] But this we are justified in saying—that the mean economy will be very considerable, as high as 70 per cent. The next point that occurs to us is, economy in machine construction. It abolishes the use of every inking appurtenance, such as the duct, distributors, and inking rollers, and their controlling parts. Conceive what this will mean on a great rotary. Then by eliminating the friction caused by moving the inking parts—the greatest in the whole machine—there must result an economy of power. Then we anticipate (but here we need the guidance of experience upon a broad scale) a sensible economy in the direction of make-ready and wear and tear, for the reason that the slightest contact between the printing surface and the paper will ensure the chemical changes necessary to produce a print of uniform colour. There is one point that among all the discussion that has surrounded the process we have not seen raised, but it will have its value. The addition of a pigment to the paper, as now practised, increases its weight, but 2oz. or 4oz. of paper electrically printed will not be increased in weight one iota. Therefore, for mailing purposes we may send an additional number of pages of matter in lieu of the ink upon which we now pay postage rate. Further, printed matter may be instantly backed up, instantly handled for any purpose whatever, without fear of set-off or smear. Instead of being the dirtiest department, as now, the electrical machine-room will in the early future be about the cleanest in an establishment. There will be no washing of formes, as the type will lift from the bed of the machine just as clean as it was laid there. This, again, implies less wear and tear of the type, as well as economy in time and material. Look at it from any point of view whatever, the change which is coming will be a boon to the printer. Mark, we speak in the future tense, not because we entertain any scepticism as to the practical solution of the method of electrical printing as evolved by the Electrical Inkless Printing Syndicate, but because it has not yet been reduced to the level of an every-day commercial possibility. This will come, must come, shortly Assuming the practical success of the process (a large assumption, notwithstanding the cocksureness of our contemporary), the case for electrical inkless printing is here well put. Assuredly the most tremendous revolution is foreshadowed by a success which we can at least hope for. The abolition of printers' ink, rollers, the dirt and "devil"-ment of the machine-room, to say nothing of hot-rolling and pressing and other devices to dry the printed sheets and give them a "finish," would be the greatest blessing ever conferred upon the great printing industry. For the publisher, the possibility of saving largely in the cost of postage of printed matter makes the subject an interesting one. Then why does the syndicate hold its hand?

Electricity Supply Failures.—At the Killarney (Ireland) Petty Sessional Court, last week, the Killarney Electric Light Co. (Ltd.) appeared to 28 summonses charging them with having made default on 28 occasions during March in the supply of electric current. The defence was that the failure was due to an accident to a steam alternator and to inability to get contractors to deliver plant which had been on order for some time. After hearing evidence the Bench inflicted a fine of 5s., with 5s. costs, on each summons.

Gift to the Nation.—Some time ago a committee of architects and representatives of the building trades organised a movement to provide homes of rest for discharged soldiers. A part of the scheme was the erection of six cottage homes with 100 beds and the necessary living and recreation rooms, workshops, and offices at Bisley, on land presented by Lord Pirbright. The whole of the work of erection, furnishing and fitting up has been borne by firms connected directly and indirectly with the building trades. The subscriptions in money and kind amount at the present time to about £19,000, and when completed the homes will be made over to the nation. The buildings are to be lighted by electricity, and an influential installation committee has been formed, of which Mr. W. G. McMillan (secretary of the Institution of Electrical Engineers, 28, Victoria-street, S.W.) is hon. sec. As soon as the specification for the plant, &c., now being prepared by Mr. Adrian Collins, is ready, the committee propose to appeal to the electrical trades for gifts, either in money or kind, to enable them to equip the homes satisfactorily.

Glasgow.—The Tramways committee recommend the Corporation to increase the salary of the manager of the Tramways department (Mr. John Young) by £150 per annum, making his salary £1,400.

Gloucester.—An inquiry was held here last week into the application of the Corporation to borrow £9,425 for electric lighting, and £8,575 for a refuse destructor. The town clerk (Mr. G. S. Blakeway) explained that £43,450 had already been sanctioned, and this sum had been overspent to the extent of £19. 10s. The new loan was for extensions of the plant and mains. The consulting engineer (Mr. Robert Hammond) gave technical details of the proposed extensions, which were rendered necessary by the increasing demand for current. The present position, Mr. Hammond said, completely justified the Council in laying down another 300 kw. set, by which the capacity of the works would be doubled. This would bring up the total effective capacity to 600 kw., after allowing 300 kw. as reserve. The experience of Gloucester had been identical with that of another cathedral city (Canterbury), namely, that by some diligent canvassing they had absolutely filled up the whole of their plant before turning on the current; 135 applications for the light had been received for a total equivalent of 13,350 8 c.p. lamps. The public lighting would require 2,000, and the power at the generating works 200, or a total of 15,550 lights. The actual commercial capacity of the works was for 10,000 lights, so that they required plant to provide for another 10,000 lights, to bring it up to 20,000. The provisional contracts for the extension plant had been obtained, subject to the sanction of the Local Government Board. In reply to a question by the Inspector, Mr. Hammond said that he considered that before Gloucester reached the limit of the electrical plant that would be required to supply the whole city they would require about 2,000 kw. They had now 600 kw., and were asking for 300 kw. more, and he thought they would want within the next five years plant three times as large. The 13,500 lights that application had already been made for were, as it were, only sample lights, for many would-be customers were

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only waiting to see them lighted before becoming consumers themselves.

Hamburg.—A project for the construction of a mono-rail line in Hamburg has been submitted by the Continentale Gesellschaft für Elektrische Unternehmungen. Stringent tests are being carried out by the works department of the municipality. The company seek a concession for 50 years.

Horsham.—Formal application for a loan of £15,000 for electricity works has been made.

Hull.—The annual report of the Electric Lighting committee for the year ended March 31 was presented at the last meeting of the Electric Lighting committee. This is the seventh year's working of the undertaking, and at the beginning of the past financial year £94,953. 12s. 10d. had been expended in buildings, plant and equipment, and during the year the committee incurred further liabilties to the extent of £38,843. 9s. 11d. The total capital expenditure is £133,802. 2s. 9d. Two 800 H.P. units were erected during the period, and on March 31 there were 1,326 consumers connected, taking 940,192 units of current, during the year, against 960 consumers and 749,690 units in the previous year. The committee have 54 motors taking supply from the mains, of sizes varying from $\frac{1}{6}$ to 35 H.P. many of which have been connected during the past year, and a 50 H.P. motor will shortly be connected. The gross receipts were £19,290. 12s. 7d.; expenditure, £10,631. 3s. 11d.; gross profit, £8,659. 8s. 8d.; less contribution to sinking fund, £2,693. 15s. 1d.; interest on loans, £3,229. 10s. 3d.; depreciation of meters, £812; leaving net profit £1,924. 3s. 4d. Although more units of electricity has been generated, and a larger number of consumers connected, a decrease of £1,736. 2s. 9d. in the net financial result has occurred, with an increased generation of 190,502 units This was owing to reduction in the charge per unit, and to the increase in price of coal and increased staffing. The rating authorities had increased the rateable value from £616. 15s. 6d. to £871. 9s. 2d. On the other hand, there was a substantial reduction in the general establishment charges. The report has been adopted.

Leeds.—The estimates for the ensuing year were considered at the Corporation meeting on Wednesday. The Lord Mayor (Ald. Gordon) said that obviously with the need for extensions of the electric light and tramways undertakings, they could not stop expenditure. They intended to levy pretty heavily on the trading concerns in order to help the income of the city to meet its expenditure. They proposed to take £6,127 from the tramways and £4,000 from the electric lighting department. The profits on electric lighting amounted to £8,046. 4s, £4,046 4s. of which would go to reserve, which would then stand at £8,287. 2s. 9d. The gas concern did not figure as a contributor this year, owing to the increase in the price of coal.

Light Railways.—Notices of intention to apply to the Light Railway Commissioners for orders to authorise the construction of light railways have been given by:—

Rhyl and Prestatyn Light Railway Co. (extensions).

Hyde Corporation, for Hyde and Dukinfield.

Staines and Egham Light Railway Co. (Ltd.), for Staines and Egham.

Kidderminster and District Electric Lighting and Traction Co. (Ltd.), for Kidderminster and Bewdley.

North Wales and District Light Railway and Electric Power Syndicate (Ltd.) from Pwllheli to Nevin.

Auxiliary Light Railways and Tramways Co. (Ltd.), for Blackburn, Whalley, and Burnley district.

International Electric Traction and Power Syndicate (Ltd.), from Stockton Heath to Runcorn.

Southwold Railway Co., to alter the 3ft. gauge of existing railway between Halesworth and Southwold to 4ft. 8½in., to raise further capital and to construct a railway from Southwold to Kessingland.

Power and Traction (Ltd.), to construct the Nidd valley light railway.

British Electric Traction Co., Sheerness and district light railway, Kingston and Surbiton and district light railways (extensions), Jarrow and South Shields light railways, Durham and district light railways, and the Barnsley and district light railways (extensions).

Bath Corporation, Bath and district light railways.

John Fell, John Lewis, W. J. Kershaw, and others, Mansfield and district light railways (extensions).

A. Anderson and A. Brown, Warrington and Northwich light railway (western extensions).

Sheppey Light Railway Co., to amend Sheppey Light Railway Order (1898) and to authorise compulsory purchase of land.

The Todmorden Town Council will oppose the Todmorden and Bacup light railway scheme.

London County Council.—At Tuesday's meeting it was agreed to loan Battersea Vestry £20,000 for electric lighting, and St. Martin-in-the-Fields £6,010 to defray the cost of providing lamps, standards, &c., for lighting the streets within the parish.

The Finance committee reported that on March 6 they received the application of Islington Vestry for sanction to borrow sums of £56,261 and £13,200 for electric lighting, and stating that they (the committee) were unable to recommend sanction to more than £38,000 and £10,000 respectively, owing to their being unable to obtain from the Vestry certain details of information. They had since been furnished with these particulars, and now recommended that sanction be given for the balances. Approved.

It was agreed that the report of the Highways committee dealing with the resolution passed at the Guildhall Telephone Conference on Feb. 1, 1899 should be withdrawn.

The Highways committee also presented a report upon the present position of the litigation and negotiations between the Council, the National Telephone Co., and the Post Office. The committee calls attention to the action of the St. Marylebone Vestry, which, on May 3, decided to grant the application of the National Co. for permission to lay underground lines in various streets of that parish. The Vestry has been informed that the Council cannot adopt the view taken by the National Co. that so long as terms can be arranged with the road authorities as to underground wayleaves the consent of the Council is unnecessary. The Vestry are further informed that its action has a tendency to weaken the Council's position in "securing favourable terms for telephone subscribers in London as regards intercommunication between the National Co.'s system and that about to be established by the Post Office." Mr. Benn, in presenting the report, stated that if the tariff of the telephone service to be established by the Government should prove to be unfavourable it would become imperative for the Council, in conjunction with the City authorities, to apply for a municipal licence. Col. Ford said it was most unfair and ungracious for the Government to step in and take the metropolitan area for its telephone service when, as in the case of Glasgow, this area ought to be available to the Council in relief of the rates.

Lymington.—The Lymington Electric Light and Power Co. have submitted alternative schemes for the electric lighting of the streets for five years. The first scheme would cost £275 per annum, and the second £322. 10s, the terms including supply of current, maintenance and repairs.

Maidstone.—An inquiry was held last week into the application of the Council to borrow £40,000 for electric lighting and dust destructor purposes. Mr. C. H. Smith appeared in support of the application. He said that a provisional order was obtained in 1892, and the area covered the whole borough. The Corporation had been several times pressed by the Board of Trade to carry out the provisions of the order, and the scheme for which the Corporation now asked for a loan had been sanctioned by them. The site of the proposed works belonged to the Corporation. In 1896, in consequence of pressure by the Board of Trade, the Corporation had practically entered into an agreement with a private company (Messrs. Thomas King and Co.) to assign their powers under the provisional order, but owing to the opposition of the ratepayers the Corporation decided to retain the order and themselves erect electricity works. The present method of dealing with refuse was unsatisfactory, and the Council wished to combine a dust destructor with electric lighting. After considerable investigation, a local firm of engineers was consulted as to the electric light works, and for the dust destructor the Horsfall Co. was approached. Originally the Local Government Board were asked to sanction £30,000, but the area in which it was proposed to lay electric lighting mains had been enlarged, and it was finally resolved to ask for £40,000, in order to carry out the whole of the work. Dust destructors were erected in a number of manufacturing districts, and no complaint had ever been made against the Horsfall destructor. Applications for, or promises to take electric current equal to 6,600 8 c.p. lamps had already been received, and the equivalent of 2,358 8 c.p. would be required for public lighting, but they anticipated applications for a total of 16,060 8 c.p. lamps. There would be 32 arcs of 1,000 c.p. for the main thoroughfares, and 119 32 c.p. incandescent lamps for the outlying streets. The net profit was estimated at £1,015. 11s. 9d., but there would be a loss of over £460 on the destructor, which would reduce the annual profit on the whole scheme to £543. 15s. 9d. The cost of the electric lighting scheme (according to tenders provisionally accepted) would be £33,598. 6s. 6d., and the dust destructor £6,431. 15s. 6d. Mr. W. A. Stevens (Messrs. Stevens and Barker, consulting engineers) gave technical details. He said the charge for current would be 7d. per unit for the first hour and 2d. after. His scheme was a continuous-current, three-wire system one, the distributing mains being fed at five points. His firm had carried out work for the Chatham and Rochester municipalities. He had been engaged in electrical work for over ten years, and was an associate of the Institute of Electrical Engineers. He had no experience in central station work. He had not based his scheme on that prepared by Messrs. Kincaid, Waller and Manville. He was aware of that firm's report, but did not copy their figures. In his estimate he put the revenue at £5,237, and the capital at £26,000. He knew of no other instance, except Tunbridge Wells, where they had made such a revenue for the outlay. He expected to make money at Maidstone in the first year or two. The life of the plant would be about 20 years if properly repaired, and in his estimate he had allowed for depreciation. He estimated the profit on the whole scheme to be £543. 11s. 9d. for the first year's working. After further evidence had been given the destructor portion of the scheme was abandoned.

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Manchester.—Mr. W. H. Vaudrey has been elected chairman of the Telephone committee in place of Ald. Southern, resigned. The committee resolved to ask for a reply from the National Telephone Co. to the inquiry as to the terms the company are prepared to sell their Manchester undertaking to the Corporation.

Mile End (London).—The Guardians have discussed a report by a special committee on the electric lighting arrangements at the workhouse, in which it was stated that their consulting engineer (Capt. J. M. Knight) had informed them that the engines, boilers, batteries and the electrical installation generally at the workhouse were unsuitable to their requirements, and the total cost of remedying the defects is put at £6,000. The committee state that the labour bill in the electrical department has been about doubled since 1895, and the coal bill quadrupled, and they recommend a rearrangement of the engineering staff. The report has been referred back.

Municipal Telephony.—On Tuesday Dover Corporation considered a report recommending the erection of a municipal telephone exchange. The report was based on the assumption that there would be 300 subscribers' and 20 public telephone lines complete at £16 each (£5,120); 150 partially completed lines at £8, £1,200; total, £6,320. To put the telephone on a remunerative basis, it was estimated that £5 10s. per line should be charged for subscribers requiring an unlimited number of calls; and £3 10s. per annum with a toll of 1d per call for others. With the estimated number of subscribers, a net profit of £125 a year would be earned. The discussion was adjourned.

The Leicester Telephone committee recommend the Council to authorise them to ascertain the probable number of customers for a municipal telephone service, and to collect further information as to the advisability of erecting an exchange. The committee have retained the services of Mr. A. R. Bennett as consulting telephone engineer. Notice has been given to the National Co. to terminate the agreement as to underground wayleaves on June 24. The committee report that there are only about 1,150 subscribers, whilst if telephone were used to the same extent as in some continental towns where there are cheaper rates the number would probably be more than 6,000. Without a competitive service they urge there is no likelihood of the existing rates being reduced. They are advised and are of opinion that a remunerative municipal service might be given on the following terms: £6. 6s. per annum for an unlimited number of calls, or alternatively £3. 10s. per annum, and 1d. a call for each call up to a mile from the exchange, and for any excess of distance beyond a mile a small extra charge. These rates are put to cover cost of installation, maintenance, and Government royalties, and will secure communication with all parts of the Leicester telephone area. The committee are of opinion that before considering the question of applying for a licence it should be ascertained what amount of support from the public could be relied upon, and a canvass for subscribers is to be undertaken. The committee do not recommend the Council to apply for a licence unless 1,000 subscribers are obtained as a start.

The Tunbridge Wells Corporation are having a specification for a municipal telephone exchange prepared.

Newcastle-on-Tyne.—The Newcastle-on-Tyne City Lunatic Asylum at Coxlodge is lighted throughout electrically. The lighting contract was carried out by the Corlett Electrical Engineering Co., and the contract for telephones, electric bells, electric clocks, &c., by Messrs. John Mills and Sons. The asylum is also ventilated by electrically-propelled fans, and electricity is employed for working the laundry machinery.

Nuneaton.—The District Council have called in Mr. W. C. C. Hawtayne to report upon the question of purchasing the undertaking of the Nuneaton Electric Supply Co.

Paisley.—From 30th inst. the charge for electric current for lighting purposes will be 6d. per unit for the first hour's maximum demand and 2d. afterwards, in place of 7d. and 3d. as at present, and that for power and heating 2½d. per unit. The Electric Light committee are considering the advisability of adopting a uniform rate for lighting.

Reigate.—The charge for electric current has been fixed at 7d. per unit for the first hour's maximum demand and 4d. after, while a uniform charge of 3d. per unit is to be charged for power.

St. Anne's-on-Sea.—An inquiry was held last week into the application of the Council for permission to change the site of their proposed electricity works. The electrical engineer (Mr. P. J. S. Tiddeman) said the new site was well suited for an electric lighting station. It was not so close to the town as the old site, and would cost a little more for feeders and cables. There was no opposition.

Skipton.—The local ratepayers are agitating in favour of the erection of electricity works.

Southampton.—The town section of the new municipal electric tramways has been officially inspected by the Board of Trade, and the line were opened for traffic on Tuesday.

Southend.—The Town Council has discussed a proposal to so extend the electric tramway scheme as to include the High-street in the new routes. The proposal was defeated.

Telegraphs and Railways in Turkey.—The Vienna correspondent of *The Times* states that active measures have already been taken for carrying into effect the Sultan's Iradé respecting the construction of a railway from Damascus to Mecca, and of a telegraph line from Selt, near Damascus, to the Hedjaz.

Telegraphs in Afghanistan.—Lord George Hamilton recently stated in the House of Commons, in reply to Mr. Maclean, that the Government of India had on several occasions advised his Highness the Ameer to give attention to the construction of telegraphs and railways, but the Ameer had never shown any desire for the extension of railways or telegraphs in Afghanistan.

Toronto.—According to a New York journal the municipality of Toronto is making arrangements with the Toronto Street Railway Co. to establish a system of electric railways, embracing the country around Toronto between Brantford, Peterboro', and Georgian Bay, a radius of nearly 100 miles, and a total track mileage of 354 miles. The expenditure involved for track and permanent way has been estimated at £570,000, and the total expenditure at £800,000.

Trieste (Austria).—The existing horse tramways in this city are about to be superseded by electric lines on the overhead trolley system. Part of the city is now lighted electrically.

War Office Contracts.—In the course of his evidence before the Parliamentary Committee on War Office contracts, Mr. Major, director of army contracts, was reported to have stated that Messrs. J. Stiff and Sons, of the London Pottery, Lambeth, S.E., had been struck off the list of War Office contractors for offences under the Corrupt Practices Act. Mr. Major's evidence was, we understand, erroneously reported. It appears that a young member of Messrs. Stiff's firm went to Woolwich and looked at some stores that were under inspection and had been rejected. In the course of his visit he offered small gratuities to the foreman and viewer, which, he said, he did for assistance they rendered him, and in ignorance, as he thought it was in the ordinary course of business, when people had done a service, to give them a little remuneration. This act was, however, held to be sufficient to justify a suspension for 12 months. We are asked to say that the War Office have not cancelled existing contracts with Messrs. Stiff and Sons, under which that firm will be supplying goods to the department until December next.

West Ham.—A scheme for wiring consumers' premises on the easy wiring system has been devised by the borough electrical engineer (Mr. J. K. Bock). The Corporation has obtained powers to borrow £10,000 for free wiring. An agreement is to be made with contractors to wire premises in the borough at the rate of 13s. per lamp (shop and factory), and 15s. (private house), and the consumer is charged 1s. 6½d. and 1s. 9½d. per annum respectively for repayment of capital and interest. Ten years are allowed in which to pay for the installation.

Wireless Telegraphy.—In the House of Commons on Monday, Mr. Hanbury, in reply to Sir John Leng, said there was no information at the Post Office as to the extent to which the Marconi system of wireless telegraphy had been adopted in America, France, Germany, or other countries, but, of course, a licence would be granted in this country if suitable terms could be arranged.

Wolverhampton.—The extensive new works of Messrs. Chubb and Sons are lighted electrically. Electric driving has also been adopted, current being taken from the town mains.

Electro-Harmonic Society.—The annual general meeting of this society was held on Tuesday. The report of the hon. sec., Mr. C. E. Grove, stated that during the past season 36 members were elected and 25 resigned, five members were lost by death, and nine owing to non-notification of address, while 10 have been struck off the register for non-payment of subscription. The membership now numbers 278, and 20 proposals are before the committee. It is satisfactory to learn that the society's concerts next season will be held in the old room of the St. James's Hall Restaurant. A suggestion is before the committee that Wednesday evening be substituted for Friday evening for the holding of the concerts, and the views of members are invited upon this point. The receipts (including £34 3s. 1d from 1899-1900) realised £205s. 8s. 1d., leaving a balance over expenditure of £25. 1s. 8d. The surplus assets to May 19 amounted to £28s. 16s. 2d.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Shoreditch (London) Vestry require tenders for the supply of eight dry-back marine-type boilers, or eight water-tube boilers, with automatic stokers, and sundry ironwork for their new generating station at Whiston-street. Specification may be obtained at the office of the electrical engineer (Mr. C. Newton Russell), Electric Light

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Station, Coronet-street, Hoxton, N., and a copy of the specification may be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders to Dr. H. Mansfield Robinson, vestry clerk and solicitor, Town Hall, Old-street, E.C., before noon on 19th inst. An advertisement contains further particulars.

Durban (Natal) Corporation invite tenders for the supply, delivery and erection of the overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, &c.; 22 double-deck motor cars complete; electricity generating plant, including three 250 kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, &c. Tenders in duplicate to the agents (Messrs. Webster, Steel and Co.), 5, East India-avenue, Leadenhall-street, London, E.C., by June 29, or to the town clerk of Durban by mail delivery on or about Monday, July 23.

Bradford Corporation require tenders for the supply and erection of a switchboard, or for alterations to existing switchboard, at the Valley-road electricity works. Specification can be obtained from the city electrical engineer (Mr. R A. Chattock), Town Hall, and tenders must be sent to the town clerk (Mr. Frederick Stevens), by June 14. An advertisement contains additional particulars.

Dudley Corporation invite proposals for wiring premises in the district on the free or easy wiring system. Particulars are set out in an advertisement, and specification, &c., may be obtained from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. H. C. Brettell), Town Hall, Dudley, by 15th inst.

The Vestry of St. Mary Magdalene *Bermondsey* (London), require tenders for the supply and laying of insulated electric mains, conduits, junction boxes, &c. Specifications, &c., can be obtained on and after June 5 at the Town Hall, Spa-road, S.E., and can be inspected at (but not obtained from) the offices of the engineers, Messrs. Kincaid, Waller and Manville, 29, Gt. George-street, Westminster. Tenders to Mr. Fred Ryall, vestry clerk, Town Hall, Bermondsey, before noon of June 18. An advertisement gives further particulars.

Glasgow Corporation require tenders for outside coal storage and steel structure for coal handling, and locomotive travelling cranes for outside coal handling, for their Pinkston power station. Specification can be obtained from the general manager of the tramways department (Mr. John Young), 88, Renfield-street, and tenders must be lodged with the town clerk (Sir J. D. Marwick) by 5 p.m. on 21st inst. An advertisement gives further particulars

Glasgow Corporation also invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders to town clerk (Sir J. D. Marwick) before 10 a.m., June 12.

The Electric Lighting committee of the *St. Mary, Newington* (London) Vestry require tenders for the supply and laying of insulated electric mains, conduits, junction boxes, &c. An advertisement contains additional particulars, and specifications may be obtained at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Tenders to vestry clerk (Mr. L. J. Dunham), Vestry Hall, Walworth, S.E., by noon 15th inst.

Stockport Gas and Electricity committee require tenders for two water-tube boilers for their Millgate electricity station. An advertisement contains further particulars, and specifications, &c., may be obtained from the engineer (Mr. S. Meunier), Gas and Electricity Offices, Portwood. Tenders to chairman of committee by 13th inst.

London County Council's Asylums committee invite tenders for the installation of electric lighting and power (except generating plant) and the installation of telephones, tell-tale clocks, fire alarms and call bells at the Horton Asylum, near Epsom, Surrey. Tenders to the committee, 6, Waterloo-place, S.W., by 10 a.m, June 16.

Blackpool Corporation invite tenders for the electrical equipment of 15 single truck tramcars. An advertisement contains further particulars, and tenders must be sent to the borough electrical engineer (Mr. Robt. C. Quin) by 18th inst.

The Provost, Magistrates, and Commissioners of the burgh of *Partick* invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught furnaces. Tenders to Mr. Jas. Donaldson, town clerk, 97, West Regent-street, Glasgow, by noon of June 8.

South London Electric Supply Corporation invite tenders for a complete installation of 3,000 lights on the premises of 500 consumers in any part of the company's area of supply, and also for the installation of two arc lights on the premises of any consumer in the same area. Tenders by June 2.

Altrincham Electric Supply (Ltd.) require tenders for erecting a chimney shaft, foundations, &c. Tenders to chief engineer by 9th inst.

Tenders are invited for the public lighting of *Larne* for three years from August 1. Tenders to clerk, Town Hall, Larne, by 18th inst.

Hackney Electric Lighting committee require tenders for the erection of electricity station buildings. Tenders to clerk by 13th inst.

Salford Tramways committee require fish and sole plate bolts. Tenders by 5th inst.

Sutton Coldfield Corporation invite tenders for the supply and erection of electricity generating plant. Tenders to the town clerk (Mr. Holbeche) before noon of June 21.

Manchester Tramways committee invite tenders for the overhead equipment of three tramway routes. Tenders to chairman by June 9.

Bootle Corporation invite tenders for supply and laying of underground electric cables, erection of arc lamps, and the supply of mechanical stokers. Tenders to town clerk (Mr. J. Henry Farmer) before June 16.

Chester Corporation invite tenders for steam, exhaust, feed-suction, condensing water pipes and valves. Tenders to town clerk (Mr. S. Smith) by 10 a.m. June 4.

North Eastern Railway Co. invite tenders for telegraph apparatus, telegraph wire, and line stores. Tenders to secretary (Mr. C. N. Wilkinson), York, by June 4.

St. Pancras (London) Vestry invite tenders for re-arranging and making additions to bare copper strip conductors. Tenders to vestry clerk (Mr. C. H. F. Barrett) by noon, June 7.

Sleaford Council invite tenders for electric lighting plant. Tenders to clerk by June 12.

Ealing District Council invite tenders for a storage battery and a steam alternator. Tenders to clerk by June 11.

Fulham (London) Vestry require tenders for the wiring of their electric lighting works. Tenders to Mr. W. J. H. Denselow, clerk, Town Hall, Walham Green, S.W., by June 4.

Bridgwater Town Council invite tenders for the supply and erection of electricity generating plant. Tenders to town clerk (Mr. W. T. Baker) before 3 p.m. on June 7th.

Luton Town Council require tenders for the erection of electricity station buildings. Tenders by June 18.

Wallasey District Council invite tenders for the maintenance of the electric installations on their ferry steamers. Tenders to the Clerk by 12th inst.

TENDERS RECEIVED AND ACCEPTED.

The following tenders for electricity generating plant are recommended for acceptance by a committee of the Melbourne City Council:—

Babcock and Wilcox (boilers and economisers)	£6,604 0 0
Thomas Parker, Ltd. (engines, dynamos, boosters and switchboard)	22,367 0 0
British Insulated Wire Co. (cables and joint boxes)	27,348 5 4
Tudor Accumulator Co. (accumulators)	3,529 0 0

At the weekly meeting of the London County Council on Tuesday the Fire Brigade committee reported that the following tenders had been received:—For wiring and fitting of electric light at the new Islington fire station:

Barlow Bros. and Co. (*accepted*)	£277 0	Private Wire and Telephone Installation Co.	£428 0
F. A. Glover and Co.	296 3	A. H. Wood	450 0
F. J. Coleby	335 0		

For wiring and fitting of the Whitechapel station:

F. A. Glover and Co. (*accepted*)	£282 6	A. H. Wood	£430 0
F. J. Coleby	331 15	Private Wire and Telephone Installation Co.	445 0

Devonport Corporation are recommended to accept the tender of the Callender Co. for the supply of electric light and traction feeders, distributors, boxes, &c, for £12,433. 6s 10d. The tenders were:—

Callender Co.	£12,433 6 10	Siemens Bros. & Co.	12,690 3 5
Western Electric Co.	14,149 18 8	W. T. Henley's Co.	£12,555 6 4
W. T. Glover & Co.	12,963 0 0	St. Helens Cable Co.	12,379 1 5
Brit. Insul. Wire Co.	12,875 16 0		

Hoylake and West Kirby Council have accepted the amended tender (the lowest) of Mr. J. Merritt, Birkenhead, for the erection of an electric lighting station for £6,500.

Leicester Corporation have accepted the tender of the Brush Co. for the supply of two 1,000 kw. inductor alternators (with Hick-Hargreaves horizontal engines) at £22,837.

Wimbledon District Council have accepted the tender of Messrs. Foote and Milne for wiring and fitting the isolation hospital for the electric light. Twenty-three tenders were received.

The Rhyl Council have accepted tenders, amounting to £16,543, in connection with the electric lighting scheme, and have decided to apply for sanction to borrow £19,000.

The tender of Mr. C. Dennes has been accepted for the erection of the Heywood electricity station buildings.

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The following tenders have been received by the Rhyl District Council for the supply of electricity generating plant.

Section A.—(Boilers.)

Babcock & Wilcox (*accepted*)	£2,013 10	Geo. Hill & Co.	£2,350 0
Stirling Boiler Co.	2,490 0	R. W. Blackwell & Co.	2,058 0
		Crompton & Co.	2,058 0

Section B.—(Engines, Dynamos, Boosters, &c.)

Lancashire Dynamo Co. (*accepted*) (Alley-Maclellan engine)	£5,759
Ditto (Willans)	6,204
Ditto (Browett-Lindley)	5,551
Ditto (Reavell)	5,359
Ditto (Willans)	7,470
Ditto (Alley-Maclellan triple)	7,453
Lowdon Bros. and Co. (Willans triple)	7,677
Ditto (Belliss triple)	6,869
Ditto (Willans compound)	6,677
Ditto Bros. (Belliss compound)	6,569
Ditto (Browett-Lindley)	5,809
Ditto (Reavell)	5,682
Siemens Bros. and Co. (Willans triple)	8,249
Ditto (Belliss)	7,264
Ditto (Willans compound)	7,239
Ditto (Belliss triple)	7,204
Ditto Bros. and Co. (Browett-Lindley)	6,444
Crompton and Co. (Alley-Maclellan triple)	7,880
Ditto (Belliss triple)	6,903
Ditto (Willans)	6,849
Ditto (Belliss)	6,806
Ditto and Co. (Davey-Paxman)	6,385
Ditto (Allen)	5,519
George Hill and Co. (Browett-Lindley)	6,210
S. H. Heywood (Alley-Maclellan triple)	7,811
Ditto (Alley-Maclellan)	6,156
Thames Ironworks Co. (Willans triple)	7,239
Ditto (Willans)	6,112
Ditto (Reavell)	5,268
Ditto (Allen)	5,133
John Fowler and Co. (Reavell)	6,042
British Westinghouse Co. (Willans triple)	7,680
Ditto (Allen)	5,560
Ditto (Belliss triple)	7,040
Ditto (Belliss compound)	6,650
Ditto (Willans compound)	6,620
Ditto (Browett-Lindley)	5,995
British Schuckert Co. (Willans triple)	7,702
Ditto (Browett-Lindley)	5,992
Ditto (Reavell)	5,762
Johnson and Phillips (Willans triple)	8,090
Ditto (Willans)	5,870
Electric Construction Co. (Willans triple)	7,931
Ditto (Willans)	6,852
Ditto (Willans compound)	6,763
Ditto (Reavell)	5,832
W. H. Allen, Son and Co. (own)	5,771
Electrical Co.	5,641
General Electric Co. (Willans triple)	7,768
Ditto (Belliss triple)	6,925
Ditto (Willans compound)	6,702
Ditto (Reavell)	5,572
C. A. Parsons and Co. (Parsons turbine)	5,017
Ashton, Frost and Co. (Willans triple)	8,525
Brush Co. (Universal)	8,314
T. Scott Anderson (Willans triple)	7,935
Frank Suter and Co. (Willans triple)	7,205
Clayton Engineering Co. (Alley-Maclellan)	6,784
E. Scott and Mountain (own)	6,750

Section C.—(Switchboard.)

Clayton Engineering Co. (*accepted*)	£590 0	Crompton & Co.	£902 0
Siemens Bros. & Co.	1242 0	Johnson & Phillips	900 0
Electric Construction Co.	1085 0	Ashton, Frost & Co.	896 0
Mechan & Sons	999 0	Veritys	851 0
Hodgson Wright	991 0	Lewis, Bayliss & Co.	782 0
Dorman & Smith	930 0	General Electric Co.	765 10
John Fowler & Co.	920 0	Brook, Hirst & Co.	745 0
		Lowdon Bros. & Co.	599 0

Section D.—(Arc Lamps, Underground Mains, Street Work, &c.)

Western Electric Co. (*accepted*)	£5,911 11	Callender Co.	£6,797 0
Telegraph Mfg. Co.	9,233 0	Oliver and Co.	6,758 0
Johnson and Phillips	8,181 0	Ditto	6,289 0
W. T. Henley's Co.	7,464 0	British Insulated Wire Co.	6,545 0
W. T. Glover and Co.	7,455 0	W. F. Dennis and Co.	6,184 0
Siemens Bros. and Co.	7,013 0	St. Helens Cable Co,	6,125 0

Section F.—(Accumulators.)

Dutilh-Smith, McMillan and Co. (Marquand accumulator) (*accepted*)	£1,304	D.P. Battery Co.	£1,446
T. Scott Anderson	1,900	Johnson and Phillips (Hart accumulator)	1,430
S. H. Heywood	1,577	Elec. Power Storage Co.	1,425
Chloride Elec. Storage Synd.	1,500	Tudor Accumulator Co.	1,395
		Hart Accumulator Co.	1,361

Section G.—(Crane.)

Marshall, Fleming and Jack (*accepted*)	£145	Stocks and Co.	£167
Iales, Ltd.	220	Carrick and Ritchie	159
		Jas. Carrick and Sons	152

APPOINTMENTS VACANT AND FILLED.

The post of senior demonstrator in the department of electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session. The salary is £150, rising to £200. Applications for the post have to be addressed, in the first instance, to the principal of the college, Leonard-street, Finsbury, London, E.C., by June 29. An advertisement gives some further particulars.

Southport Corporation are open to receive applications for the following appointments in connection with their new tramway scheme :—(1) Depot superintendent, wages £2 per week ; (2) Inpector, wages 35s. per week and uniform. Applications to Mr. J. Ernest Jarratt, town clerk, Town Hall, Southport, by June 6. Further particulars will be found in an advertisement.

Birmingham Corporation require two lecturers for the electrical and engineering departments of the municipal technical school in September next. An advertisement contains further particulars, and applications must be sent to the secretary (Mr. Geo. Miller), Suffolk-street, by 30th inst.

The Council of the Municipal Electrical Association require a secretary to act under the direction of the honorary secretary. Applications to the president (Mr. A. B. Mountain, borough electrical engineer, Huddersfield), by 14th inst. An advertisement contains additional particulars.

The governing body of the Battersea Polytechnic require an assistant lecturer in physics and electrical engineering from September next. Particulars from secretary, Battersea Polytechnic, S.W. See advertisement.

Hull Electric Lighting committee require an assistant electrical engineer at their Sculcoates lane generating station. An advertisement contains further particulars, and applications must be sent to the city electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull, by noon of 7th inst.

Johnson and Phillips' Electric Cable Works, Old Charlton, Kent require a draughtsman and a shop foreman for their additional lead-covering cable factories. Particulars will be found in an advertisement on another page.

Buxton District Council require an assistant electrical engineer. An advertisement gives further particulars, and applications must be sent to the chief engineer (Mr. Edward Calvert) by noon of 12th inst. There is also a vacancy for a premium pupil at the works.

An assistant engineer and draughtsman is required for the Ohm Electric Works, Northallerton. See advertisement.

Pembroke (Co. Dublin) Township Commissioners require a fitter-driver, and a cable jointer for their electricity works. Applications to the clerk (Mr. J. C. Manly), Town Hall, Ballsbridge, Co. Dublin. See advertisement.

A principal is required for Wandsworth Technical Institute at a commencing salary of £400 per annum. Applications to Mr. A. R Gridley, 4, Galveston-road, Putney, by June 18.

Two university lectureships in experimental physics are vacant at the Cambridge University. The appointments are for five years, and the stipend £50 a year. Applications to Vice-Chancellor by June 2.

An assistant lecturer and demonstrator in electrical engineering is required for the University College of North Wales, Bangor. Applications to Mr. J. Lloyd, M.A., by June 9.

A head-master is required for the Industrial School, Lucknow, India. Forms of application and further particulars from Director-General of Stores, India Office, Whitehall, London, S.W.

Jandus Electric Co., Hartham Works, Hartham-road, Holloway, London, N, require an assistant tester. See advertisement.

Brighton Corporation require an engineer in connection with their proposed electric tramway scheme. Applications to town clerk (Mr. F. J. Tillstone), Town Hall, Brighton, before 10 a.m. on June 8.

The Belfast Electric committee require an engineer-in-charge and a junior assistant for their electricity works. Applications to Mr. Victor A. H. McCowen by June 5.

There is a vacancy for an assistant superintendent in the telegraph department of the Government of India. Applications to Secretary, Public Works Department, India Office, London, S.W., by June 30.

An assistant manager is required for an electric incandescent lamp factory near London. See advertisement.

Mr. W. M. Heller, B.Sc., head master of the day science school in connection with the Birmingham Technical School, has been appointed by the National Board of Education of Ireland organiser of science instruction in Irish schools, and will take up his new duties in the autumn.

Mr. Charles Dudding, an assistant engineer at the Yarmouth electricity works, has been appointed assistant electrical engineer to the Hastings Corporation at a salary of £120 per annum. There were 95 applications.

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Mr. George E. Heath, of Dundee, has been appointed second assistant at the York electricity works.

Mr. E. Taylor, assistant engineer at the Kelham Island Tramway power station, Sheffield, has been appointed chief assistant engineer for the Birkenhead electric tramways.

BUSINESS NOTICES.

Messrs. R. W. Blackwell and Co. (Ltd.), 39, Victoria-street, London, S.W., are about moving their stores and offices to new premises in the City-road, E.C., adjoining Wesley's Chapel.

The Electrical Engineer Institute of Correspondence Instruction has removed from 120-122, Liberty-street to 240-242, West 23rd-street, New York, U.S.A., as, owing to the rapid growth of the Institute, the old quarters some time ago became inadequate to meet the demands for space. The Institute has, we are informed, a vast number of students located all over Great Britain and the Colonies as well as in the Western Hemisphere, and carries on its work in nearly every civilised country. Catalogues, giving full information regarding the courses of instruction, will be supplied on application.

Messrs. W. Scholes, J. Whitehead and J. E. Shore, electrical and mechanical engineers (trading as Scholes and Son, at 85, Corporation-street, Manchester, and as J. Whitehead and Son, at 10, Rochdale-road, Middleton), have dissolved partnership. Debts by Mr. Scholes, who continues under the style of Scholes and Son.

Mr. J. Burns, of 15, Long-lane, is removing to 76, Little Britain, London, E.C., and communications should be sent to the new address from to-day.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against M. H. Barber (trading as Donnison, Barber and Co.), electrical engineer and contractor, 10, Corporation-street, Manchester, must be sent by June 14 to the trustee, Mr. J. Wilson, 37, Brown-street, Manchester.

The discharge of W. P. O'Reilly, manufacturing electrician, 397, Edgware-road, and lately trading at 397 and 399, Edgware-road, and 124, Old Broad-street, London, has been suspended for three years.

Business for Disposal.—An electrical engineering business is advertised for sale in another column. The works are conveniently situated within 10 minutes of London.

For Sale.—A leasehold factory and about four acres of land, situated in Essex, and about 12 miles from London, together with tools and plant and surplus stock, are offered for sale by private tender. Tenders by June 19 to Messrs. Sydney Lee, and Co. (Ltd.) 9, Furnival-street, Holborn, London, E.C., from whom forms of tender and conditions of sale may be obtained.

An advertisement elsewhere contains particulars of an important Planté process for forming accumulator plates, the foreign rights of which are for sale.

Gas and Oil Engines.—The Dudbridge Ironworks (Ltd.), Stroud, have just issued a neat pamphlet describing their make of gas and oil engines. The "Dudbridge" gas engine for electric lighting, of which particulars are given, is made in sizes from 2 to 30 B.H.P.

Steam Specialities.—An interesting and useful catalogue of steam users' requirements manufactured by the British Steam Specialities (Ltd.), of Fleet street, Leicester, is just issued, and contains numerous illustrations and fairly complete particulars relating to a large variety of these specialities, including reducing valves, extractors, governors, steam traps, damper regulators, temperature controllers, &c. The catalogue is well got up, and can be obtained on application to the company.

Electric Motor Vehicles.—Messrs. Shippey Brothers have now ready an illustrated pamphlet describing various types of electric motor vehicles manufactured on the "Still" system, for which they are agents in this country.

"Phono" Electric Wire.—This wire, made by the Bridgeport Brass Co., of New York, is being introduced into this country by Messrs. Maguire and Baucus. According to a neat book of tables, &c., which has been sent us, it appears that the wire, made of a special alloy, has a specific resistance somewhat more than twice that of copper, but that its mechanical properties are far superior to those of hard-drawn copper wire. An interesting table is given showing the effect, on the tensile strength, of removing the surface from hard-drawn copper wire, and a similar table for the "Phono" electric wire.

Machine Tool Catalogue.—Messrs. George Richards and Co. (Ltd.), of Broadheath, Manchester, have issued an abridged illustrated catalogue of machine tools, pattern-making machinery, &c., in which a number of well-made, highly-finished planing, shaping, scarfing, drilling, boring, sawing, facing, and turning machines are described. The catalogue further illustrates several types of single and duplex vertical and horizontal air compressors and a variety of pulleys, hangers, suspension brackets, couplings, and bearings, for which Messrs. Richards and Co. have an established reputation.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 23 to May 29, with the ports of destination:—

Africa—Alexandria, £173; Cape Town, £283; Durban, £74; East London, £94; Port Elizabeth, £100. *Argentina*—Buenos Ayres, £393 (telegraph wire). *Australasia*—Lyttleton, £75; Sydney, £140. *Brazil*—Rio Janeiro, £54. *Ceylon*—Colombo, £110. *Chili*—Valparaiso, £75. *China*—Hankow, £2); Shanghai, £815 (including £118 old telegraph wire) and 25 tons old telegraph wire). *Denmark*—Copenhagen, £279 (telegraph wire). *France*—Boulogne, £20; Rouen, £76. *Germany*—Hamburg, £400 (telegraph material). *Gibraltar*, £135 (including £25 telegraph material). *Holland*—Amsterdam, £155. *Hong Kong*, £60 *India*—Bombay, £184 (including £49 telegraph material); Calcutta £490. *Japan*—Hiogo, £90; Nagasaki, £4,700 (telegraph cable); Yokoska £3,078. *Russia*—St. Petersburg, £587 (including £157 telegraph cable). *Spain*—Barcelona, £340 (telegraph material). *Straits Settlements*—Singapore, £564 (including £482 telegraph material). *Sweden*—Gothenburg, £23 (telegraph cable); Stockholm, £428 (telegraph wire). Total £14,575, against £13,706 for six days last year (May 25 to May 30).

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Co. (Ltd.)

The forty-sixth ordinary general meeting of the members of this company was held at Winchester House, Old Broad-street, on Wednesday, May 30, 1900, under the presidency of Mr. WILLIAM ANDREWS.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, I am afraid that the remarks we shall have to make to-day will throw a very disagreeable light on the present position of the British West India islands. If there is any truth in the close connection which is said to subsist between the activity of the telegraph and the activity of trade and commerce of given districts, the story we have to tell to-day will not be a cheerful one. For instance, the receipts this last half-year, to Dec. 31, were £22,643 as against £51,937 in the corresponding period of the previous year, showing a decrease of £29,294. That is not one of the features that we shall have to dwell upon to-day, because the large receipt in the December half of 1898 was quite abnormal; it was, as you know, owing to the Spanish-American war, which altogether, so to say, revolutionised our receipts in 1898. A more proper comparison would be made with the last half of 1897; but even here there was a reduction shown in the comparative revenues of £9,584. There is no doubt that our present very low receipts are owing to the reductions in the rates which were made in January, 1898, and February, 1899, coupled with a paucity of business. Further reduced subsidies only account for a loss this half-year of £356, and there is a loss of about £500 owing to the interruption of the Colon cable. Therefore in fact, the failure of low rates to stimulate business, owing to the deplorable sluggishness of trade and commerce in the West India Islands, has alone caused the diminished revenues. There is no fault to be found with the expenses, which amounted in the past six months to £21,433, against £24,443 for the corresponding period of the previous year, showing a decrease of £3,011. Practically, our expenses are at about their lowest ebb, and this decrease is owing to an exceptional state of things. For instance, in the repair of cables there is a reduction of £611; that is a thing which we cannot control. The expenses of the London office were £265 less; that is a matter we can control, but it compares with a period when extra work had to be done. The same may be said of the stations abroad, at which there was a decrease in the expenses of £857. There is also a less amount by £1,031 for depreciation of ships. Those figures make a decrease of £3,011, and the only increase deductable from that is £265 in maintenance of land lines. The shareholders have doubtless observed that last Monday week, in the High Court, Mr. Justice Farwell thought that the plaintiffs were entitled to succeed in the action brought by the Cuba Co. against this company to determine the construction of the agreement between the companies, but a declaration had to be settled by counsel and mentioned at a later date; and then it was understood that an appeal would have to be made. It would therefore be very improper for me at this stage of the proceedings to make any observation on the case, except to say that practically the matter has gone against us in the first Court, and we shall now have to do our best in the Court above. A feature that is disappointing in our company again is that the Legislature of the colony of Barbados reduced the company's subsidy as from Jan. 1, 1900, by £1,000 per annum. As you know, these colonies have been continually reducing the subsidies we received from them, and in the present case the reduction was made despite the opinion of the Barbados Government. The consequence of that and of other reductions is that the current subsidies now amount to only £13,100 per annum, as against £24,400 in the year 1886. Of course, we cannot but see that if the prosperity of the islands is so interfered with, as it has been and is, by want of trade and commerce, it is not an unnatural thing that they should try and save money by reducing their subsidies. It is an unpleasant thing for us, but it is not an unnatural step for the colonies to take. We do our best to maintain the subsidies, but unfortunately, unless something can be done to keep up these islands, I do not know how that sort of nibbling of the subsidies may end; and when we consider that we have 4,639 miles of cable and 194 miles of land lines to support, and that the whole of the subsidies we get now is only £13,100 a year, besides an insufficient revenue from other sources, you will not be surprised at the present state of the accounts. Another extraordinary fact is that the number of words which

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were exchanged in 1877, on the introduction of the word rate, intercolonially—that is, between the islands of the West Indies—amounted to 533,639, and since then, notwithstanding fluctuations of rates—always, by-the-bye, in the direction of lower rates—and, notwithstanding the recent large reductions, the number of words in 1899 had actually dropped to 163,714. That is about 3½ times less than the number of words exchanged between the islands when the word rate was introduced. Of course, we do the best we can for your interests, but we cannot increase the traffic of the West Indies. We cannot give the West Indies trade and commerce which they do not seem at present to possess. Now, reverting to the traffic, the words transmitted in 1899—after the large reductions that have been made—as compared with the corresponding period of 1897 (again omitting the war year)—do show an increase over the entire system of some 34,700 words, principally, I may say, at foreign stations. But here again, unfortunately, there is a decrease at the British stations in intercolonial traffic of 2,016 words. In fact, as we can see, the British West Indies are getting decidedly the worst of it. The net increase, I need hardly tell you, is totally inadequate to compensate us for the great reductions that were made in the rates. It seems clear to me—it is a matter of personal opinion, perhaps—that without extraneous aid the measure of the traffic must be the measure of the tariff. If, for instance, the traffic only measured 100 messages per annum between given points, it is clear that that 100 messages must be tariffed so as to cover all the charges and the payment of reasonable dividends for the employment of the capital of any company, whatever it might be. That seems to me only reasonable; in fact, I do not see how one can get away from it. It is no use talking about low rates increasing business, which is the general pabulum one is favoured with. Of course, in a certain sense an increase of business, an additional number of words, may be sent, as we have seen in our case, but it is inadequate—inadequate to the necessities of the case. I now move the adoption of the report and accounts and the payment of the dividends therein set out.

Mr. HENRY HOLMES seconded the motion.

Mr. VARLEY observed that the Company had had a most chequered career. He thought that when the position of the Company had been shown to be what it was so clearly, from the circumstances stated, they ought to get a favourable hearing from the Government in the appeal which the Directors had made to them.

Mr. BIRKS expressed his sympathy with the Directors, who had stuck to the ship so long, and had worked so hard in the shareholders' interests. As to the action brought against them by the Cuba Company, if they really were held by the throat, as the Cuba Company's action suggested, he did not think that it would be such a terrible thing to face liquidation, and afterwards see whether they could not make terms with their natural friends, the Direct West India and the Halifax and Bermuda Cos. He had seen a circular during the last few days from the Direct West India Co., which showed that within two years of their existence they were prepared to pay off £9,000 of their debentures. It appeared to him that they were face to face with a crisis, and he suggested that the Directors should have an interview with the other companies mentioned, and save this company from the claim of the Cuba Company.

Mr. VEARS commended the Directors for their decision to draw on the reserve fund in order to pay the proposed dividends. The shareholders must exercise patience, and he believed that they would ultimately see the cloud now hanging over them disappear.

A SHAREHOLDER called attention to the expenses in connection with the ship the "Duchess of Marlborough," lying at the docks, and advocated the disposal of the vessel in order to save expenses.

Mr. EDWARDS stated that the chairman had compared the revenue of the past half-year with that of the December half of 1897, and had called attention to the decrease in the receipts of £9,500; but he had omitted to mention that the expenditure showed an increase of £1,700. He thought that some explanation was wanted respecting this increase. The position of the Company would be strengthened, he thought, if the debentures were paid off.

The CHAIRMAN: With respect to the small difference that exists between the interest we receive from investments and the amount we pay for debenture interest, we stated at the time that, with regard to this £80,000 of debentures, we should have to pay a premium of 5 per cent. to get rid of them, a fact which, to begin with, diminishes the advantage of paying them off. With reference to the "Duchess of Marlborough," we found from experience that one ship was not sufficient. When the duplication took place—which some gentleman referred to just now as unnecessary, but which we found very necessary—we thought that we could do with one ship instead of two. The little ship now laid up was costing us £8,000 a year when in commission, and that little vessel is kept as a stand-by in case of accident, and is now costing us £400 a year. Although she is kept as a stand-by we keep her with some reluctance, and I may say that we have been endeavouring to sell her, and we are, in fact, now awaiting a reply. With regard to the question of competition with the Direct Company, I am in a difficulty, because what the competition may finally turn out to be, and what we may have to pay to this other company, whichever way the messages go—that question and several other questions depend upon the final decision of the case. We have been very strongly advised, and we are now again told that we ought to succeed on appeal. That is why we are going on with the appeal, and that is why it would be improper for me at the present time to speak of the effects of competition as being this or that when, as a fact, we do not know what it will be until the case is finally decided. The increase in our expenses in 1899 compared with 1897 arose, first of all, from a sum of £500 which had to be spent on the maintenance of land lines. An electrical tramway was started in Jamaica, and the strong current from it interfered with our lines. We therefore had to devise certain measures for protecting our property, and the cost of that, together with the cost connected with the hurricane, amounted to £500. That was an absolutely unavoidable expense. At the stations there was an increase of £372, but this is always a fluctuating item. In further reply to a shareholder, he said: We receive subsidies from the Leeward Islands, the Windward Islands, St. Thomas, St. Croix, Barbados, Trinidad, and Demerara. The Government of Columbia gives us no subsidy.

The motion was carried unanimously; and resolutions were afterwards passed re-electing the retiring Director, Mr. W. B. Kingsford, and the retiring auditors, Messrs. Deloitte, Dever, Griffiths and Co.

A cordial vote of thanks to the Chairman and Directors terminated the proceedings.

India Rubber, Gutta Percha, and Telegraph Works Co. (Ltd.).

The half-yearly general meeting was held yesterday, the Hon. HENRY MARSHAM presiding.

Mr. R. K. GRAY having read the notice calling the meeting,

The CHAIRMAN said: I shall, as usual on these occasions, make a few remarks which will doubtless prove of interest. I am glad to state that the company's turnover in general business continues to show an increase when compared with the similar months of last year, and that although in certain lines there has been a considerable decrease, yet this decrease has been more than balanced by the increase in other directions. In addition to this increase of general business we have had more submarine cable work to do. Our steamer "Silvertown" is now loading at our moorings in the Thames, and will in a few days sail to lay about 1,000 miles of cable between Canso (Nova Scotia) and New York. We hope we shall be fortunate enough to complete this cable with our usual despatch, and so enable the "Silvertown" to return to England just as we are on the point of completing the manufacture of a cable which we have to lay between Waterville (Ireland) and Weston-super-Mare. The "Silvertown" has lately been thoroughly overhauled, and a considerable amount of money has been spent in doing so. The steamer "Dacia" returned safely from her voyage to the West Indies, where she was employed in work which I reported at the ordinary general meeting. The steamer "Buccaneer" is now on charter to the Western Telegraph Co. While making these favourable remarks as to the employment of your works, ships, and staff, I wish to impress on you the fact that competition is keen, the price of raw material is high, and that the coal we consume costs us per ton about 25 per cent. more than we were paying in the spring of 1899. I now move that an interim dividend of 2½ per cent. (or 5s. per share) be paid, free of tax.

Mr. S. WM. SILVER seconded the motion, which was carried unanimously.

A vote of thanks to the chairman terminated the proceedings.

Castner-Kellner Alkali Co. (Ltd.).

The fourth ordinary general meeting of this Company was held yesterday, Mr. WILLIAM MATHER, M.P., presiding.

The CHAIRMAN said the working of the Company's process had been, in every respect, all the board could desire, and it improved from year to year. The concern, from its initiation, had been conducted more like a private partnership than as a public company with a board of directors who only occasionally met. His colleagues and himself had devoted as much time to this enterprise as anyone could be expected to devote to a property of their own. Perhaps to that may be attributed the fact that, in a comparatively short time, they had succeeded in creating an entirely new industry, and obtained such results as were disclosed in the report. During the past four or five years the board had been largely assisted by the late Mr. Hamilton Castner, who was, to a large extent, the inventor of the process. The Matthieson Alkali Co. in America had developed into a very successful concern. That company, with which this company was in close alliance, had been singularly successful in working, as they possessed very cheap power—the Niagara Falls. The development of that company promised to be much greater than could possibly be hoped for in this country, or perhaps in Europe. His remarks applied to that department of the Matthieson Alkali Co. concerned in the working of the Castner process. He then moved the adoption of the report.

Mr. F. HARDCASTLE second the motion.

Replying to questions, the CHAIRMAN explained that the plant of the company was maintained in thoroughly efficient order throughout the year. The staff that had to be kept to ensure that the electrical efficiency of the cells never fell below a fractional point of the requisite high standard, necessitated a constant expenditure on plant, and was not required in any other industry with which he was acquainted. Therefore, at the close of the year the plant was practically in the same condition as at the beginning. Apart from the cost of maintenance of plant, it was proposed to carry £10,000 to depreciation. The increase of about £20,000 in the item of land, buildings, plant, &c., was explained by additions considered advisable in the interests of the business. The report was adopted, and the proposed dividend of 8 per cent. agreed to.

Isle of Man Tramways and Electric Power Co. (Ltd.).

At the annual meeting held on Friday,

Mr. J. R. COWELL said he was elected a director in March last year, and soon afterwards went to America for six months, and on returning was laid up. The first notice he received to attend a meeting of the board was for Feb. 7 last, four days after the failure of Dumbell's Bank. He proceeded to carefully examine the affairs of the company, and found

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them to be in an exceedingly difficult condition, but he did not resign, as he thought it would have been cowardly to have done so when his colleagues were faced with serious difficulties. Messrs. Turquand, Youngs and Co. had been appointed to audit the accounts independently, and when their exhaustive report was issued the Board endeavoured to get financial assistance, but without avail. Meanwhile, as there was a difficulty in keeping the line running and staving off creditors, the expenditure was cut down to the lowest point. The liabilities of the general undertaking were £84,967, and adding £10,000 for working capital, £95,000 was arrived at as the amount required for the general undertaking. For the separate Ramsey undertaking, he estimated that £35,000 would be required. He described Messrs. Turquand, Youngs and Co.'s report as extremely severe and in some parts hardly fair. He admitted that steps should long ago have been taken to increase the capital, and remarked that if Messrs. Aldred, the auditors, had exercised that care and strictness which they might have done the shareholders would not now be in their present unfortunate position. The Board had every confidence in their late chairman. The auditors had last year, six days before the annual meeting, sent in a supplementary report recommending an immediate increase of capital, but immediately on its receipt, and before it was even read by the secretary, it was taken away by Mr. Bruce, who never communicated its purport to the directors or secretary. He estimated that after increasing the capital of the general undertaking and providing for all existing additional charges, the amount available for dividend would be £2,447, which represented 3 per cent. on preference shares and left a small balance. As to the separate undertaking, he estimated £12,000 would be required to pay all charges, and that shareholders could expect nothing. He considered the prospects of the company were hopeful.

Mr. YOUNG, the late secretary, said he had resigned in 1898 on account of the friction with the directors. He had frequently urged lower dividends and a depreciation, but got no support. The position of the company in February, 1893, was so weak that the Board passed a resolution to include in the revenue accounts as profit £6,000 said to be a portion of the profits made on the purchase of the engines, &c., for Laxey to Ramsey tramway, and the auditors agreed that this was a perfectly legitimate course. He protested, and the matter was so strained that he tendered his resignation as secretary and called in the aid of the legal advisers of the company, with the result that the resolution previously passed was rescinded, and the dividend from that balance-sheet was reduced by 1 per cent. Notwithstanding this, at the Board meeting in September, 1898, a dividend at the rate of 7½ per cent. was declared. On the chairman announcing that a profit of £10,000 had so far been made on the construction and equipment of the Ramsey line, he (Mr. Young) was dumbfounded. The dividend warrants were sent out, and his notice of resignation was sent to the chairman at the same time.

The CHAIRMAN moved the adoption of the report and balance-sheet.

Mr. MITCHELL ECCLES opposed the motion, and declared that in the face of Messrs. Turquand, Youngs and Co.'s report the meeting would not accept the balance-sheet before them.

The CHAIRMAN suggested the appointment of a committee of investigation representative of the shareholders and creditors. This course was agreed to, and the meeting adjourned to June 15th.

Telegraph Manufacturing Co. (Ltd.).

The directors' report for year ended March 31, 1900, states that the profit on the year's working was £41,284. 0s. 2d., which, with the amount from last year (£5,161. 15s. 3d.) amounted to £46,445. 15s. 5d. From this sum the managing director's salary (including a special grant to him of £1,000) and the directors' fees, amounting in all to £2,400, the preference dividend for the year, £4,833. 6s. 8d., and the interim dividend paid in December, £3,000, have to be deducted, and after placing to depreciation account £3,887. and to reserve £17,500, there remains a balance of £14,825. 8s. 9d., which the directors recommend shall be dealt with as follows: In payment of a further dividend at the rate of 14 per cent. per annum for the half-year (7s. per share), and a bonus of 2 per cent. (2s. per share), both tax free, being in all at the rate of 12 per cent. for the year, and that the balance, £5,825. 8s. 9d., be carried forward. During the period the works have been fully employed, and to meet the increasing trade large extensions have been made, and are still in progress, in consequence of which the directors will submit a resolution proposing that the capital of the company be increased by the creation of 20,000 additional ordinary shares of £5 each. The shares are to be offered, in the first instance, to the ordinary shareholders.

REUTER'S TELEGRAM CO. (LTD.)—The annual meeting of this company was held on Wednesday. The chairman (Admiral Sir J. C. D. Hay) said the year 1899 was an eventful one from the standpoint of a newsagency. At present they had 30 special correspondents engaged at the seat of war in South Africa. If they had not on all occasions given such an efficient service as could have been wished, the fault must be attributed partly to the restrictions imposed by the military censors and partly to the strain thrown both on the South African land lines and cables by the enormous number of messages which had had to be telegraphed. On many occasions, particularly at Ladysmith, runners failed to get through with despatches, having either been captured or killed by the enemy. Despite occasional shortcomings, the company's telegrams appeared, on the whole, to have given satisfaction to the Press, particularly by their uniform accuracy. The report was adopted, and a dividend of 5 per cent. declared.

RUSTON, PROCTOR, AND CO. (LTD.)—Col. G. M. Hutton, C.B., presiding over the annual meeting on Wednesday and said the policy inaugurated by the directors of keeping pace with the times in regard to plant and tools had been continued during the past year, the total outlay under that head being £20,521. 5s. 1d. The introduction of complete telephonic communication with the woodworks had been borne out of revenue. The stock in trade at Lincoln and abroad amounted to £248,836, and at the same period of 1899 was £289,000. The actual profit for the year was £48,159, against £45,674 in 1899, an an increase of £2,484. After allowance for depreciation and other items there was £28,659 left, which it was recommended should be disposed of by payment of a dividend of 7 per cent. for the year (absorbing £17,500), transferring to equalisation account £10,000, and carrying forward £1,115.—At an extraordinary meeting the chairman explained that it was necessary to extend the company's works and premises, and the directors had come to the conclusion that the most satisfactory way of dealing with the matter would be to issue 10,000 shares of £10, at a premium of £1 per share to the present shareholders. A resolution to this effect was adopted.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH ELECTRIC PLANT CO. (LTD.)—This company was registered in Edinburgh on May 26, with a capital of £100,000 in £10 shares, to carry on the business of electrical and general engineers, electric plant manufacturers, machinists, founders, &c. The subscribers, with one share each, are: J. G. Stewart, T. Lander, Wilfred Z. Spence, W. Dick, W. Tod, J. Allen, and J. Mackenzie. The first directors are: J. G. Stewart, T. Lander, W. Dick, and Wilfred Spence.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—This company was registered on May 26, with a capital of £200,000 in £1 shares, to carry on in Victoria (Australia) or elsewhere, the business of electricians, electrical and mechanical engineers, suppliers of electricity, makers of electrical appliances, contractors, &c.

WILLIAM M'GEOCH AND CO. (LTD.)—This company has been registered in Edinburgh, with a capital of £100,000, in £1 shares, to acquire and carry on the business of manufacturers of and dealers in electric light fittings, ironmongers, &c., hitherto carried on by Messrs. W. M'Geoch and Co. in Glasgow, Birmingham, and London.

MELDRUM BROS. (LTD.)—This company was registered on May 12, with a capital of £125,000 in £1 shares, to acquire the business of Meldrum Bros., and to carry on the business of mechanical engineers, furnace makers, electrical engineers, manufacturers of mechanical stokers, &c. The first directors are J. J. Meldrum (chairman), T. F. Meldrum, and J. W. Meldrum.

STAINES AND EGHAM LIGHT RAILWAY CO. (LTD.)—This company was registered on May 19, with a capital of £1,000 in £1 shares, to construct, maintain and control light and other railways and tramways, to supply electrical and other power, and to carry on the business of engineers, electricians, &c.

WEAR ELECTRICAL ENGINEERING CO. (LTD.).—This company was registered on May 25, with a capital of £5,000 in £1 shares, to carry on the business of electricians, electrical engineers, manufacturers of electrical apparatus and appliances, mechanical engineers, &c. The subscribers, with one share each, are:—J. G. Kirtley, G. W. Bain, T. Harrison, W. Burns, F. J. Trewhitt, T. S. Roden, and A. White, electrical engineer; the first directors are: , J. G. Kirtley, G. W. Bain, T. Harrison, W. Burns, and F. J. Trewhitt.

CITY NOTES.

MEMORANDA.—Bank rate 3½ per cent. (since May 24, 1900). Price of silver 27 5/16d. per oz. (May 31). Consols (2¾ per cent.) 102⅞—103 for money, 103—103⅛ for account; 2½ per cent. 99½—100 (May 31). Stock Exchange Settling Day: Consols, June 1; Stocks and Shares Continuation Days, June 12 and 26; Ticket Days, June 13 and 27; Pay Day, June 14; Mining Share Carry-over Days, June 11 and 25.

CITY AND SOUTH LONDON RAILWAY CO. (LTD.)—A special meeting of shareholders will be held on the 12th inst. for considering and approving the Baker-street and Waterloo Railway Bill.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—Letters of allotment in connection with the recent issue to shareholders of the balance 50,000 shares have been posted.

ELECTRICAL JOINT STOCK DEVELOPMENT IN ITALY.—In 1899 114 new companies were registered in Italy, with a capital of £9,040,000, against 66 companies in 1898 and a capital of £3,680,000. In 1896-97 the capital of new companies only amounted to £1,600,000 in the two years. This total for the four years of £14,320,000 is, in the main, represented by the great development of electrical enterprise in Italy. There can be no doubt this country has an important industrial future before her, and that she offers a productive field for foreign capital and energy judiciously employed and directed. The greater portion of foreign capital at present invested in Italian industry, which now represents a very large sum, is German and Swiss.

IMPROVED ELECTRIC GLOW LAMP CO. (LTD.)—A private meeting of this company was held yesterday (Thursday) at Cannon-street Hotel, London.

ROLLER BEARINGS CO. (LTD.)—The committee of shareholders appointed on April 26 to confer with the directors as to the present position and possible future of this company recommends a reconstruction.

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The company was formed in 1896 with a capital of £150,000 in 6 per cent. cumulative preference and ordinary shares. The prospectus profits were estimated at the rate of 10 per cent. per annum on the ordinary shares after the payment of preference dividends. The public subscribed for rather less than one-fourth of the issue. The purchase price of the patents acquired by the company was £91,000, £15,500 in cash, £37,500 in preference, and £38,000 in ordinary shares. The small amount of working capital subscribed by the public speedily decreased, and the company's operations, unless further working capital is now provided, must apparently cease. A loss was incurred on the first year's trading of £1,865, on the second year £2,310, and the total trading loss to September last was £8,560. Other losses increase this total to over £10,000, and neither preference nor ordinary dividend has ever been paid. The chief reasons assigned for this condition of affairs is (*a*) that the cost of management has been altogether disproportionate to the amount of business done by the company, and (*b*) that heavy expenses have been incurred in connection with "unsuccessful experimental bearings." This is, briefly, the state of affairs which the shareholders were called upon to discuss at the meeting held on Wednesday at the Westminster Palace Hotel. A circular which has been issued to the shareholders justifying the appeal for further working capital states that "better material and better workmanship are needed in manufacturing the roller bearings," for which it is believed that "for certain purposes, notably electric traction, there is a good prospect of profitable business in the future." The shareholders are invited in order to obviate the company going into liquidation, to make all shares of the same class by (1) abandoning all preference and all arrears of dividend; (2) making an absolute transfer of one quarter of the shares in favour of a trustee, such trust shares to be utilised for the purpose of placing £5,000 of debentures; (3) creating £5,000 first mortgage debentures of £5 or £10 each, bearing interest at 5 per cent. per annum, each subscriber for the debentures to receive out of the shares surrendered as mentioned five bonus shares for each £1 subscribed in cash. £5,000 is the minimum which, it is urged, would justify the directors in proceeding with the scheme. Truly a novel and drastic proposal.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has been asked to appoint a special settling day in 180,000 vendors' £1 fully-paid ordinary shares (Nos. 1 to 180,000) and 25,000 vendors' 7 per cent. non-cumulative £1 fully-paid preference shares (Nos. 115,001 to 140,000) of *Nernst Electric Light (Ltd.)*.

TELEGRAPH MANUFACTURING CO. (LTD.)—Notice is given that the ordinary general meeting of this company will be held at the Law Institution Rooms, Cook-street, Liverpool, to-day (Friday), June 1, at 3 p.m. After the ordinary meeting a resolution will be proposed for increasing the capital of the company to £300,000 by the creation of 20,000 additional shares of £5 each. The transfer books are closed from May 25th to June 9th inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways	May 26	4,555	+ 46	20	86,724	+ 4,460
Blackpool Corporation..	„ 24	353	- 475	8	2,815	+ 40
Blackpool and Fleetwood	„ 26	413	- 1,022	21	5,523	- 960
Bolton Corporation	„ 27	1,362	...	8	9,390	...
Bradford Corporation...	„ 27	527	- 17	8	3,670	+ 727
Brisbane Trams	Apl. 11	1,831	+ 541	2	3,491	+ 851
*Bristol Trams & Carriage	May 25	3,169	- 648	21	57,703	+ 1,155
*Buenos Ayres & Belgrano	Apl. 29	2,209	- 75	17	33,982	+ 5,228
City & South London Ry	May 27	1,355	+ 443	21	26,319	+ 4,085
Dover Corporation	„ 26	207	- 7	8	1,533	+ 119
Dublin United	„ 25	3,550	- 73	21	68,066	+12,771
Dublin Southern Dist...	„ 25	823	- 233	21	16,474	
*Glasgow Corporation ...	„ 26	9,624	+ 519	...	...	...
*Liverpool Corporation...	„ 19	7,882	+1,255	20	139,350	+17,833
Liverpool Overhead Rly	„ 27	1,429	- 396	21	29,657	+ 809
*Sheffield Tramways	„ 27	2,321	+ 659	21	41,002	+13,808
*South Staffs. Trams.....	„ 25	711	- 237	21	13,640	+ 375

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 23.		Price Wednesday, May 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 30.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£110,000	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 17 4	January and July	106⅜	...
26,000	10	...	Amazon Telegraph	...		...		...	June and December	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£323,720	Stock	15/0	Anglo-American	62	65	62	65	5 12 8	Feb., May, Aug., Nov.	64½	63
£3,088,640	Stock	20/0	Do. Preferred	114½	115½	114½	115½	5 4 5	„ „	116⅛	114
£3,088,640	Stock	27/0	Do. Deferred	13⅞	14⅛	13⅞	14⅛	9 9 6	„ „	14	13⅞
$13,333,200	$100	$1⅛	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,559,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	103	104	3 17 0	„ „	103½	102⅝
16,000	10	6/0	Cuba Submarine Ordinary	7⅛	8⅛	7	8	8 15 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	17	18	16	17	5 17 8	„ „	16	...
12,981	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£80,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞	105⅞	101⅞	105⅞	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11⅛	12	11⅛	12	5 16 8	Jan., Apr., July, Oct.	12	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100	103	101	103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150	155	150	155	4 10 4	Jan., Apr., July, Oct.	153⅜	151
£1,926,858	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	97	100	3 10 3	„ „	99¾	98
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111	116	111	116	3 9 0	May and November	114	...
250,000	10	6/6	Eastern Extension	15⅝	16⅛	15⅛	16	4 7 6	Jan., Apr., July, Oct.	16⅜	15⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112	117	112	117	3 9 2	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.)	100	103	100	103	4 17 1	January and July	...	...
£35,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100	103	100	103	3 18 5	February and August	103½	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100⅞	103⅞	103⅞	103⅞	3 17 8	May and November	...	...
120,227	10	2/6	Globe Telegraph and Trust	11⅛	11⅜	11⅛	11⅜	4 9 4	Jan., Apr., July, Oct.	11⅛	1⅜
120,042	10	3/0	Do. 6 per Cent. Preference	15⅛	15⅜	15⅛	15⅜	3 16 2	„ „	15⅜	15⅛
150,000	10	15/0	Great Northern of Copenhagen	32	34	32	34	3 13 6	January and July	33⅛	33⅛
£286,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100	103	100	104	4 8 0	June and December	...	...
17,000	25	37/6	Indo-European	53	57	53	57	4 7 9	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	105	108	105	108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102	105	102	105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7⅛	8⅛	7⅛	8⅛	4 14 1	April and October	...	...
2,381	£100 Cert.	6%	Submarine Cables Trust	128	129	124	129	4 13 0	„ „	...	...
15,000	10	...	West African Telegraph	2⅛	3⅛	2⅛	3⅛	4 9 3	December and July	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97	100	97	100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	⅛	1	⅛	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 14 7	January and July	...	...
88,231	10	6d.	West India and Panama	¾	1	¾	1	...	May and November	⅞	⅞
34,553	10	6/0	Do. 6 per Cent. 1st Preference	9	9½	7	8	7 10 0	„ „	7¼	7⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	6½	7½	8 0 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	106	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	102	105	102	105	3 17 4	June and December	...	...
207,980	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜	15½	14⅜	15½	4 11 10	Mar., June, Oct., Dec.	15⅛	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105	108	105	108	4 13 10	June and December	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2½	3½	2½	3½	4 5 9	August	...	...
324,850	10/)	1½d.	Consolidated Telephone Con. and Manfg.	...		...		...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛	¼	⅛	¼	5 0 0	November	...	...
86,402	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
490,000	5	3/0	National	4⅜	5⅛	4⅜	5⅛	5 17 1	February and August	5	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13	15	13	14	4 5 9	„ „	12½	12⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11	13	11	13	4 12 4	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5	5½	5	5½	4 15 3	„ „	5⅛	5
3,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	98	98	101	3 10 3	June and December	99⅜	97½
171,504	1	0/3	Oriental	1⅛	1⅛	1⅛	1⅛	4 14 1	April and October	1	...
58,000	5	2/6	United River Plate	4⅜	5⅛	4⅜	5⅛	7 2 10	July	...	...
16,689	5	1/4	Do. 5% Cumulative Preference	4⅜	5⅛	4⅜	5⅛	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, May 23.		Price Wednesday, May 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 30.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	⅞	⅞	⅞	...	...	...	...
6,000	10	10 0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	8½	8½
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7	7½	7	7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	8½	9½	8½	9½	4 14 9	February and August	9⅛	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	5¾	5⅞
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6½	7½	6½	7½	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	103	111	103	111	4 2 2	June and December	100½	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	10	11	9½	10½	3 16 2	February and August	10	9¼
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 12 4	January and July	12¾	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	3 15 2	...	9½	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	13	11½	12½	4 16 0	March and September	12½	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109	112	110	113	4 1 1	...	112	111½
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7½	7	7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1½	2	1½	2	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	4⅝	4½
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100	103	100	102	3 19 3	Mar., June, Sept., Dec.	100	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½	14½	13½	14½	3 9 0	April and October	13½	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	2¼/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93	93	93	93	3 11 10	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March	16½	...
10,000	5	5/0	Oxford Electric Ordinary	6½	7	6½	7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	¾	¾	¾	¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	170	190	170	190	4 4 2	April and October	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15⅝	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85	90	85	95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	4 3 10	March and September	15½	14⅞
			ELECTRIC MANUFACTURING &c. COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾	⅞	¾	⅞	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅞	1	⅞	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16	1/8	1/16	1/8	...	...	...	...
£250,000	100	4½%	Do. First Mortgage Debentures	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6	6½	6	6½	4 12 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅝	5⅛	4⅝	5⅛	...	...	...	...
90,060	2	1/2⅝	Brush Electrical Engineering	1⅝	2	1⅝	2	4 0 0	September	1⅝	1⅝
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cum.	2	2⅛	2	2⅛	5 6 8	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103	113	103	113	3 19 8	February and August	...	...
£103,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103	105	103	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½	15½	14½	15½	4 16 9	,, ,,	15½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	,, ,,	5¾	5½
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112	116	112	116	3 18 5	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 18 5	...	1⅜	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝	1⅛	¾	1⅛	5 6 8	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½	4	3½	4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100	103	100	103	4 19 0	,, ,,	103	101
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½	4½	3½	4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4½	5	4½	5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101	104	101	104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2	2¼	2	2½	5 6 8	January and July	2½	2⅛
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½	3¼	2½	3¼	4 6 2	July	3⅛	2⅝
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	103	103	103	3 16 2	January and July	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½	14½	13½	14½	3 15 10	February and August	13¾	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5½	5¾	5½	5¾	3 18 3	,, ,,	5⅞	5¾
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	2 ⅛	21½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 17 6	March and September	...	...
37,350	12	2/0	Telegraph Construction and Maintenance	34	38	34	38	4 14 6	March and July	36½	34⅜
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	11½	12½	11½	12½	2 16 0	...	12⅛	12
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	11½	12½	11½	12½	4 16 0	April and October	12⅝	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 7	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	105	104	106	4 0 2	May and November	105	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½	18½	17½	18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102	104	102	104	4 16 2	...	...	...
50,000	10	8½	Bristol Tramways and Carriage Ordinary	22½	23½	22½	23½	3 3 10	February and August	...	...
25,000	10	4½	Do. Cumulative Preference (£3 paid)	8½	8½	8½	8½	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 8 5	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10¼	10¾	10¼	10¾	4 13 0	May and November	10¾	10⅜
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15⅜	15½	15⅜	15½	3 12 9	...	16½	...
15,000	10	...	Do. (Nos. 60,001 to 75,000)	15½	16½	15½	16½	...	...	15⅝	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12	13	12	13	4 12 4	February and August	12⅝	12⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	...	...
40,000	5	2/8 5/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5	5½	5	5½	5 14 4	...	...	...
27,500	5	...	Do. "B"	4	4½	4	4½	...	...	4⅜	...
£120,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	103	105	4 16 5	...	104	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk. Prov. Certs. (£57½% to be p.d.)	37	40	37	40	...	...	105	...
208,040	10	3/0	Central London Ordinary	10	10½	10	10½	2 17 2	June and December	10½	10½
£355,000	Stock	1½%	City and South London Railway Con. Ordinary	61	64	61	64	2 13 7	February and August	63½	63
370,500	10	1/5 1/5	Do. (Nos. 22,501 to 60,000)	5½	6½	5½	6½	2 5 4	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	,, ,,	...	...
£200,000	Stock	5%	Do. (1898)	132	137	132	137	3 13 8	...	...	...
£114,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123	123	123	123	3 2 6	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½	23½	22½	23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	,, ,,	...	...
£390,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tramway and Elec. Power Ord.	¼	⅜	¼	⅜	13 4 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16	⅛	1/16	⅛	16 0 0	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅜	10½	9⅜	10⅜	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9	9½	9 1/16	9 1/16	4 0 8	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½	13⅝	13½	13⅝	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 15 8	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
130,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4¾	5½	4¾	5½	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜	10½	10⅜	10½	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½	12½	11½	12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9½	10½	4 15 3	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100	103	101	104	2 18 3	June and December	101	100

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,151. [No. 7, Vol. XLV.] FRIDAY, JUNE 8, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents, or 80/r., or 70pf.

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NOTES.

WE publish in another column an interesting Paper by Mr. C. W. SCHAEFER on "Simultaneous Testing as applied to Fault Localisation in Submarine Cables," in which he gives some practical examples of the method suggested by him in a previous article contributed to *The Electrician*, Vol. XL., p. 17. Although there is no claim to originality in his communication as regards the theory of fault-testing, the method he employs is strikingly simple and accurate, and undoubtedly reduces the liability to personal error or that due to a want of manipulative skill in the observer. The facts themselves, however, are all well known to those employed in this kind of work, and Mr. SCHAEFER'S method would seem to be simply a novel way of applying them. Thus, an ordinary bridge reading to "false zero" gives $x + \frac{fy}{f+y}$, where x and y are the resistances on either side of the fault and f the resistance of the fault itself. By observing the ratios of the two currents the ratio of f to y is obtained, which is all that is necessary.

Mr. SCHAEFER is quite right in insisting upon the importance of simultaneous observations; and it is principally, we understand, for this reason that the majority of cable-repairing steamers are now provided with dead-beat galvanometers, which by enabling observers to obtain readings in rapid sequence, are almost equivalent in value for localisation purposes to simultaneous observations. With such variable faults, however, as those described in Mr. SCHAEFER'S Paper—one of which is peculiarly interesting—absolute simultaneity is imperative if results are to be comparable, and it is doubtful if any other method than the one described would have been equally successful in the circumstances. For a long time difficult high resistance faults were usually localised by the "fall of potential" test, or the bridge modification of it. This is, of course, a simultaneous method, potentials being observed instead of currents, but it has now been almost universally superseded by the "earth overlap" test, partly on account of the latter's simplicity. The results obtained by the potential test were always very variable owing to the difficulty in estimating and correcting for the E.M.F. set up at the fault, and it is probable that the error due to this cause is less when measuring currents than when observing potentials—a view which is borne out by the fact that in general practice observations obtained with the distant end of the cable earthed are invariably steadier and more reliable than those measured with the cable end free. It is for this reason also that the "earth overlap" method is so undoubtedly superior to the "overlap free," although theoretically they should be equally accurate.

THERE can be no doubt that the subject of fault localisation is one of extreme importance, especially to submarine cable companies, in whose repair work a mistake in the calculation of the distance of a fault may mean the unnecessary expenditure of costly cable, and therefore any suggested improvement upon existing methods of testing should be especially welcomed and recognised by them. The value of articles, describing, as does Mr. SCHAEFER'S, not only the methods, but the actual tests cannot be over-estimated.

DR. PETERS comments in No. 9 of the *Centralblatt für Accumulatoren und Elementenkunde* on Mr. WADE'S Paper on "Storage Battery Problems." He states that in a series of experiments on positive active material—the results of which have already appeared in *The Electrician*, May 18, p. 186—he found that, when it was in a healthy, good condition, it possessed a density of 7·55 to 7·65, which fell to between 7·02 and 6·48 when the paste on the plates had become softened through being long in use. Dr. PETERS further notes that as it is a hydrated peroxide of lead which is formed in the cell, and one whose density has not yet been determined, it is not safe to make any deductions based on the density of the material as compared with that of pure peroxide of lead, in which the hydration of the electrolytic peroxide is not

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taken into account. It will be remembered that as long ago as 1887 Mr. DESMOND G. FITZGERALD advocated in *The Electrician* the theory that electrolytic peroxide of lead is either itself hydrated or is admixed with an hydroxide, but the difficulties in the way of experimental proof are very great, and until the recent publication of Dr. PETERS' analyses there have been practically no data bearing on the question to which much weight could be attached.

REVERTING again to Mr. WADE'S Paper, Dr. PETERS, in the following number of the *Centralblatt*, says that too little importance has been attached to the part which persulphuric acid plays in the formation of the active material. In order to investigate this he proposes to place a layer of lead oxide on the bottom of the cell, in which persulphuric acid will be formed by electrolysis, care being taken to raise the anode sufficiently high to prevent contact between it and the lead oxide, and to allow of the free escape of gas; or, in lieu of this, he suggests enclosing the lead oxide between two diaphragms. With reference to the function of persulphuric acid in the cell, we would remind Dr. PETERS that Dr. ARMSTRONG stated in the discussion on Mr. WADE'S Paper that he was at present pursuing research on persulphuric acid, to the presence of which in the cell he and Mr. ROBERTSON were the first to draw attention in a joint communication to the Royal Society in June, 1891 (see *The Electrician*, Vol. XXVII., p. 196).

A recent number of *Science*, of New York, discusses the researches of Prof. CHILD on the phenomena of the electric arc. Prof. CHILD has applied the theory of ionic dissociation to this phenomena, and he explains on this hypothesis the well-known curve, obtained by Mrs. AYRTON, representing the fall of potential between the carbons. According to this hypothesis the curvature at each point in Mrs. AYRTON'S curve represents the density of the charge at each point, and this explanation of the curve is said to be sufficient to settle the extremely perplexing question of the existence of a counter E.M.F. within the carbon arc. Thus it is explained that the work done by the current against the alleged counter E.M.F. is the result of the transference or movement of freshly dissociated ions along the path of the arc, the positive ions having to be pushed up by the impressed E.M.F. into the region of highly positive ions, and the negative ions having to be pulled down, as it were, into the region of highly negatively-charged ions. This explanation is beyond question ingenious, but it can only be held to settle the hypothesis of a counter E.M.F. by substituting a different phraseology for what is practically an identical phenomenon. Prof. CHILD'S conception of the work done in moving ions along a path through a definitely mapped out region of potentials is, in fact, nothing more than another way of conceiving a counter E.M.F. Such an E.M.F. be it observed, is under no necessity to be found at any one particular point in that path, since it is equally a counter E.M.F. when it represents the line integral of the work done in moving a charge along any path where it encounters opposing electric force.

AT the annual general meeting of the American Institute of Electrical Engineers held in Philadelphia last month, Dr. M. I. PUPIN read a Paper on "Telephony over Cables and Long-Distance Air Lines," which, from the reports published so far in our American contemporaries, appears to be of considerable importance. Dr. PUPIN is a follower of OLIVER HEAVISIDE, and has been directing his attention to the question of a practical approximation to a distortionless circuit for the purpose of telephoning through cables or over long distances. He starts with HEAVISIDE'S result that it is advantageous to distribute inductance along the length of the cable, and, referring to the difficulty of obtaining sufficiently high inductances uniformly distributed throughout the line, he proceeds to discuss mathematically what is the least subdivision necessary to obtain good results. This part of the Paper is, however, not reproduced in the abstracts before us, and we reserve our comment on it until we have received the complete text.

IT was the second part of the Paper, in which actual experiments are recorded, that aroused most interest at the meeting. An artificial line was made up, consisting of 250 sections having resistance and capacity, and between these sections inductance coils could be connected. Without the inductance coils, transmission was "good" through 50 sections, "fair" through 75 sections, and "impracticable" through 100 sections. With the inductance coils connected between the sections, conversation could easily be carried on through all the 250 sections, the articulation being clear.

THESE results are worthy of careful consideration, but it will be necessary to have further numerical details as to the relative values of the four line constants, resistance, capacity, insulation, and inductance, and also to know the actual local circumstance of the experiments, before definite conclusions can be drawn as to their practical applicability. For instance, the distance in feet as well as the distance in ohms between the inductance coils will have a bearing on the test, for in the extreme case of the coils being too near to one another all the energy might be simply transmitted by induction from the first coil to the last, the capacity of the cable being perhaps sufficient to prevent the interference of the current waves transmitted by conduction. We have a dim recollection of a successful experiment, carried out several years ago, of telephoning through a long cable coiled up in a tank at a cable factory. On this occasion, however, congratulations were interrupted by the discovery that the two ends of the cable to which the telephones were connected did not belong to the same piece. We do not wish to suggest that Dr. PUPIN has not taken every precaution to preserve the required experimental conditions in his test, including the avoidance of inductive short-circuits of this nature; but, nevertheless, it is safer to await the receipt of his actual Paper before regarding the results mentioned above as absolutely conclusive.

French Academy of Sciences.—M. Darboux has been elected permanent secretary for the mathematical science sections of the French Academy of Sciences, in place of the late M. Bertrand.

Canadian Electrical Association.—Owing to the recent disastrous fire at Ottawa the meeting of the next Convention cannot be held in that city as intended. A new meeting-place has not yet been decided upon.

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University College of North Wales, Bangor.—Prof. E. Taylor Jones will begin in October next a systematic course of instruction in electrical measurement and practical electricity. The physical laboratory at the college is fully equipped with plant and apparatus for the study of all branches of practical engineering. Further particulars are given in an advertisement.

Wireless Telegraphy in the French Navy.—The French Government have decided to equip the whole of their Mediterranean squadron with wireless telegraphy installations. Demonstrations made between the Government vessel "Utile" and the coast forts showed that communications could be successfully maintained between ship and shore at distances of 60 miles between them.

City and Guilds of London Institute.—The session 1900 1901 of this Institute's Central Technical College, Exhibition-road, and the Technical College, Finsbury, commences in October. The entrance examinations to both colleges are held in September. Some further particulars are given in an advertisement, and all information can be obtained from the colleges or from the head office, Gresham College, Basinghall-street, E.C.

Cable Interruptions:—

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
San Thomé—Loanda	May 20, 1900
Durban—Delagoa Bay	May 31, 1900

Extraction of Indiarubber.—A somewhat novel process for the extraction of indiarubber from the tree was recently described in a Paper before the French Society of Civil Engineers. The bark and roots are cut up and soaked in dilute sulphuric acid, and the effect of this is to decompose the woody portions without affecting the indiarubber. A division is thus made between the valuable rubber and the rest of the bark and roots, and it is claimed that the rubber so produced is quite pure. The author stated that 1lb. of indiarubber could thus be produced at a cost of about 2½d.

Personal.—At a meeting of the Court of Governors of the Victoria University, held on the 31st ult., the following names were submitted by the Committee of Honorary Degrees to receive the honorary degree of Doctor of Science: Lord Rayleigh, Sir W. Abney, Prof. A. Michelson (University of Chicago), Prof. H. A. Rowland (Johns Hopkins University), Prof. E. Pickering (Harvard), Prof. J. J. Thomson, Dr. T. E. Thorpe, Mr. Henry Wilde, Prof. Dewar, Sir William Huggins, Sir W. C. Roberts-Austen, Mr. R. T. Glazebrook, and Mr. A. R. Forsyth.——Mr. R. L. Wilberforce, of Trinity College, has been elected to the Cambridge University Lectureship in Experimental Science, formerly held by Mr. W. N. Shaw, F.R.S.

Verband Deutscher Elektrotechniker.—Among the Papers already announced to be read at the annual general meeting of this association, which will be held at Kiel from the 17th to 20th June, are the following: "On the Influence of the Curve-Form of Alternate Current on Iron Losses," by Dr. G. Benischke; two Papers on fire alarms, by Freiherr C. von Moltke and Herr E. Anshagen; "Rail Welding by the Process of Producing High Temperatures by Means of Burning Aluminium," by Dr. Hans Goldschmidt; "Directibility of Apparatus for Wave Telegraphy," by Dr. R. Blochmann, and "The New Bremer System of Electric Light," by Dr. Wedding.

Proposed Memorial to the late Mr. G. J. Symons, F.R.S.—At a meeting of the Royal Meteorological Society held on May 31, it was unanimously resolved that a memorial to the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist and founder of the British Rainfall Organisation, be formed. This memorial was to take the form of a gold medal, to be awarded from time to time by the Council of the Royal Meteorological Society for distinguished work in connection with meteorological science. An executive committee, containing representatives from many of the societies with which Mr. Symons was associated, was constituted to raise funds for this purpose. Contributions will be received by the assistant-secretary, Mr. W. Marriott, 70, Victoria-street, Westminster, S.W.

A Selector System of Wireless Telegraphy.—Messrs. B. S. Cohen and P. H. Cole have recently devised an ingenious selector system for working a number of wireless telegraph stations. After various experiments in this direction the inventors patented a method of synchronising the stations by means of falling mercury drops. The system is described in patent No. 5543[99]. The main or master station sends out successive waves at equal intervals of time, these waves actuating an electromagnet device whereby a mercury drop is liberated simultaneously at all the stations. In its descent each drop passes a number of contacts, closing the message circuits. Thus when a signal wave is sent out at any one station, it is received only by that station in which the receiving circuit is simultaneously closed by the falling mercury drop. To effect this, of course, the stations are connected in rotation to the contacts in the path of the mercury drops. We trust that the inventors will carry their investigations further and develop the system on a larger and more practical scale; for whatever the difficulties may be, there can be little doubt a good selector system would be welcomed by wireless telegraphists.

Patent Office Reforms.—We referred last week in our leading article to the appointment of a committee under the chairmanship of Sir E. Fry to deal with the subject of amending patent procedure. We also gave the text of the reference to this committee. Another departmental committee, presided over by Mr. F. J. S. Hopwood, of the Board of Trade, has completed its investigation into the subject, and has already made a report. As a result of the recommendations of this committee, certain modifications in Patent Office procedure have already been introduced. Among these are the following:—First: It is to be arranged that deposit accounts can be opened with the Patent Office for the supply of Patent Office publications. This will obviate the sending of small sums with each separate order and will also do away with the use of the 8d. postcard which was introduced some time ago, but has not been found altogether satisfactory. Second: It has been decided to reprint some of the specifications which are out of print. It is, however, impracticable to reprint the entire 8,900 specifications which are at present unavailable owing to being out of print. The committee recommend that any specification out of print should be reprinted on the applicant guaranteeing to take not less than six copies at 8d. each. It is further recommended that illustrated abridgments of all the specifications between the years 1617 and 1883 should be published. Another matter raised in the report of this committee, which is about to be published, is the question of notifying patentees of the impending expiration of patents. This recommendation, however, appears to be opposed by the majority of patent agents on the ground that the work of reminding patentees is far better carried out by the patent agent himself. We believe that no decision has yet been arrived at by the Patent Office with regard to this last proposed reform.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, June 8th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Magnetic Properties of Iron and Aluminium Alloys, Part II.," by Dr. S. W. Richardson; (2) "Note on Crystallisation Produced in Solid Metal by Pressure," by W. Campbell; (3) "On the Viscosity of Mixtures of Liquids and of Solutions," by Dr. C. H. Lees.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "The Effect of Physical Agents on Bacterial Life," by Allan Macfadyen.

MONDAY, June 11th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7.30 p.m. Ordinary Meeting at the Royal United Service Institution, when a Paper on "Notes on Electric Traction," by A. H. Binyon, will be read.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Penetration of Radium Rays.—H. Becquerel has shown that the transmission of radium radiation across a screen is attended by several distinct phenomena: selective absorption, diffusion, emission of secondary rays, some of which are deflected by a magnet, while others are not; and, finally, a direct transmission of part of the radiation from the source. The transmitted portion appears to be identical with the incident radiation, and suffers the same deflection by a magnetic field. This identity has been doubted by Villard on the ground of some experiments, which seemed to show that the transmitted beam consists of rays which are not deflected by a magnet, while the deflected rays behave like cathode rays, and emerge at right angles to the absorbing surface. Becquerel has therefore repeated his experiments in a modified form. He employed a linear source of radium rays, consisting of a lead block with a furrow containing a radium preparation. A copper wire was placed a few millimetres above the furrow and parallel to it. Above that again was placed a sensitive plate wrapped in black paper, and the shadow cast by the copper was photographed with and without a magnetic field. Under the influence of the latter, with its lines of force parallel to the copper wire, the rays describe circular arcs of slight curvature, and by reversing the field two shadows may be obtained which are displaced with respect to each other. When a sheet of aluminium is introduced, either above or below the copper, these two images are obtained in the same manner, showing that the rays transmitted by the sheet are also deflected by a magnet. Villard's contrary result is probably due to a peculiar effect of the edge of the screen, which has been fully accounted for by the author.

[H. Becquerel, *Comptes Rendus*, April 30, 1900.]

Transient Deflection of Cathode Rays.—In 1896 Jaumann described a peculiar experiment which has not yet been satisfactorily accounted for. He immersed a very highly exhausted vacuum in ordinary vegetable oil. The tube was provided with a single electrode, which served as a cathode, while the anode was outside the tube and in the oil. When the tube was working the approach of a charged glass rod apparently produced a repulsion of the beam of cathode rays and the fluorescent spot produced by it. This repulsion rapidly subsided while the glass rod was held in the same position. When the rod is removed, or when the charge is of the opposite sign, the repulsion becomes an attraction. P. Villard has repeated the experiment and verified the effects as stated, but he does not follow Jaumann in ascribing them to a peculiar property of the cathode rays, such as the "self-stretching" property which the latter connected with his hypothesis of "longitudinal light." The author points out that commercial oils are very poor insulators, whereas true dielectrics have been shown by Bouty to intercept an electrostatic field as effectively as a layer of mercury. Consequently the electrostatic field produced in the interior of the tube by the glass rod outside depends upon the conductivity of the oil, and if the oil takes some time to adjust itself to an external field, there will be an electrostatic process within the oil which may well last a second. Such a process would explain the temporary deflection of the cathode beam described. In confirmation of this explanation the author replaces the cathode beam by a conductor joined through a screened wire with an electroscope outside. A temporary deflection of the electroscope is then observed, corresponding to the deflection of the cathode beam.

[P. Villard, *Comptes Rendus*, April 30, 1900.]

Luminous Effects on Wires.—A metallic wire which is not covered by an insulating layer becomes covered with a luminous aureole when it is inserted in the circuit of an induction coil containing a spark-gap or a vacuum tube. J. Borgman has further invested this phenomenon by means of wires sealed into cylindrical tubes, and traversing their axis. The tubes were several feet long and 3cm. to 6cm. wide. Some of the tubes were traversed by capillary glass tubes containing liquid conductors. As exhaustion proceeds, the luminous phenomena show a peculiar development. The aureole decreases in intensity, and is gradually replaced by a series of equidistant stars, around which luminous discs are formed with their planes at right angles to the wire. The number of stars and discs increases, until the latter touch each other and fill the whole tube with a luminosity having a slightly stratified aspect. These effects are the same whether the tube is attached to the positive or the negative terminal of the secondary. When a spark-gap is inserted in parallel with it, and the wire is attached to the negative terminal, there is only a continuous luminous envelope, which broadens out as exhaustion proceeds and finally detaches itself from the wire. The stars reappear on attaching the wire to the positive terminal, and at a certain pressure the discs reappear also, their diameter increasing with the length of the spark-gap. As exhaustion proceeds, the number of discs decreases, some of them remaining, while others disappear. Finally, they are transformed into nebulæ with a starry nucleus. The approach of a magnet has the effect of inclining the plane of the rings.

[J. Borgman, *Comptes Rendus*, April 30, 1900.]

Velocity of Ions.—The velocity of ions in a gas ionised by Rontgen rays has been determined by Zeleny, Rutherford and others, by first determining the sum of the velocities of the positive and negative ions, and then the ratio of the same velocities. J. Zeleny has now made a direct determination of the velocities in question by balancing them against the velocity of a stream of gas. The gas was made to flow between two concentric cylinders, which were maintained at different potentials. By passing a narrow beam of Rontgen rays through the cylinders at right angles to their length, a narrow layer of ionised gas was produced. Owing to the electric field between the two cylinders, the ions of this layer tended to move radially towards, or away from, the axis of the two cylinders, but at the same time they were carried along by the stream of gas. For obtaining the difference of potential which must be used to allow the ions to be carried a certain distance along the tubes by the gas stream, the inner cylinder was divided at some distance from the beam of rays into two parts insulated from each other. That one of these which was not traversed by the rays was connected to a pair of quadrants of an electrometer, so that it was possible to tell when any ions reached it. The gases studied were air, oxygen, carbonic acid, and hydrogen, both moist and dry. The presence of moisture diminished the velocity, except that of the positive ions in moist air and moist carbonic acid. The ionic velocities obtained range from 0·76 (CO_2) to 8cm. per second (H) in a field of one volt per cm. The negative ion is the faster, except in moist CO_2. But the charge of both is equal, and probably equal to the electrolytic charge of hydrogen.

[J. Zeleny, *Proc. R. Soc.*, April 14, 1900.]

Dual Nature of Radium Rays.—P. Villard describes an instructive experiment which brings out clearly the heterogeneous nature of the rays given out by "radium" preparations. Radium rays are transmitted through a slit in a lead plate, and impinge at nearly grazing incidence upon two sensitive plates laid one over the other and wrapped in black paper. The rays are exposed to a strong magnetic field. It is evident that under these circumstances the upper plate receives rays which have traversed the black paper only, while the lower one receives rays which have traversed in addition the glass and film of the upper plate, and an increasing thickness of both as the angle of incidence increases towards the edge. On development the upper plate shows two impressions—one deviated and spread out, the other feebler, but absolutely rectilinear and sharp. On the lower plate only one impression is visible, that due to the non-deflected rays. The impression is as clear as that on the upper plate, and indeed clearer, if anything, owing to the absence of fog. A prolonged exposure brings out a very feeble indication of the deflected rays. A band of lead 0·3mm. thick, laid across the upper plate, intercepts the deflected rays over its whole width, whereas the rectilinear rays are only weakened. Thus the two classes of rays may be distinguished from each

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other in the region where they are superposed. The author simply calls the two classes of rays X-rays and cathode rays. Taking these names in a wider sense, there seems to be no objection to their use in this manner, especially as there remains no quality which could serve to distinguish the two kinds of radium rays from the two classes of rays obtained from vacuum tubes. But if their identity is finally established, it will be obviously necessary to substitute another name for cathode rays, a cathode not being essential to their generation.

[P. VILLARD, *Comptes Rendus*, April 30 1900.]

Atomic and Molecular Magnetism.—Some further interesting work has been done by S. Meyer on the atomic magnetism of the elements and the manner in which it is affected by the combination of atoms to form molecules. Measurements made with vanadium chloride show that is a somewhat feebly paramagnetic substance of susceptibility about one-quarter of that of nickel. Provisionally, it may be placed at the beginning of the series of susceptibilities of the iron elements discovered by the author, thus

$$V:Ni:Cr:Fe^1:Co:Fe:Mn = \tfrac{1}{2}:2:2\tfrac{1}{2}:3:4:5:6.$$

Studies of gadolinium and samarium make it appear likely that both these metals contain traces of a new substance of very high susceptibility. This new element is revealed in the spectrum, which shows a large number of lines, and this, as we know from the author's researches, invariably indicates a high susceptibility. Special attention was devoted to the salts of copper. Previous work had shown that in some diamagnetic compounds the molecular magnetism shows a greater diamagnetic value than would correspond to the sum of the atomic magnetisms. This happens in every case where the combination is accompanied by a considerable expansion, as in the iodides of silver, mercury and lead. This suggests that the converse might occur in the case of contraction of volume, and for this investigation the salts of copper, with their very small susceptibilities, are specially valuable. Measurements made on a number of copper salts show that there is no fundamental difference between cupric and cuprous salts in Wiedemann's sense, since both the sulphides are equally diamagnetic. But the influence of volume changes is very decided and regular. Volume expansion increases the diamagnetic character of a substance, and contraction emphasises its paramagnetic character. The magnetic properties of the elements can therefore only be deduced from the elements themselves, or from compounds which undergo no change of volume during their formation.

[S. MEYER, *Ann. der Phys.*, No. 4, 1900.]

ELECTROMAGNETIC THEORY.—CXV.*

BY OLIVER HEAVISIDE.

(*Continued from p. 921, Vol. XLIV.*)

§ 463. In Vol. I., § 164, it was shown that a point charge q in steady rectilinear motion along the axis of z, at a speed u, less than v, was associated with the potential

$$V = \frac{q}{4\pi c\{z^2 + \kappa^2(x^2+y^2)\}^{\frac{1}{2}}}, \quad (1)$$

where $\kappa^2 = 1 - u^2/v^2$, a fraction ranging from 1 to 0, as u increases from 0 to v. Here it is to be understood that V is the potential at the point x, y, z when the origin is at the charge, so that V accompanies q in its motion. It is further to be understood that the electric force is derived from the potential in the eolotropic manner specified by

$$\mathbf{E} = -(i\nabla_1 + j\nabla_2 + \kappa^2 k\nabla_3)V. \quad (2)$$

The displacement is obtained by multiplying by c, as usual. The result, as regards the displacement, is therefore the same as if the charge were at rest, but the permittivity in the direction of z both ways were reduced from c to $\kappa^2 c$. This produces a lateral concentration of the displacement, with the ultimate result that when u is increased to v, the displacement is entirely in the equatorial plane, forming an impulsive plane wave with circular magnetic force. In any case, the magnetic force is the vector product of the velocity **u** and the displacement **D**.

The question now to be considered is what occurs when u is greater than v. Are the formulæ still valid? We can see immediately that some reservations are necessary, even though no change of formula may be required. For κ^2 is now negative; and V, and also **E** and **H** are made imaginary when

$$z^2 < \kappa^2(x^2+y^2), \text{ or } z^2 > s^2(x^2+y^2), \quad (3)$$

where

$$s^2 = u^2/v^2 - 1 = \operatorname{cosec}^2\theta - 1 = \cot^2\theta. \quad (4)$$

This means that V is real inside the two cones to right and left of the moving charge whose angles are 2θ, connected with s^2 by equation (4), but unreal in the intermediate region outside the cones. We must certainly reject the unreal V, because this is a matter of physics ultimately, not of possible mathematics. In Vol. II. were numerous formulæ relating to waves which had no existence when they assumed unreal meanings. Certainly it is the same thing here.

But next, seeing that disturbances are propagated only at speed v, whilst the charge q moves at the greater speed u, the locus of the spherical waves sent out by the charge as it moves along forms the *left* conical surface only. So we must reject the right cone altogether, if we are considering a charge brought from rest up to speed u.

So far is rejection without change. But closer consideration will make it probable, if not certain, that a change in the formula is wanted as well. For, assuming that equation (1) is correct when κ^2 is negative, provided we keep to real values,

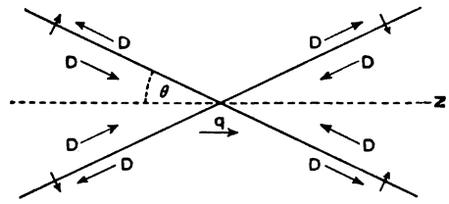

FIG. 23.

it still belongs to both cones. Now it was standardised so as to make the total displacement leaving the charge be q. This was with $u < v$, when the displacement emanated in all directions. As we employ now the same formula, the same property should hold good, keeping to the real values, however. But V is symmetrical. At corresponding points in the two cones V is the same. So the displacement leaving q for the right cone can be only $\frac{1}{2}q$, and similarly for the left cone. The practical meaning is that if we reject the right cone, and still have the charge at the apex of the left cone represented by q, we must double the right side of equation (1). That is to say,

$$V = \frac{q}{2\pi c\{z^2 - s^2(x^2+y^2)\}^{\frac{1}{2}}}. \quad (5)$$

should be the proper solution. Similarly, the right members of the formulæ for **E** and **H**, true when $u < v$, must be doubled when $u > v$. I gave this result in 1892, El. Pa., v. 2, p. 516, footnote, having obtained it by a straightforward operational process, to be given later. It is possible, however, that some readers may find the above reasoning sufficiently convincing. It is plausible enough, but by no means demonstrative, on account of the infinite values concerned, which evade evaluation. There are two ways of corroborating equation (5), viz., to use it to construct a known solution, and to prove it directly from the operational solution. The first way is much the easier.

At any point P inside the cone, we have

$$V = \frac{q}{2\pi c}\frac{\tan\theta}{\{z^2\tan^2\theta - (x^2+y^2)\}^{\frac{1}{2}}}, \quad (6)$$

or

$$V = \frac{q}{2\pi c}\frac{\tan\theta}{(PQ \times PR)^{\frac{1}{2}}}. \quad (7)$$

The last form shows the meaning, the second denominator expressing the geometrical mean of the two parts into which

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P divides the diameter QR. So V is a minimum on the axis, and increases to infinity on the cone. Outside the cone V is zero. Deriving the electric force by equation (2), it will be found that **E** is radial, and is directed *towards* the charge. This is inside the cone. Its size is

$$\mathrm{E} = \frac{q}{2\pi c}\,\frac{r\tan\theta}{l^3}, \qquad (8)$$

at distance r from the apex, where l is the above-mentioned geometrical mean. The conical surface is the seat of a sheet of displacement away from the apex. This follows because V suddenly drops to zero outside the cone. The amount of displacement in the sheet at QR going outward must exceed the amount crossing QPR radially towards the apex by the amount q. This is obvious by the meaning of electrification in relation to displacement.

A difficulty arises here. For on integrating the flux of D inwards across QPR, according to (8), the result is infinity, the infinite part arising at the boundary. So the outward flux on the outside must be also infinity, plus q. The meaning of this double infinity will appear later.

Now use equation (6) to calculate V by integration in the case of an electrified line moving transversely. We know the result already, so can disprove equation (6) if it does not work properly. Let σ be the linear density of the electrified line. Then, by (6),

$$\mathrm{V} = \frac{\sigma}{2\pi c}\int \frac{\tan\theta\, dx}{(z^2\tan^2\theta - x^2 - y^2)^{\frac{1}{2}}}, \qquad (9)$$

where x is the distance of dx from the plane of the paper in

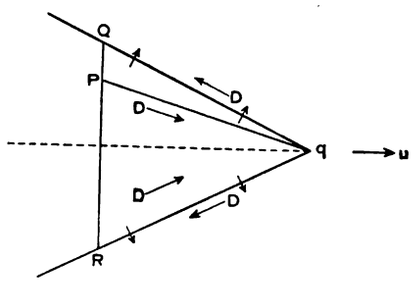

FIG. 24.

Fig. 24, it being supposed that the electrified line passes through q, and y is measured upward on the paper. To find the limits, observe that every element of the electrified line has its cone to correspond, of angle 2θ, and that those portions only of the line contribute to V whose cones cover the point in question where V is wanted. The extreme cones therefore have the point on their surfaces. Therefore

$$z^2\tan^2\theta - x^2 - y^2 = 0,$$

or

$$x = \pm(z^2\tan^2\theta - y^2)^{\frac{1}{2}} \qquad (10)$$

at the limits. The net result is that (9) includes all real values. The integral is an easy one, and makes

$$\mathrm{V} = \frac{\sigma}{2\pi c}\tan\theta\left[\sin^{-1}\frac{x}{x_0}\right]_{-x_0}^{+x_0}, \qquad (11)$$

where x_0 is given by (10). Or, finally,

$$\mathrm{V} = \frac{\sigma}{2c}\tan\theta. \qquad (12)$$

So V = 0 everywhere outside the two planes which envelop the cones, and V has the constant value just written inside the planes. This means that there is no **E** or **H** anywhere save at the planes themselves. The total displacement they carry can be estimated by the sudden drop in V in passing through the planes to be $\frac{1}{2}\sigma$ on both; and the magnetic force to correspond satisfies $\mathrm{E} = \mu v \mathrm{H}$, as in all pure plane waves.

Now these results agree with the arrangement in Fig. 10, which was proved. So the proper standardisation of the potential formula for a point charge is assured. In the case of a moving strip of surface density σ and breadth a, the potential is

$$\mathrm{V}_0 = \frac{\sigma a}{2c}\tan\theta, \qquad (13)$$

constant, on the left side of the slab waves; V = 0 on the right side; whilst in the waves themselves V rises uniformly from 0 outside to V_0 inside—that is,

$$\mathrm{V} = \mathrm{V}_0 \times \frac{\mathrm{PQ}}{\mathrm{PR}} = \frac{\sigma}{2c}(z\tan\theta - y) = \frac{\sigma}{2c}\times \mathrm{PS}, \qquad (14)$$

where PS is the vertical distance of P, where V is reckoned, from the outer plane.

Thus the equipotential surfaces are parallel to the wave fronts, and **E** lies in them. This property remains true until u is reduced to v. After that they split, separate, and widen out both ways into closed surfaces, and the disturbance spreads over all space.

In the case of a point charge, the equipotential surfaces are hyperboloids of revolution. The conical surface is the extreme limit, to which the last hyperboloid goes infinitely near. These surfaces become infinitely compressed into one plane when $u = v$. After that, with $u < v$, they split and become flattened ellipsoids, and ultimately spheres, when u is reduced to nothing. The ellipsoidal theory was given in Vol. I., §§ 164 to 167. I should add that Mr. Searle has added interesting developments to the ellipsoidal part of the subject (*Phil. Trans.*, 1896, and *Phil. Mag.*, 1896).

What is not clear in the above is the state of things at and just within the conical surface itself. To elucidate this, consider a more general case—viz., that of the motion of an electrified line of finite length, or at least infinite only one

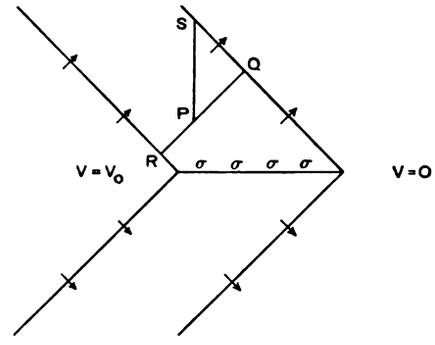

FIG. 25.

way, in its own line. The investigation of V will follow later. The formula is

$$\mathrm{V} = \frac{\sigma}{2\pi c}\log\left\{\frac{z\tan\theta}{h} + \left(\frac{z^2\tan^2\theta}{h^2} - 1\right)^{\frac{1}{2}}\right\} \qquad (15)$$

where

$$h^2 = x^2 + y^2. \qquad (16)$$

This is when the electrified line, linear density σ, is infinitely long one way, its termination being at the origin. The angle θ has the same meaning as before, in relation to the conical boundary of the region occupied by **E** and **H**. Now when the line is of finite length a, the V is the difference of two formulæ of the type (15) having their origins at the two ends of the line. That is,

$$\mathrm{V} = \frac{\sigma}{2\pi c}\log\frac{z\tan\theta + (z^2\tan^2\theta - h^2)^{\frac{1}{2}}}{z_0\tan\theta + (z_0^2\tan^2\theta - h^2)^{\frac{1}{2}}} \qquad (17)$$

where $z_0 = z - a$. The quantity z_0 is always positive. The formula (15) is true in the region between the two cones, and (17) inside the inner one.

Considering (15) first, it may be seen that the equipotential surfaces are all cones with a common apex at the forward end of the line, and that V increases from 0 on the outer cone to infinity at the axis. Deriving the electric force by (2), the result is

$$\mathbf{E} = \frac{\sigma}{2\pi c h\tan\theta}\,\frac{z\tan^2\theta.\mathbf{h}_1 + h\mathbf{k}}{(z^2\tan^2\theta - h^2)^{\frac{1}{2}}} \qquad (18)$$

where $\mathbf{k}$ and $\mathbf{h}_1$ are unit vectors along and transverse to the axis. The ratio of the transverse to the axial component is

$$\frac{\mathrm{E}_h}{\mathrm{E}_z} = \frac{z\tan^2\theta}{h}. \qquad (19)$$

Now z/h = constant is an equipotential surface. So, by (19), all the lines of force cut a given equipotential surface at the

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same angle. Observe that for a given distance from the axis, the ratio of the transverse to the axial component increases in proportion to the distance from the apex. On the axis itself the axial component is

$$E_z = \frac{\sigma}{2\pi cz \tan^2 \theta'} \qquad (20)$$

varying inversely as the distance from the apex. Also, when h/z is small,

$$E_h = \frac{\sigma}{2\pi ch}. \qquad (21)$$

That is to say, the displacement at the axis is perpendicular thereto, spreading out all round from the electrified line precisely as if the line were at rest. But this does not continue, for all the displacement eventually goes to the conical boundary, or infinitely near. The turning round of the displacement takes place instantly at the apex, and more

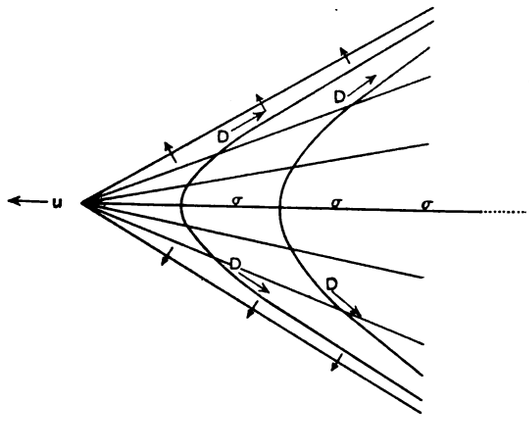

Fig. 26.

and more slowly the further away from it. As all the displacement ultimately concentrates about the boundary, the amount collected there tends to increase uniformly with z. At the same time, so does the surface of the cone. So the amount of displacement per unit area tends to become uniform, and since $H = VuD$, the state of affairs at the surface tends towards that of a pure electromagnetic wave, away from the apex, as the surface becomes more planar. A purely conical wave of the kind cannot exist alone. The lines of force are hyperbolas.

Fig. 26 will give some notion of the conical surfaces of potential and the hyperbolic lines of force, though, being done out of my head, I cannot vouch for the accuracy of shape of the curves.

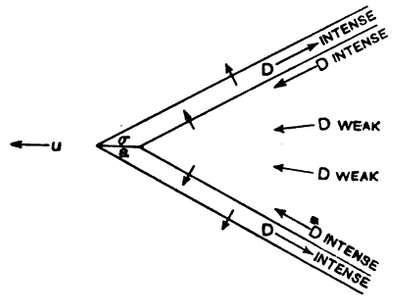

Fig. 27.

Now let the electrified line be of finite length a. We must then superpose on the field of force in Fig. 27, the exact negative copy of the same, but shifted through the distance a to the right. The result of the superposition is that in the overlapping region D tends to become radial, towards the moving charge, weak about the axis, and very intense at the conical surface; whilst outside, between the inner and outer cones, is an impure conical electromagnetic wave, in which D is very intense. Pushing things to the limit, reducing a to zero, and keeping the charge upon it finite, we come to the theory of the moving point charge, already given. It may seem to be much ado about nothing, but is there any easier way?

(*To be continued.*)

MR. A. W. HEAVISIDE'S PRESIDENTIAL ADDRESS TO THE NEWCASTLE-ON-TYNE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

I have thought that, as the establishment of a section of the Institution in the ancient city of Newcastle-on-Tyne earmarks both the place and the time, that perhaps it would not be altogether uninteresting to the members if an effort was made to locate in some degree the position held by the district, of which this city is the centre, in the electrical industry. To do this by way of historical introduction it is not necessary to go back to Thales, of Miletus, and his excited amber, but only to a more recent period which is scored all over with the honourable marks of discoveries and inventions which have mainly assisted in making electricity the servant of man.

As we all know, the pioneer industry is that of the electric telegraph. Like our venerable Queen, it came to the throne in 1837, where, similarly, it has reigned with ever-increasing beneficence ever since. Just look askance over one's shoulder down the back entry of time. There are always the shadowy forms, looming largely on the horizon, of Gray, an Englishman, who, in 1729, discovered the difference between conductors and insulators, using moistened packthread for the former and silk loops for the latter; of our great Anglo-American Franklin, who, in 1752, with his kite in the sky, conducted the lightning to the earth, thus establishing its identity with electricity; of Galvani and Volta, the eminent Italians, who, from 1786 to 1789, developed one source of electricity—namely, "the chemical battery." Oersted, the Dane, in 1819, deflected a magnetic needle by means of a current in a wire parallel with it, thus proving that currents and magnets have similar properties; whilst Ampère, the renowned Frenchman, in 1820, made another step by discovering that a suspended coil of wire carrying a current was a magnet. Then Italy, in the same year, in illustrious Arago, provided another link by temporarily magnetising soft iron during the presence of the current. Finally, Sturgeon, the sturdy Englishman, in 1825, made a last elemental step who by placing Arago's soft iron into Ampère's coil, producing the electromagnet of to-day, which, in conjunction with a needle or armature, is the basis of telegraphy and many other things.

The mental activity of the 12 years following, which gave a clearer grasp of the laws of electrical action, is marked by the mere mention of the names of such giants in science as Gauss, Weber, Coulomb, Faraday, Henry, Neuman, who also, in one way or another, contributed to the almost simultaneous invention of practical electric telegraphs in three great countries—viz., England, Germany, and the United States of America in the year 1837. June of that year gave the world Cooke and Wheatstone's needle telegraph; July, Steinheils' needle, bell and printed marks telegraphs; and October, Morse's marks embossed on paper. With many apologies to the names of the unnamed illustrious ones, I must conclude this stride over a century and endeavour to show Newcastle's place in telegraphy and kindred things.

In 1837, as I have said, a practical five-needle telegraph was invented (which was soon simplified to two needles only). This invention was slow of appreciation, for seven years elapsed before a joint stock company was established to exploit it. However, in 1844 the Electric Telegraph Co. started the combined railway and public service, and in two years their operations extended to this neighbourhood, where they established a double-needle circuit from Gateshead to York. At that time 13s. 4d. was charged for a message of 20 words from Gateshead to London viâ York. The basis of this charge needs to be placed on record. One penny per mile for the first 50 miles, one halfpenny per mile for the second 50 miles, and one farthing for every additional mile, with certain extras for porterage and addresses. In 1849 the high level bridge across the Tyne was completed, and with it came the establishment of an office on the Sandhill, about the site of Gosmas' restaurant. Newcastle's first direct connection with the metropolis was in 1851, when it was temporarily established with the first International Exhibition in Hyde Park. The double needle now began to give way to the single needle and the Bains' chemical recorder, which were succeeded by the Morse embosser in 1858.

In 1853-4 the Magnetic Telegraph Co., using Highton's single-needle and Bright's acoustic-bell system, a forecast of the American sounder, came to Newcastle with transmitting centres at Leeds and Carlisle, competitively reducing the before-named 13s. 4d. to 3s. as the Newcastle-London rate.

Another ten years, and 1864 saw the shilling or United Kingdom Telegraph Co., in local existence, using the Morse printer and the beautiful Hughes typewriter, invented in 1853-4-5, which brought Prof. Hughes honourable distinction in every civilised country but his own.

* Delivered at the Durham College of Physical Science, May 15th. Abstract.

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But in 1867 a great jump was made. Up to this time the usual controlling force in all signalling by battery contact, or interruption, was the hand of the operator, which limited the speed of working on any wire to 30 or 40 words per minute at most. The Wheatstone automatic apparatus was first introduced for practical work in this country between Newcastle-on-Tyne and London; Edinburgh and Glasgow following after. Daily practical work is carried on with it at a normal speed of 330 words per minute on the local wires of this district, and between London and Birmingham, 600 per minute; of course, if duplexed, these figures become about 550 and 1,000 respectively.

In 1870, the Post Office acquired the telegraphs, and introduced universal shilling telegrams, followed in 1885 by sixpenny telegrams. By the kindness of Mr. T. Stevenson and Mr. A. Mellersh, the Post Office surveyors of this district, I am able to give the following figures of the traffic of this district for the year ending March 31, 1900:—

Telegrams forwarded.	Received.	Transmitted.	Total.
3,034,030	3,193,890	2,523,971	8,751,691

The first figure is the money-earning one and shows that, taking the population of the district at 2 000,000, rather more than 1½ messages per head of the population originate in the district per annum, but taking the forwarded and received, the traffic of the district is rather more than three per head of the population. The wires provided in the district by the engineers' department amount to 14,889 miles, carried along 1,794 miles of route; 287 post offices absorb 823 sets of telegraph apparatus, and 1,214 private offices absorb 1,418. The National Telephone Co.'s amount to *about* 5,000 exchange connections, using 6,657 miles of wire, serving 32 exchanges. The number of offices in direct communication with Newcastle at the present time equals 155, served by 104 wires, exclusive of wires that pass through Newcastle en route for other places. Of these 40 are for duplex working, 18 simplex, 18 single needle, 8 Wheatstone A B C, 7 Wheatstone automatic, 5 quadruplex, 1 diplex, and 7 for telephone and other uses. In addition there are eight lines to various submarine cables and a few spare lines.

To continue our story, of course, duplex and quadruplex telegraphy is largely employed. Gintl, in 1853, invented duplex telegraphy, but it did not come into practical use until Stearns applied a counter-kick condenser to it in 1873. O. Heaviside suggested quadruplex telegraphy which was developed by Edison and others, and was followed by the multiplex of La Cour and Delaney. In duplex telegraphy, as we all know, the outgoing current divides equally upon the apparatus nullifying local responses, consequently it is left free to respond to currents from the distant end only. Quadruplex is the addition to the latter of currents of two strengths with selective apparatus at each end which responds only to the current suited to it.

In multiplex telegraphy, six or more instruments are synchronously and successively connected to one wire with such short intervals between each connection that practically each operator has an independent use of the wire. Newcastle has not risen to the dignity of the use of this apparatus at present. The search for various methods of multiplex telegraphy led to the use of vibrating reeds of different responses. A reed may be a tongue of iron before an electromagnet. Here we have the magnetic telephone *in nubibus*. The tongue may respond to vocal vibrations, and be developed into a membrane of disc shape still more responsive. It is remarkable that there is a mysterious connection between the search for multiplex telegraphy and telephony, which just preceded the invention of the telephone.

It may be usefully mentioned here that in 1868 the importance of Newcastle-on-Tyne telegraphically was greatly increased in consequence of the Anglo-Danish, now Great Northern, Telegraph Co. commencing operations. Their first cable was laid in 1868, by Mr. R. S. Newall, between Newbiggin-by-the-Sea and Sondervig, on the west coast of Jutland, 335 nautical miles. The second cable was laid in 1873, between Newbiggin and Hirtsholson, on the same coast, 430 miles. The third cable was laid in 1880, between Newbiggin and Arendal, in Norway, 520 nautical miles; and their fourth and last cable was laid in 1890, between Newbiggin and Marstrand, in Sweden, 509¾ nautical miles. In addition, this company have two land lines to London, and one to Peterhead, in Scotland, in connection with another submarine cable to Norway.

The apparatus employed is one of remarkable delicacy (a first cousin to Lord Kelvin's siphon recorder, which is still more sensitive), called the "undulator"; indeed, so sensitive is the arrangement which works through the cables and the land lines to Scandinavia, at a normal speed of 80 words per minute simplex, and 120 duplex, that great care has to be taken to avoid lateral inductive effects.

The Commercial Cable Co. and the Anglo-American Cable Co. have each land wires to Newcastle to feed their cables.

Going back to 1859-60, at this time the Universal Private Telegraph Co. exploited the Wheatstone A B C telegraph for private conversation at a rental. This was introduced into Newcastle in 1863. Out of it developed the A B C exchange system, by which private circuits converging on a centre were joined together for conversational purposes. This was the forerunner of all telephone exchanges. Printing Court Building is the historic spot where this was first done in this country in 1864. Sir William Armstrong and Co., Thompson and Boyd, and Charles Mitchell and Co. were the first to keenly realise its advantages. This magneto-electric telegraph took 18 years to develop, from 1840 to 1858, and again the hand of Stroh helped Wheatstone. This instrument is really the baby of the alternating inductor dynamo of Mordey and others of to-day.

But in 1877 came the epoch-making telephone—the receiver perfect from the hand of Bell, our Anglo-American, at a bound (Alexander Graham Bell somehow stepped in front of Elisha Gray, who was first in the field). The instrument has appealed more powerfully to the mind of the thinker as a physical demonstrator of the existence of electrical vibrations than anything before and up to the time of Herz, in 1887. This instrument made the detection of long distance induction practical for telegraph purposes and preceded the no less extraordinary detector of Branly and others called the coherer. So great was the interest excited by the invention of the telephone, that in May, 1877, two of my staff, Mr. Frank Reid and Mr. W. R. Smith, needed no initiative to make the first telephones in this district from parts of the A B C telegraph.

Then Hughes, in 1878, crowned the telephonic edifice with the invention of the pencil microphone, nearly as we now have it, making a gift of it to the world, thus paying tribute to humanity as he has since done by bequeathing his great wealth to the London hospitals. Of course, from the first the days of the A B C were numbered, and the problem, how to get the telephone under control stared one in the face.

As it is with Newcastle we are mostly concerned in this address it behoves one to touch, alas, too lightly, in this lightning survey, on what was locally done as the result of the midnight oil. We can only stop to record one observation which, though it attracted little attention at the time, was eventually more far reaching in its consequences than any other. In May, 1877, a local circuit was made up of four lines converging on an Umschalter switch. When conversation was held between my office and three other rooms, better speech was obtained when all the telephones were in parallel than when all were in series. Why it was so, only revealed itself as time disclosed its importance.

On December 24, 1880, judgment was given that a telephone was a telegraph. This opened the door of the department for its exploitation. In 1881, a Post Office exchange was opened at Sunderland. It was joined up on the usual plan with the intermediate apparatus in sequence, upon double wire twisted loops, as first suggested by Prof. Hughes. The apparatus in sequence choked the speech, threw the line out of balance, let in lateral induction, undoing the benefit of Hughes' twist. Shift was made in this district, as all over the world, with this arrangement, its imperfections being condoned. With underground work it died at four miles length; by putting one intermediate on one side of the loop and another on the other side its life was resuscitated to eight miles of underground work, and there speech stopped dead. But, as had already been proved, there was one and one way only to secure telephonic speech unlimited as to distance and free from vagrant sounds. That way was hidden in the elemental principle of putting the intermediate apparatus in bridge across the line. Savants looked askance—it abrogated Ohm's law; why it short-circuited the line! However, its efficiency was drastically put to the proof by partial use in 1881; it survived the whips and scorns of time and was finally adopted *in toto*. Stockton was the first exchange entirely joined up in this manner, a new post office—involving new construction—was the opportunity. This exchange was opened on January 26, 1885. The kernel of the system is, that by putting apparatus of great impedence at the intermediate points, vocal high frequency telephonic undulations gave the short circuit the go-by, whilst low frequency call signal currents operated the signalling indicators at the bridges *con amore*.

The operating in the Post Office system is arranged so that overhearing on the part of the switch clerks is unnecessary, a system of automatic block signalling by means of needle deflections telling the operators all they need to know; hence all the conversations are heard only by those whose property they are—the principals in the transaction.

Telephone trunk wires were early introduced in this district, the first being between Newcastle and Sunderland in 1883. In October, 1896, when the National trunk wires became the property of the State, the Newcastle service had already reached 33, to which had to be added the National, giving a total of 68. Now they reach 72, and there is direct communication with 14 in number. If to this is added all the towns now served by telephone trunk wires, the total is 303. In the Tees-to-Tweed district, for the year ending March 31, the number of trunk calls reached 3,127,689. Local exchange calls reach about 12,000,000 per annum.

As already referred to, the telephone's detection of inductive effects at long distances is marked. This is the so-called wireless telegraphy of the electromagnetic order. It was always there—

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most people knew of it from the days of Faraday and Henry in 1831; but what they did not know was its extent, which, after all, depends upon the force of the source, the delicacy of the detector, and to some extent on the opacity and transparency of the medium.

In the Newcastle battery room, as recorded in the *Journal* of the Society of Telegraph Engineers, Vol. X., p. 21, Jan. 26, 1881, in December, 1880, one had only to walk about the room with a telephone and a coil of wire to read the Morse signalling from every battery in use. This work was resumed in 1886 by a series of experiments, which had for their object four things: (1) At what distance from a primary parallel could these effects be detected on the telephone. (2) How much of the effect was conductive. (3) How much was induction. (4) Were all bodies transparent to them. On April 14 and 15, 1886, 14 years ago, on the Newcastle Town Moor, I proved, with 120 reversals per second and half an ampere of current, that it might be both, or whichever you pleased, inductive or conductive, dependent upon whether earth returns or insulated metallic returns were employed; also that where earth returns were used the earth could be tapped by driving two ends of four yards of wire with a telephone in circuit into the earth. It was also proved that with a secondary or with a primary only connected to earth at one point, static effects could be easily detected though diminished in loudness. Further, it was proved that if the distance from the primary was more than the length of the primary the effects diminished in loudness very rapidly.

From this time until August 15, 1886, the changes upon the above experiments were rung in many ways, always extending the distances, ending in Morse speaking across 40 miles of country, between Shap and Gretna on the west and Newcastle and Jedburgh on the east, produced by interrupting the vibrations with a Morse key. Up to this time the primary wires were usually single wires put to earth at each end, and the secondaries insulated squares or rectangles, and the difficulty was to get a space large enough to lay out insulated wires on the surface without exciting the hostility of the tenants of the Northumberland moors. However, Mr. Hugh Andrews, of Swarland Park, came to the rescue, and placed his estate at my disposal. Here it was, in the last week of August, 1886, that with two miles of insulated wire laid out as two squares of quarter mile sides, and a quarter of a mile apart, or half-mile centres, that articulate telephonic talk was inductively held between one square and the other. Hearable with closed circuits, difficult to hear, but present, with open circuits. Of course, this test was with undulatory currents of microscopic value and forms the highest testimony of the extraordinary sensitiveness of the telephone. This was followed up by telephonically speaking from the workings of Broomhill colliery to a triangle of insulated wire, three-quarters of a mile each side, laid roughly parallel over the colliery workings, the medium for the waves to travel being 360ft. of the crust of the earth. Of course, as every one knows, with the all-important addition of Evershed's call, this electromagnetic system has been developed and applied practically by Sir William H. Preece, and is in use between Flatholm and Lavernock in the Bristol Channel.

But in 1897-8-9 Marconi has, by combining the labours of Branly, Righi, Oliver Lodge and others, coupled with his own clever insight into the subject, signalled over great distances, truly without wires, for really what wire he does use may be considered as part of his electrostatic apparatus. In connection with the coherer which coheres in response to an electric flash, it is singular that Mr. Augustus Stroh has observed something akin in the adhesion of surfaces when traversed by an electric current (see *Journal* of Society of Electrical Engineers, Vol. IX., p. 182). And it is sad that, misguided by the savants, Prof. Hughes, the cruelly neglected scientist, did not go further in anticipating wireless telegraphy than as brought to light last year. Like Cavendish, it is a pity he did not publish his researches at the time.

We must now hurry forward to see where we stand with the other great electrical industries, better known than telegraphs and telephones in one sense, arising out of their control, not being that of the State, or of the monopolist, but everybody's business. Let us ask, What is Newcastle famous for in original work? Well, first we have Lord Armstrong's hydro-electrical frictional machine of 50 to 60 years ago, showing the electrification produced by steam rushing through an orifice, and then we have Lord Armstrong's *magnum opus* of 1897 on the "Electrical Movements in Air and Water."

Second in the order of date comes Joseph Wilson Swan, F.R.S., of Newcastle-on-Tyne, the inventor of the Swan lamp, which assumed practical form in the autumn of 1880. From the days of King, in 1845, to the days of Swan, in 1878-80, many tried their hands at getting light from incandescent platinum or carbon in vacua. But whilst all they did established the soundness of the principle, nothing they did brought more than disappointment from a practical point of view. Mr. Swan himself laboured and experimented with the incandescent lamp in the decade 1850-60 with like result. He used carbon strips in loops and spirals carbonised in Wallace's Forth Banks pottery kilns in crucibles filled with powdered charcoal, but the available mechanical air pumps gave a bad vacuum for such a purpose. Yet, at this early date, Mr. Swan had grasped the necessities of the case—a cheap source of electricity, an excellent filament, and a good vacuum. The filament was the crux of the problem, and as late as April 3, 1880, after much work in the meantime, taking four lamps as samples, their cold resistance was only 38, 45, 47, and 65 ohms, and 3½ amperes only made them red hot or a little more. But on June 15, 1880, Mr. Swan gave me the pleasure of testing one of 120 ohms, and another of 118 ohms resistance. This happier result was brought about by carbonising crotchet cotton—a true filament. [In the meantime it is interesting to note that Edison was more successful in his world-wide search for a vegetable fibre as a filament than Diogenes was in his search for an honest man. But then he did not use candles.] After this Mr. Swan made such progress that by the autumn Lord Armstrong's Craigside House was installed with 20 lamps; and on November 24, 1880, Mr. Swan brilliantly illuminated the auditorium of the Institution of Civil Engineers, in Great George-street, Westminster, to the delight of a distinguished audience of the members of the Institute of Telegraph Engineers and Electricians.

It is worthy of remark that Swan foreshadowed the Faure pasted plate (which Lord Kelvin brought in a box from Paris containing a million foot-pounds of energy). At his lecture before the Literary and Philosophical Society, of Newcastle-on-Tyne, on February 2, 1879, when exhibiting a crude lamp, he spoke of the need for storage and showed a modification of the Planté cell, in which there was the novel feature of spongy lead having been deposited around the frillings of the peroxide element previous to oxidation, to form what is now called positive element.

Swan's domestic lamp suggested a large incandescent lamp as a rival to the arc, and early in 1887 Mr. T. W. Edmondson, a disciple of Mr. Swan's, succeeded in making the Sunbeam lamp, of from 100 to 500, or even up to 2,000 c.p. It is deserving of honourable mention as a Tyneside development.

The Hon. Chas. F. Parsons has earned distinction to the district by his invention in 1876 and 1884 of the turbo-generator. For the horse-power developed, it is perhaps the lightest machine in existence, occupying little space, perfectly elastic, dancing in its bearings, and said to cost little to mechanically maintain. It is idle for me to attempt to describe what is done so much better by its inventor, who I shall now ask permission to quote:—

> The first condensing turbine of the radial flow type was of 200 H.P., and at a speed of 4,800 revs. per min. drove an alternator of 150 kw. output. It was tested by Prof. Ewing. With a steam pressure of 100lb., the steam being moderately superheated, and a vacuum of 28in. of mercury, the consumption was 27lb. per kilowatt-hour, which is equivalent to about 16lb. of steam per indicated horse-power. Turbine alternators and turbine dynamos of 2,500 H.P. are now in course of construction in England and the United States, and larger sizes are in prospect. A turbo-alternator manufactured at Heaton Works, Newcastle-on-Tyne, for the Corporation of Elberfield, in Germany, was tested a few days ago by a committee of experts from Germany, Prof. Ewing being also present. At the full load of 1,200 kw., and with a steam pressure of 130lb. at the engine, and 10°C. of superheat, the engine driving its own air pumps, the consumption of steam was found to be at the rate of 18·8lb. per kilowatt hour.

At the present time ten large towns in this district, including Newcastle, Gateshead, Sunderland, South Shields, Tynemouth, Wallsend, Hiddlesboro, Stockton, Darlington and West Hartlepool, have either electric power houses in active operation or in course of construction. But I cannot stop to say much of them, except the pioneer ones of Newcastle-on-Tyne. In this city we have two services, that of the Newcastle and District Electric Lighting Co., projected by the Hon. C. A. Parsons, late in 1888, and that of the Newcastle-on-Tyne Electric Supply Co., projected by Dr. Robert Spencer Watson, in 1881, but not brought to a practical issue until 1888.

Taking Parson's Co. first.—The original turbo-generators are employed at a speed of 4,800 revolutions, the later machines only 2,400 revolutions, with a pressure of 1,050 volts and a frequency of 80 periods. Last year the company generated 1,571,650 units, sold 963,622 units, and the peak reached 756 amperes upon an installation of 1,490,130 watts, the number of consumers being about 400.

The Newcastle-on-Tyne Electric Supply Co.'s plant is the very antithesis of that of its companion company. It is slow moving and heavy. Horizontal compound long-stroke Corliss engines of 70 to 80 revolutions and Mordey dynamos up to 150 kw. each. The engines, which are of Robey and Co.'s well-known make, and fitted with their trip expansion gear, have performed admirably. During the 11 year's working no main bearing cap on any engine has been lifted, and no new part has been supplied, excepting piston rings, and all the engines are now in first-rate working condition. The steam consumption may be said to average 16lb. with the low vacuum of under 20in., the larger units of course giving the best results. Similarly, the Mordey uniphase dynamos, 2,100 volts, have been equally successful. They are nearly self-regulating, the larger units being the most satisfactory. As is well known they are remarkably efficient, having the characteristic of steadiness under all loads. In 1899 the company generated 1,517,311 units for the supply of an installation of 1,924,680 watts, reaching a peak of 416 amperes upon a sale of 990,551 units, the number of consumers being nearly 1,000

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Both companies use rubber cables, the "District" using a complete network of high tension single cables in iron pipes, and the "supply" a network of concentric cables in iron pipes. Rubber insulated cables, if not starved, and treated properly, either wholly concentric or wholly single pairs in a uniform atmosphere and a uniform mechanically protective environment, give little trouble. Both companies have cable 10 years old still doing excellent service. Both companies are developing direct low-tension services in congested places. Dr. Watson's company has two accumulator sub-stations, one in operation, another on the eve of practical employment.

Nowadays, when electric supply is an assured success, everyone can go to work with confidence, if only over-capitalisation is avoided. This is in the first degree the active danger of municipal undertakings governed by committees, all experts, of course. The need for dividends acts as the check in company undertakings—it tends to ensure both economy in capital, in production, and in maintenance. Production to serve a wide area of many needs assures continuity of load. This assures economy of production. An average of less than two hours' daily use of all the machinery in established pioneer stations brings 8 per cent. dividend. But suppose we build anew on the experience gained. Cease to put down what now may be considered toy machines all in a row and tobacco-pipe chimneys, jealously watched by vigilant smoke inspectors catching the specks upon sheets of white blotting paper. Emulate the courage of the Americans, the Swiss, and the Continent generally.

Of electric traction one can speak as eulogistically as of the bicycle. Happily now it is booming in this country, and one sighs with relief that at last our conservatism has been broken down, and we shall soon be as our colonies and other civilised nations are. Only build strongly; make a good, sightly, workmanlike structure, looking as if it fitted its purpose, then the cry of the æsthetic will cease and the cloud of the benighted disappear. I would like to express my unqualified condemnation of the extremely short-sighted policy of not starting with a double track right away in the busy towns of this district. It is only excusable when there is lack of width, and that is rare.

Another word, and this retrospect is done. The result of a circular I sent out to ascertain the number of persons employed on electrical work in this district gives the following approximate figures:—

Telegraphs and telephones	3,900
Electric supply companies	335
Manufacturers	2,400
Installers	219
Sundry employment	146
	7,000

ELECTRICITY WORKS ACCOUNTS.

The Metropolitan Electric Supply Company (Limited).

We are glad to be able to furnish our readers with an analysis of the accounts for the years 1898 and 1899 of this company, whose operations derive an unique interest from their magnitude.

A short history of this undertaking appeared in our description of the company's new works at Willesden on page 691 of our issue of March 9 last, so it is unnecessary here to introduce further remarks on that score.

As is well-known, in consequence of the delay in the completion of the Willesden station the concern has been considerably embarrassed during the period covered by the accounts with which we deal. This fact must, to a great extent, account for the somewhat unsatisfactory results which are shown. In 1899 the output advanced nearly 21·7 per cent., and the lamp connections about 15·6 per cent. A most satisfactory improvement is that shown in the load factor, which in 1899 was 12·6 per cent., as compared with 11·95 per cent. in 1898. Had it not been for these better conditions it is probable that the difficulties and forced rate of working necessitated by insufficient plant would have resulted in increased costs. As it is, and in the circumstances, we must say that the reduction of nearly 0·2d. in the aggregate costs is a commendable result. There is, however, plenty of room for further improvement in these costs, which are still at least 0·4d. per unit above what they should stand at in our opinion.

Running down the costs column attention is arrested at the high works, and more particularly, the generating costs which, in the aggregate, are quite 1d. per unit too high. It may be noticed that all the generating items are high except station wages. The fuel charges, as might be expected from the conditions under which the supply was met, is quite double the average.

We shall await with interest the results of the current year, showing the influence of the new station and more normal conditions of working upon the costs.

St. Pancras Vestry Electric Supply Works.

After the interposition of a year, in which this undertaking showed a falling off in the results obtained, we are glad to be able to record a resumption of the progress towards more economical working.

As may be gathered from the small table appended to these notes, the advance in the lamp connections during 1899, as well as in the output, has been most satisfactory—the former have advanced 22·5 per cent. and the latter—viz., the output—shows an increase over 1898 of 24 per cent.

Equally satisfactory is the reduction which has been effected in the costs. In 1898 the total costs, it may be remembered, showed a material increase on those of 1897. Last year, however, they fell to 2·64d. per unit—a good result; but, in view of the splendid load-factor of 15·8 per cent, coupled with the order of the output, a result still falling short by quite 0·5d. per unit of the possible.

The management and property charges, although showing an increase, are most satisfactory, but among the generating costs those of fuel and repairs and maintenance at the station are high.

There are some unusual expenses included in the costs, and it is only fair to note them. Thus there was £746 expended in re-arranging the public arc lighting mains and £1,348 alterations in connection with change of pressure to 220 volts. There was also £126 in respect of hire and erection of temporary plant.

Year ended Dec.	No. of consumers.	Current sold, not including arc lighting.		No. of lamps, &c., applied for.		
		At 3d. per unit.	At 4d., 5d., and 6d. per unit.	16 c.p. glow.	Arc.	Motors.
1892	172	...	£8,167	9,990	82	11
1893	238	£385	9,161	12,851	110	19
1894	349	1,237	10,820	15,542	129	22
1895	447	2,142	12,682	19,195	139	37
1896	672	2,949	19,430	26,423	187	47
1897	808	4,062	25,221	32,250	256	78
1898	984	8,415	23,446	38,124	292	91
1899	1,184	11,700	25,993	46,172	315	126

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.)(Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 4, 1900	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, 1899	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, 1900	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Salford (Municipal)	Feb. 23, 1900
Clerkenwell (Company)	May 18, 1900	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	May 26, 1899
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, ,,
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 22, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wandsworth (Company)	May 12, 1900
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Woolwich (Company)	Jan. 12, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kensington & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	June 9, 1899		

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	LONDON.	ST. PANCRAS (LONDON).
Undertaking Worked by	The Metropolitan Electric Supply Co. (Ltd.)	St. Pancras Vestry.
Date of Commencement of Supply	1890.	November, 1891.
System of Supply	Alt.-cur. trans. in houses and sub-sta. with 3-w. distri-	Three-wire continuous, with batteries.
Chief Engineer	R. R. Todd. [but'n, con.-cur. 2-w., also extra h.-p. 2-phase from Willesden, with rotaries	S. W. Baynes.

YEAR ENDED	DEC. 31, 1898.	DEC. 31, 1899.	DEC. 31, 1898.	DEC. 31, 1899.
QUANTITIES—				
Units generated	10,809,258	12,891,250	2,282,885	3,069,477
„ SOLD (TOTAL)	6,845,066	8,327,939	1,996,877	2,477,508
„ sold to consumers	—	—	1,646,529	2,017,722
„ sold for public lighting, &c.	—	—	350,348	459,786
„ used on works	—	—	118,320	162,023
UNITS SOLD PER 8 C.P. LAMP CAPACITY	—	—	27·4	30·6
Maximum supply demanded	6,540 kilowatts	7,630 kilowatts	26,659 amperes	1,789 kilowatts
Number of public lamps	20 arc	20 arc	197	228
Number of consumers	6,800	7,900	984	1,286
Connections to mains in 8-c.p. lamps	432,478	500,036	90,136	110,462
CAPACITY OF PLANT IN 8-C.P. LAMPS	—	—	73,063	81,000
CAPACITY OF PLANT IN KILOWATTS	—	—[a]	2,340	2,590

CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£1,850,000	—	£1,850,000	—	£184,930	£79·0	£236,780	£91·4
Share	1,000,000	—	1,000,000	—	—	—	—	—
Loan (including Debenture charges)	850,000	—	850,000	—	184,930	79·0	236,780	91·4
RECEIVED (TOTAL)	998,959[b]	—	1,225,276[c]	—	184,930	79·0	236,780	91·4
Share	743,530	—	850,000	—	—	—	—	—
Loan (including Debenture charges)	220,000	—	345,000	—	184,930	79·0	236,780	91·4
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	886,470	—	655,000	—	nil	—	nil	—
Share (unissued)	150,000	—	150,000	—	—	—	—	—
Share (uncalled)	106,470	—	nil	—	—	—	—	—
Loan (including Debentures)	630,000	—	505,000	—	nil	—	nil	—
REPAID (TOTAL)	—	—	—	—	13,872	5·93	17,247	6·66
RESERVE OR SINKING FUND	51,361	—	64,361	—	—	—	—	—
DEPRECIATION FUND					8,000	3·42	8,000	3·09
EXPENDED (TOTAL)	993,762	—	1,244,254	—	241,994	103	288,147	111
Lands and buildings	222,982	—	285,702	—	45,048	19·2	59,548	23·0
Plant	407,704	—	517,666	—	88,986[a]	38·0	102,355[h]	39·5
Mains	295,310	—	371,320	—	107,448	45·9	125,745	48·5
Miscellaneous	67,766	—	69,566	—	512	0·219	498	0·192
BALANCE OF CAPITAL ACCOUNT	+9,198[b]	—	−18,978[d]	—	−57,064[b]	−24·4	−51,367[b]	−19·8

REVENUE—	Total.	Per unit sold.	Total.	Per unit sold	Total.	Per unit sold.	Total.	Per unit sold.
TOTAL	£151,606	5·318d.	£179,190	5·163d.	£38,164	4·585d.	£44,768	4·338d.
Revenue from supply	146,974	5·154d.	173,374	4·998d.	31,769	3·820d.	37,580	3·640d.
„ meters, &c.	4,478	0·157d.	5,324	0·153d.	46	0·005d.	97	0·009d.
„ public lighting	—	—	—	—	5,979[e]	0·719d.	6,640[e]	0·643d.
„ sale of lamps, &c.	56	0·002d.	52	0·001d.	—	—	115	0·011d.
„ miscellaneous sources	98	0·003d.	440	0·013d.	370	0·045d.	336	0·033d.
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£98,042	3·440d.	£112,797	3·250d.	£24,490	2·945d.	£27,231	2·638d.
WORKS COSTS	79,127	2·774d.	92,351	2·660d.	21,318	2·562d.	22,933	2·220d.
Generation of electricity	*76,736[e]*	*2·690d.*	*90,419[h]*	*2·605d.*	*12,837*	*1·544d.*	*16,567*	*1·604d.*
Fuel (including cartage, &c.)	45,393	1·592d.	55,585	1·601d.	7,029	0·845d.	9,499	0·920d.
Oil, waste, water, stores	5,521	0·194d.	5,800	0·167d.	587	0·071d.	977	0·095d.
Wages at station	10,870	0·381d.	11,799	0·340d.	3,303	0·397d.	3,386	0·328d.
Repairs and maintenance at station	10,244	0·359d.	15,020	0·433d.	1,847	0·222d.	2,610	0·253d.
Distribution of electricity	*2,391*	*0·084d.*	*1,932*	*0·056d.*	*7,307[d]*	*0·880d.*	*5,250[i]*	*0·509d.*
Wages, &c.	2,391	0·084d.	1,932	0·056d.	7,307[d]	0·880d.	1,171	0·113d.
Repairs, renewals of mains, &c.							4,079[i]	0·395d.
Public lighting	—	—	—	—	*1,174*	*0·141d.*	*1,116*	*0·108d.*
Attendance	—	—	—	—	561	0·068d.	546	0·053d.
Renewals	—	—	—	—	613[e]	0·074d.	570[e]	0·055d.
MANAGEMENT AND PROPERTY CHARGES	18,915	0·664d.	20,446	0·589d.	3,173	0·381d.	4,299	0·416d.
Royalties	—	—	—	—	*27*	*0·003d.*	*29*	*0·003d.*
Rent, rates, taxes	*3,591*	*0·126d.*	*3,806*	*0·110d.*	*605*	*0·073d.*	*1,164*	*0·113d.*
Management	*15,324*	*0·537d.*	*16,640*	*0·480d.*	*2,541*	*0·305d.*	*3,106*	*0·301d.*
Salaries	8,809	0·309d.	8,797	0·253d.	1,140	0·137d.	1,721	0·167d.
Stationery, &c.	818	0·029d.	920	0·027d.	220	0·026d.	238	0·023d.
Establishment charges	2,748	0·096d.	3,215	0·093d.	272	0·033d.	261	0·025d.
Law charges, &c.	2,949[f]	0·103d.	3,708[g]	0·107d.	909[f]	0·109d.	886[j]	0·086d.

FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£53,564	5·81%	£66,393	5·93%	£13,674	6·04%	£17,537	6·62%
Sum carried to Depreciation Fund	13,000	1·41%	13,000	1·16%	4,000	1·77%	—	—
Sum carried to Reserve or Sinking Fund					2,941	1·30%	3,374	1·27%
Net interest on loans (incl. Debenture charges)	8,934	0·969%	9,575	0·855%	6,558	2·90%	7,321	2·76%
BALANCE FROM LAST ACCOUNT	1,774	0·192%	1,451	0·130%	1,717	0·760%	1,892	0·714%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	33,497	3·63%	45,340	4·05%	5,892	2·63%	8,734	3·30%
Deficit	—	—	—	—	—	—	—	—
ORDINARY DIVIDEND PAID	5%	—	5%	—	—	—	—	—
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	64·7%		63%		64·2%		60·8%	
Expenditure per kilowatt capacity	—		—		£10. 9s. 2d.		£10. 10s. 0d.	
REVENUE PER KILOWATT CAPACITY	—		—		£16. 6s. 0d.		£17. 5s. 7d.	
Expenditure per 8-c. lamp capacity	—		—		6s. 8½d.		6s. 8½d.	
REVENUE PER 8-C.P. LAMP CAPACITY	—		—		10s. 5½d.		11s. 0¾d.	
REVENUE PER 8-C.P. LAMP CONNECTED	7s. 0d.		7s. 2d.		8s. 5½d.		8s. 1d	
Price charged for lighting, per unit	6d. to 5d.		6d. to 5d.		6d. to 3d.[g]		6d. to 3d.[g]	
Price charged for power, per unit	4d.		4d.		3d.		3d.	
Price charged for public lighting	—		—		£30. 6s. 5d. per lamp.		£29. 2s. 0d.[e]	

LONDON.—REMARKS—*a* The generating capacity of plant installed at the Willesden power house is 4,500 kilowatts. *b* Including £35,429 premiums on stock. *c* Including £30,276 premiums on stock. *d* Over-expended. *e* Includes £4,709 to purchase of current. *f* Includes £242 to auditing, £913 Parliamentary charges, and £848 insurances. *g* Includes £243 auditing, £1,192 Parliamentary charges, and £1,482 to insurances. *h* Includes £2,216 to purchase of current.

ST. PANCRAS (LONDON).—REMARKS—*a* Inclusive of £8,994 to public lamps. *b* Over-expended. *c* For current and all maintenance and capital charges. *d* Includes £3,893 to "re-arranging public arc lighting mains." *e* Includes carbons. *f* Includes £39 to law, £281 to insurance, £343 to temporary plant, and £194 expenses re-winding consumers' motors. *g* By maximum demand system on 3-hour scale during first six months, and 1½-hour scale during latter six months of year. *h* Includes £1,314 on public lamps. *i* Includes £746 to re-arranging public arc lighting mains, and £1,352 alterations in connection with change of pressure to 220 volts. *j* Includes insurances £247, expenses obtaining loans £115, compensation claims £94, hire and erection of temporary plant £126, and to L.C.C. items disallowed on

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

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ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

We conclude this week our reprint of the Paper recently read before the Institution of Electrical Engineers, by Mr. H. M. Sayers, on "Distributing Systems of Electric Traction under British Conditions"; and we give a short abstract of the not-particularly-important discussion this Paper evoked. The title of Mr. Sayers' Paper ends with a noteworthy reservation. The phrase "under British conditions" as applied to electric traction is significant of much; only those who know the conditions of electric traction in the United States and elsewhere abroad can say how much. Several factors exist to produce these special conditions in this country. Chief among them, of course, are the wisely-framed regulations of the Board of Trade; but there is also the important factor of cultured public taste to be reckoned with, in the designing and erection of British electric tramways; again, the engineers who have been responsible for this work have been able to draw upon a reserve of national experience in the design and erection of electric supply works unequalled by that of any other country. Thus it has come to pass that the United Kingdom, which for a long time lagged behind all the rest of the civilised world in regard to electric traction, is now setting an example to all the world in solid and thorough work. Nowhere outside the United Kingdom can better examples of electric traction be found than exist in our principal electrically-equipped cities—a fact which, by the way, may be pressed upon the attention of globe-trotting municipal delegates.

Into the question as to whether the Board of Trade conditions and regulations ought or ought not to be revised we do not at present propose to enter. In the main it must be admitted by even those who would entirely revise them that under their influence a healthy growth of electric traction has taken place. Mr. Sayers' Paper deals with these conditions as they stand, and he discusses therein the various systems of distribution of power for electric traction which are compatible with these conditions. It is possible, however, to acquiesce in the Board of Trade regulations and the general conditions of British electric traction *in toto*, and yet to disagree with many of Mr. Sayers' conclusions. The key-

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note of these objections might be found in Mr. JENKIN'S remark, during the discussion, that the Paper deals with "a particular case." It is possible, of course, so to deal with a particular case that the conclusions derived therefrom shall be of general applicability. On the other hand, a particular case is often an isolated case, an exception to the general rule, an instance in which deductions "go by contraries." We think Mr. SAYERS' Paper falls under the second rather than the first category; his deductions as to the relative merits of various systems of distribution being inapplicable to the general problem. Take, as an instance, his remarkable advocacy of multiple power stations in preference to a central power station for the entire tramway system. It would be a fair inference to draw from Mr. SAYERS' Paper that the correct method is to place a generating station at every four miles or so along the electric line, letting this supply merely over a radius of two miles. Curiously enough, on the very day Mr. SAYERS advanced this extraordinary postulate in electric traction design, a number of eminent electrical engineers and others were endeavouring to convince Parliament that the most economical and best way of distributing electric power for traction, lighting and public supply is to have one or two large generating stations for each area as large as an entire county. Are we to be told that this has nothing to do with Mr. SAYERS' "particular case"? Are we to hear in Parliamentary committee rooms that the conditions of modern electrical supply demand wider scope, ampler fields of action and greater variety in the character of the demand; while, on the selfsame day, the Institution of Electrical Engineers presents a Paper to the world, in which one of the fundamental conditions of a system of British electric tramways or railways is stated to be the erection of a separate power station at every few miles? Mr. SAYERS, indeed, is out of harmony with the march of electrical engineering; his conclusions belong to a bygone stage of electrical progress. While he is troubled about how to eke out the volts along a few miles of trolley line, polyphase engineers are designing and building power stations that are capable of doing all the traction and other electrical work for 20 miles or more around them.

We have attacked Mr. SAYERS' most vital position, for upon the decision as to the number and distribution of the power stations turns the whole question discussed in his Paper. Of the rest of the Paper it must be said that there is much instructive and useful information, especially as to matters of detail. It is, perhaps, the misfortune of the critic that he sometimes finds more useful work in exposing and rebutting errors than in enlarging upon points of merit. If we have devoted the greater part of our space in this leading article to criticism rather than to praise, it is not because Mr. SAYERS' Paper does not contain many passages which are worthy of the thankful attention of electric traction engineers. A man of wide experience in electrical affairs, Mr. SAYERS has embodied usefully the results of his past work. Though the broad lines of design Mr. SAYERS lays down are not such as we think the future will justify, it is, nevertheless, certain that the mass of details in Mr. SAYERS' design upon those debatable lines are *sans reproche*. Even if, to take another example, his interpretation of KELVIN'S law of economy is open to criticism, he would be the last to pledge himself to the dictates of his mathematics where they appeared to conflict with common sense or mature practical experience. Distributing systems may be calculated on paper by rigid rules, but the rigidity must generally be greatly relaxed before they can be transferred from paper to *terra firma*.

PRACTICAL EXAMPLES OF SIMULTANEOUS TESTING, AS APPLIED TO FAULT LOCALISATION IN SUBMARINE CABLES.

BY C. W. SCHAEFER.

Apropos of editorial remarks in connection with certain modifications of methods of fault localisation by simultaneous tests, which up to the time of my describing them* had merely been proved a practical success by experimental tests on artificial faults, opportunities have since occurred enabling me to supply some of the desired numerical data obtained in actual work, aptly illustrating the feasibility and power of these theoretically perfect methods.

The first occasion on which one of the tests was applied practically, happened to be an unusually interesting case of a rare type of fault, which, perhaps, is unparalleled in the annals of cable testing, and may be classed as one of those somewhat doubted "Phantom" faults, only two of which had previously come under my observation. It occurred on an important cable with no duplicate section at hand by which a loop test could be attempted, whilst duplex working was rendered impossible by reason of the fault's variability, which could not be compensated for by placing a leak suitably on the artificial line. It was therefore of importance that it should be removed.

Several attempts were made to localise it, but the fault neither remained at any sufficiently low nor constant value to allow of a single test being taken by any of the usual methods. At times its resistance fell as low as 800 ohms, but merely for a fraction of a second, whilst from that value it would leap up in a single bound to thousands of ohms, and frequently to megohms, thus apparently vanishing from the cable, the normal insulation of which was some six megohms. Its general condition was such that even with exceedingly small currents there was no possibility of getting it down to localisable limits both as regards its resistance and the length of time it remained low, the matter being further complicated by the length of the section—viz., 812 nauts, the copper resistance and inductive capacity being respectively 8,315 ohms, and approximately 250 microfarads.

Off and on, attempts extended over a period of more than three months; but the actual time that the fault was under observation and test amounted to 44 hours in the aggregate, during which time it was not possible to get even one single overlap test.

Finally, after having made cuts in order to ascertain the extreme limits of its position, and having gathered from experience that even under the smallest practicable currents the fault, if low, generally sealed very rapidly to some megohms, an attempt was made to localise it during its brief period of lowness by a simultaneous test. And, further, to minimise the margin of error, a position was selected for cutting in such that the fault was between the ship and the nearer station, that is to say, the copper resistance of the line actually was 2,285 ohms.

Neither of the terminals being provided with a milammeter, prior to the ship's departure, a test was taken of the station's 30 cell Leclanché battery, and its internal resistance found to be 75 ohms; but in common with other Leclanchés, especially those of the porous pot type, its polarisation was great and rapid. Since also the station was not acquainted with the modification of Kempe's loss of current test, which necessitated an earth current correction being made to the scale zero bridge reading, it was pre-arranged that the readings ashore were to be taken to earth current zero, whilst at the ship the received currents were observed on a Weston milammeter, having a coefficient of 4·85 divisions per milliampere, together with an auxiliary milammeter composed of a shunted Sullivan galvanometer, for which a preliminary calculation had been made, the coefficient being 52·7 divisions per milliampere.

To increase the shunting effect of the fault, which was known to be within 1,100 ohms, or 107 nauts, from the ship, a resistance was added, which together with the milammeters amounted to 504·5 ohms.

* *The Electrician*, Oct. 29, 1897.

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It was arranged with the station to test with 80 Leclanchés and 1,000/1,000 ratio for 10 minutes, the first five being taken with 504·5 ohms in circuit on board, whilst during the the second period of five minutes that resistance was increased to 1,004 ohms.

The fault, however, did not remain low nor steady during the latter period, and the observation was therefore limited to within the first *five* minutes, the result being as follows:—

Resistance observed to E.C. zero by shore.

2587·5 ohms (corrected).

Current observed on milammeters on board.

Weston	Galvanometer
35·5 to 36 (with roll of ship)	430
4·35	52·7
= 8·15 to 8·27 milliamperes.	= 8·16 milliamperes.

Shortly after this test the fault was found to have sealed to over 2·5 megohms, and neither potentials as high as could be used with discretion, nor extremely small ones, would reduce its resistance, which, with the exception of brief "kicks" down to 6,000 ohms, and on one occasion as low as 700 ohms, generally kept at its high figure of 2·5 megohms.

The opportunity was taken advantage of, while the fault was high, to determine the correct copper resistance (2,285 ohms), and also to get a test of the station's battery by observations on board ship upon a basis of which the limits of the fault's distance were assigned. The process was as follows: The shore station was instructed to take a scale zero bridge reading under the same conditions of battery power and bridge ratio as previously used, keeping his current on for five minutes, whilst the received current on board afforded a means of determining the percentage of battery polarisation and also its effective E.M.F. The station's bridge reading was 2,252 ohms, whilst the current received on board fell from $\frac{55}{4\cdot35} = 12\cdot63$ milliamperes to $\frac{51}{4\cdot35} = 11\cdot7$ milliamperes in about 3½ min.; therefore the *effective received current* appeared to fall about 7·3 per cent., or the battery E.M.F. from

$$0\cdot01263\ (2\times75+1000+2252) = 42\cdot97 \text{ volts}$$

to $$0\cdot0117\ (2\times75+1000+2252) = 39\cdot8 \text{ volts.}$$

This indicated also that polarisation had come into play by the time the received current could be observed, for the normal E.M.F. of the battery should have been about $80\times1\cdot45 = 43\cdot5$ volts.

Allowing that during the shorter applications of the current in taking the earth current zero test, the polarisation was less, or say at least 8½ per cent. on the free potential of the battery, the current entering the cable would be $\frac{42000}{3737} =$ 11·24 milliamperes, and therefore, using the formula

$$x = \left(\frac{nA_1 - L}{n-1}\right),$$

where $$n = \frac{11\cdot24}{8\cdot16} = 1\cdot377,$$

$$A_1 = 2587\cdot5,$$

$$L = 2285 + 504\cdot5 = 2789\cdot5,$$

$$x = \frac{(1\cdot377\times2587\cdot5) - 2789\cdot5}{1\cdot377-1} = 2053\cdot5 \text{ ohms,}$$

which was accepted as the superior limit of the fault's distance from the shore station, whilst its apparent resistance during the test was $f = \left(\frac{n}{n-1}\right)(A_1 - x)$,

or $$\frac{1\cdot377}{1\cdot377-1}(2587\cdot5 - 2053\cdot5) = 1952 \text{ ohms.}$$

For the inferior limit an allowance of 7½ per cent. on th full battery E.M.F. was made, and consequently the current entering line would be $\frac{40200}{3737} = 10\cdot76$ milliamperes, from which we get

$$x = \left\{\frac{\left(\frac{10\cdot76}{8\cdot16}\times2587\cdot5\right) - 2789\cdot5}{\frac{10\cdot76}{8\cdot16}-1}\right\} = 1962 \text{ ohms from shore,}$$

and the apparent resistance of the fault in this case

$$\frac{1\cdot318}{1\cdot318-1}(2587\cdot5 - 1962) = 2592 \text{ ohms.}$$

Absolutely no other test could be taken as a check upon this solitary observation, and although somewhat diffident as to the reliability of this method, hitherto untried in actual practical work, the result was considered good enough to work upon, and the cable was subsequently hooked 2,065 ohms from shore. Here again the fault behaved in its usual peculiar manner and corroborative tests being quite impossible, there was no alternative but to pick up to the inside limit indicated by the test.

When 650 fathoms had been recovered, the joint resistance through the fault and dielectric intervening between ship and shore increased to 16 megohms, and it was suspected that the fault had come into the tank. Accordingly the cable was cut, and after waiting for eight hours, a drop to 8½ megohms on the sea end indicated that it had not yet been removed. Picking up was therefore continued until a splice had been reached 1,958 ohms from shore, where the cable was again cut, the fault being then found in the tank portion. A dielectric resistance test shorewards gave a result 30 megohms, showing that at its highest value, when submerged in 240 fathoms of water, the fault must have had a resistance of over 30 megohms.

Even when in the tank, the behaviour was much the same as when submerged, and it was only by keeping a continuous watch for some hours that in one of its momentary falls in resistance a loop test placed the fault 15·6 ohms from the top end, that is to say 1978·6 ohms from shore; practically at the inside position of the accepted limits, proving that the shore stations battery must have almost attained its maximum polarisation during the earth current zero test.

Whilst in the tank, potentials as high as 140 volts were tried without in any way tending to open up the fault. On stripping the faulty portion, a small fragment of a hard substance resembling a portion of a tooth was found embedded in the gutta-percha, the dimensions of which were approximately 2·5mm. long, 1mm. wide, and about 0·8mm. in thickness. This projected externally to the gutta-percha about 0·3mm., and around this projection the jute adhered firmly, there being no brass tape on the core. There was no visible defect on the sheathing, and, it was perhaps, merely a factory fault, which, however, did not assert itself until some six years after submersion. On removal of this substance the resistance of the fault was generally 35,000 ohms, and fell to a minimum of 1,200 ohms.

In describing this, perhaps, the first practical application of this improved method of simultaneous testing, I think I am justified in saying that this fault could not have been localised within the above limits by any other of the known methods applicable to a single cable. Considering also that the conditions were rendered the more doubtful by the mere fact that a milammeter was not available ashore (although the vanishing fault was to a certain extent generous in affording a means of accurately determining the copper resistance of the line, and also of ascertaining the effective E.M.F. of the shore battery, and, consequently, the limits of current entering the cable), this instance is, I hope, sufficiently important to prove the practicability of this method.

Still more recently, other opportunities have arisen in which this particular method of simultaneous localisation has been resorted to with complete success and a minimum expenditure of time, permitting faults to be localised with no skilled assistance at the shore station other than that required for the correct reading of the milammeter at preconcerted intervals.

The following example I quote as being a typical one, in which, in spite of circumstances that prevented confirmatory tests being taken without endangering the cable whilst the ship was hanging on to it, a mean of seven consecutive readings gave a distance 11·8 ohms short of the real one, a second fault of much higher resistance nearer the ship being, perhaps, wholly responsible for this error.

Before leaving to remove a series of faults from a section, a milammeter was left ashore through which the cable was

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earthed during the tests, the routine being as follows: A chronograph was started on board at the instant a "dot" was received from the shore, and at each consecutive minute from that signal simultaneous readings were taken until the cessation of the testing current signified that results were to be communicated. The readings on board were balanced to instrument zero with an even ratio in the bridge, whilst the milammeter being placed in the battery circuit registered twice the amount of current entering line. The earth current was so small that it was negligible.

Ship.				Shore.	L = 1,473 ohms.		
Time: Minutes.	Current (milliamperes): Entering fork.	Current (milliamperes): Entering line.	Resistance observed to instrument zero (A_1).	Current (milliamperes).	Ratio of currents (n).	x.	f.
1	20·9	10·45	827	23·25 ÷ 4·35 = 5·33	1·96	154·7	1,373
2	20·2	10·10	910	25·00 ÷ 4·35 = 5·73	1·76	172·4	1,708
3	19·9	9·95	929	25·25 ÷ 4·35 = 5·80	1·715	169·2	1,822
4	24·9	12·45	921	31·50 ÷ 4·35 = 7·23	1·72	156·9	1,825
5	24·6	12·30	920	31·50 ÷ 4·35 = 7·23	1·70	131·4	1,915
6	25·0	12·50	890	30·75 ÷ 4·35 = 7·07	1·76	132·2	1,755
7	25·2	12·60	877	30·00 ÷ 4·35 = 6·90	1·826	155·7	1,595

Mean value of x = 153·2 ohms.

It is a good plan when taking a set of readings to vary the current, as was done at the end of the third minute. This fulfils the double purpose of finding the range of current best suited to the fault under test and of serving as a check on the other observations. It is interesting, too, to observe that the somewhat large range of the "apparent" distance indicated the existence of the second fault. This "wandering" is to be expected even with a single fault that is at all variable, for the impossibility of absolute simultaneity would cause incontrollable disturbances which could only be eliminated by taking the mean of a few sets with various currents.

The following set, with another and still more variable fault shows the manner in which the earth current correction is applied. The resistance of the line, including the milammeter, was estimated at 1,319 ohms.

Constant.—1 Leclanché cell (1·45 volt) through high resistance (H.R.), approximately 20,000 ohms, gave 567 divisions ∴391 divisions per 1,000 millivolts.

Preliminary earth current deflection (e) = 20 divs. *left* = 51 millivolts (additive).

Ship.						Shore.	L = 1,319 ohms.		
Time: Minutes.	Current (milliamp.): Thro' fork.	Current (milliamp.): To line (c).	Reading A corrected for temp.	Earth current corr'ctn $\left(\frac{e}{c}\right)$	Reading corrected (A_1)	Current received (milliamperes).	Ratio of currents (n).	x.	f.
			ohms.	ohms.	ohms.			ohms.	ohms.
1	21·9	10·95	490*	4·6	494·6	16·75 + 4·35 = 3·85	2·85	48·6	687
2	21·4	10·7	524	4·7	528·7	18·25 ÷ 4·35 = 4·2	2·55	18·7	1,437
3	21·8	10·9	475	4·7	479·7	16·75 ÷ 4·35 = 3·85	2·83	21·3	1,010
4	22·4	11·2	430	4·5	434·5	15·75 ÷ 4·35 = 3·61	3·10	13·3	804
5	22·6	11·3	390*	4·5	394·5	15·0 ÷ 4·35 = 3·45	3·28	neg.	—
6	23·0	11·5	372	4·4	376·4	14·0 ÷ 4·35 = 3·215	3·58	18·3	585

* Approximately.

Ignoring the first test, which was observed at the most variable period, and also the fifth, which works out about 11 ohms negative, the mean value of x is nearly 18 ohms, the true distance proving to be 12·5 ohms.

The mean swings of deflections were accepted as balance for the bridge readings, and, in both cases cited above, these swings were at times almost across scale! Whenever possible it is, of course, always desirable that, as a further check, the order of the test should be reversed—that is to say, the current should be applied from the other end of the cable, a resistance being added to the line at the terminal taking readings of c alone if it happens to be very close to the fault, in order that its shunting effect may be made adequately great.

Before observing the preliminary earth current, it is advisable to earth the cable for one minute *at least*, more especially if the Morse has to be used instead of mirror for signalling purposes; and, if possible, the simultaneous readings should be taken every 15 or 30 seconds, so as to minimise the error that would be occasioned by a change of earth current.

I believe that the test above exemplified will eventually prove itself more frequently serviceable than the simultaneous null-method bridge test which, besides requiring a little more skill in execution, depends upon observations of current as well as bridge readings at both ends of the cable, although in certain cases the latter test can claim superiority.

I may state, finally, that in the instances above quoted, the method adopted was the only one practicable excepting "Blavier's"; and it is, perhaps, needless to point out the economy of time and material that may be expected when the adoption of the milammeter method becomes universal.

THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.*

BY H. M. SAYERS.

(*Concluded from page 182*).

Obviously, the calculations above described will only give correct results for the distribution of traffic and current assumed. Such assumptions can only approximate to average working conditions, and it is only prudent to allow a considerable margin on the upper side in assuming the traffic, for growth and other obvious possibilities. Again, the feeding points so found may not be the best practically. It would be better, for example, to feed the track at a junction, connecting the feeder to all the diverging roads, than at a near point indicated by calculation, which should result in excessive current density in the rails of one road. Such excessive density may damage rails and possibly cause local damage to pipes near by. The best density of current for track feeders is determined exactly as for trolley feeders, giving the wasted watts their proper rate as "boosted watts." Unboosted track feeders are of no commercial value, as Mr. Parshall distinctly showed in the Paper before referred to. In our example, the density for boosted feeders has already been shown to be 306 per square inch, giving a drop of 13·75 volts per mile run. From these figures the feeder sections and losses, and sizes of boosters, can be readily applied to suit the feeding points found in the manner above explained. The detailed calculation for track feeders is given in Appendix No. 4, and all track feeders needed on this system are shown in diagram B. The list of them is as follows:—

No.	Route.	Length.	Current.	Sections, sq. in.	Tons, Cu.	Value.	Drop.	Loss in watts.
1	T E'wards	2·97	120	0·39	10·5	£1,585	41·6	5,000
2	T W'wards	4·00	273	0·89	32·3	4,877	60·24	17,000
3	T to J	2·15	127·5	0·415	8·1	1,223	32·4	4,200
		9·12			50·9	£7,685		26,200

Boosters to a total capacity of, say, 36 kw. would be needed, costing, say, £15 per kw. or £540. Annual charges at 15 per cent. on these amount to £81. As before, the interest on the mains is rather less than the cost of power, the assistance of the rails coming in to reduce it. We then get on the track side:—

Loss in feeders, 26·2 k.w., worth annually	£600
Interest on cables, 7 per cent. on £7,685	538
Charges on boosters	81
	£1,219

Adding this to the cost on trolley side, £1,291, we get a total of £2,510. This equals 0·266d. per unit delivered to the cars making its cost there 1·016d.; and the total annual generating and distribution costs, as far as here considered, £9,936. There will be 25·645 miles of cable laid in 12·025 miles of trenching, weighing 104·15 tons, to the value of £15,853, in addition to the cost of laying them. Boosters will cost £740. The electrical efficiency of the whole system will be about 427·5/499 = 86 per cent. or a trifle higher. These figures show very strongly that a single low tension station for this system is very expensive in first cost of distribution plant, cables alone costing £32 per kilowatt capacity. The regulation as to potential drop in rails puts direct supply out of court as soon as the distances and traffic exceed certain moderate figures. It seems, however, that a modification in track construction, using continuous girder supports under the rails and dispensing with concrete and setts between them, should be a logical consequence of electrical

* Paper read before the Institution of Electrical Engineers, May 3rd.

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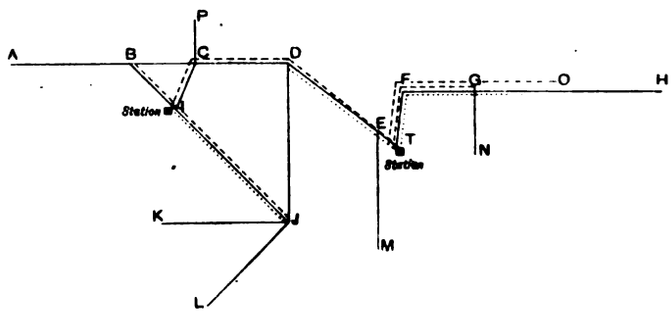
traction, and that the conductivity of the track might thus be largely increased and bonding made much more permanent without much increase in construction costs. The difficulty now experienced at the joints of tram rails should disappear, and the life of the road be greatly increased. For electric traction purposes the granite between the rails is entirely unnecessary. Municipal tramway engineers might give this a trial; companies cannot do so in the present state of the law.

The first alternative to this costly single station system is the provision of a second generating station (diagram C), still using low-tension plant and distribution, and retaining T as one station, as the plan indicates that T is fairly well placed for the eastern part of the system. The junction I appears to be a good position, consequently the second station is assumed to be at that point. The arrangements east of T will remain unaltered. On the west, the two stations ought to supply power up to equidistant points measured along the tracks. The cross-country conductor TJ will not be needed, and though useful for enabling one station to assist the other in case of breakdown (a valuable advantage of multiplicity of stations), it will not be further considered here. The equidistant point on the route TDCI is 0·1 mile west of D, and on the route TDJI it is 1·68 miles south of D. The western station I will then supply all the cars between C and D and two out of the five between D and J; its load will then be 24 cars or 360 amperes, leaving T to provide for 33 cars or 495 amperes. The cost of generating



Trolley feeders – – – – – – Track Feeders
Limits as in Diagram B.

DIAGRAM C.—Low Tension, Two Stations.

and the most economical current density are taken at the same figures as for the single station. T has to supply westward the current for 14 cars, or 210 amperes as follows:—

60 amperes for branch EM, average distance 1·35 miles.					
105	ditto	TD,	ditto	1·17	do
45	ditto	DJ,	ditto	3·20	do

The two cars on branch FD are taken as before, as supplied via F. At the voltage drop of 15·8 per mile the total watts lost come to 5,500. East of T they are as before, 8,250 unboosted, 720 boosted. I has to supply 360 amperes as follows:—

30 amperes to branch DJ, average distance 3·3 miles.					
45	ditto	IJ,	ditto	1·4	do.
30	ditto	JK,	ditto	3·9	do.
15	ditto	JL,	ditto	3·8	do.
90	ditto	CD,	ditto	1·6	do.
30	ditto	CP,	ditto	0·8	do.
30	ditto	ICB,	ditto	1·35	do.
45	ditto	IBC,	ditto	0·7	do.
45	ditto	AB,	ditto	2·1	do.

The total watts lost come to 10,602. No provision is made in this for boosting, as only a little current is carried beyond the 50-volt drop limit, and under the circumstances that drop is unlikely to be exceeded in actual work. The copper sections, weights, and values needed will be as follows:—

Direct Feeders.

Line.	Length, miles.	Amperes, mean.	Section, Cu., sq. in.	Tons, Cu.	Value.
TF	0·9	187·5	0·531	4·35	£655
FG	1·25	120	0·342	3·56	533
TE	0·35	203	0·579	1·84	278
ED	2·00	98	0·277	5·02	758
IB	1·1	75	0·213	2·13	323
IC	0·9	142	0·404	3·30	498
IJ	2·8	98	0·277	7·01	1,058
CD	1·65	45	0·129	1·93	292
	10·95			29·14	£4,400

Boosted.

TO ... 3·8/14·75 ... 45 ... 0·134 ... 4·63 ... £699

Total 33·77 tons, value £5,099.

The cost of distribution on the trolley side is thus:—

Loss in direct feeders, 24·37 kw., worth annually	£411
Loss in boosted feeders, 0·72 kw., worth annually.....	16
Annual charge on boosters	6
Interest on direct feeders, 7 per cent. £4,400	308
Interest on boosted feeders, 7 per cent. £699	49
	—£796

This works out per unit delivered to the cars £796/2,340,000 = 0·81d., or total 0·831d., disregarding losses in returns. The track feeder east of T remains as before, and that west of T must tap the rails at D and carry 120 amperes, have a section of 0·391 sq. in. with a drop of 35·5 volts, needing a booster of 4,260 watts. From I one feeder to J carrying 43 amperes section 0·140 sq. in. drop 42·2 volts, will require a booster for 2,600 watts. No other will be needed, though a small addition to the service and load on the line between A and D would call for a feeder to B or C. The track feeders are then as follows:—

Line.	Miles.	Amperes	Section sq. in.	Tons, Cu.	Value.	Drop.	Loss watts.
T E'wards	2·97	120	0·39	10·5	£1,585	41·6	5,000
T W'wards	2·35	120	0·39	8·33	1,258	35·5	4,260
ISE.....	2·8	43	0·14	3·55	536	42·2	1,815
	8·12			22·33	£3,379		11,075

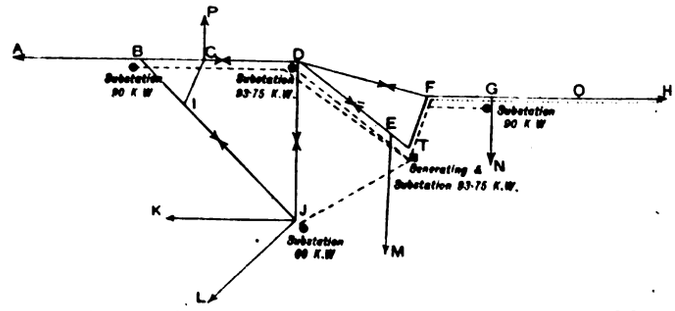
Boosters to a capacity of, say, 18 kw. will be needed, costing £270. The cost of distribution on track side will thus be:—

Loss in feeders, 11·075 kw. worth annually	£252
Interest on cables, 7 per cent. on £3,379	236
Charges on boosters, 15 per cent. on £270	41
	——£529

and the total cost of distribution:—

Trolley side.....	£796
Track side	529
	——£1,325

equal to 0·135d. per unit, or a total of 0·885d. The capital cost of the cables will be £8,478, their length 22·87 miles, laid in 13·85 miles



High tension 3-phase feeders – – – – – – No low tension feeders needed.
Arrow heads indicate supply limits from sub-stations.

DIAGRAM D.—High Tension, One Generating Station and Five Transforming Stations, one being at Generating Station.

of trenching, and the cost of boosters £310. The cost of the cables amounts to £18 per kilowatt full load output, and the efficiency about

427·5/468 = 91·5 per cent.

The annual costs of generation and distribution as above qualified will be £8,751, or £1,185 less than with the single station, and this sum is the margin out of which the extra working and capital charges due to the use of a second station have to be met. Unless such extra charges exceed the saving in distribution, the two-station system will be the more economical. A sound knowledge of the local conditions should enable a fair estimate to be made, but it is not susceptible of calculation on general principles. The incidental advantages of the multiple-station system should be carefully considered in each case, and if the calculable operating costs are about equal, those advantages should turn the scale in its favour.

Multiphase Distribution.—Assume one station, at T (diagram D), generating plant to give three-phase current at 2,500 volts. Using three-wire mains, the current per conductor will be

Kw. $1{,}000/2{,}500 \times \sqrt{3} = (\text{Kw. } 0\,23)$ amperes.

The cables will be of the three-core twisted or equivalent type, and on this account as well as the larger amount of insulating material needed, their cost per ton of copper will be higher. The depreciation will also be at a higher rate. First, because the scrap price will be a lower proportion of total value; and, second, because high-tension cables certainly suffer more from faults than those under low tension. Therefore R is taken at 9 per cent., p at £208, the other values remaining as before—

$$t^2 = 9 \times 58{\cdot}45 \times 208 \times 0{\cdot}045 \times 9{\cdot}1/100 = 448 \text{ and } T = 21{\cdot}2,$$

the density $21{\cdot}2/0{\cdot}045 = 470$ per sq. in., and the drop per mile 21·2 volts. The loss in any three-wire three-phase conductor will be $3\,C \times 21{\cdot}2$ per mile, where C is the current as given above for the

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load transmitted, so that the loss per kilowatt delivered to the cables will be 0·69 × 21·2 = 14·62 watts per mile, or 1·46 per cent. per mile. Transformers will be required at G, T, D, J, and B, the output needed being as follows :—

From G	.....	12 cars	.....	90 kw.
„ T	.....	12·5 „	.....	93·75 kw.
„ D	.....	12·5 „	.....	93·75 kw.
„ J	.....	8·0 „	.....	60·0 kw.
„ B	.....	22·0 „	.....	90·0 kw.
	Total	57·0 cars		427·5 kw.

These loads are allocated on the simple consideration that each transformer should supply half-way to its neighbour in each direction, and represent the energy delivered to the cars. Loss on the low-tension side has to be added to get the gross output, which may be taken at 450 kw. Hence at four of the five stations 100 kw. sets, and at the other a 65kw. or 70 kw. set would suit. But allowance must be made for spares and for unusual demands due to local pressure or bunching of traffic. Whether it would be better to put down two 100 kw. or three 50 kw. sets at the larger stations should in every case be determined on comparison of the cost of the different sized sets with their switch gear, the probabilities of exceptional traffic, and other fairly obvious considerations. It might well happen that the two larger sets would cost little more to instal than the three small ones, and that the extra flexibility would be well worth the cost. Assuming, however, that the three-set plan is adopted, it will be necessary to instal transformers to a total capacity of 705 kw.

The high-tension feeders to these sub-stations will be as follows, assuming a full-load efficiency of transformation of 85 per cent., or rather a constant loss during operation at the rate of 15 per cent. of the rated capacity, and 2,500 volts pressure :—

Line.	Miles.	Amperes.	Sec. (sq. in.).	Tons, Cu.	Value.	Loss in watts
TG	2·15	3 × 24·2	3 × 0·051	2·98	£620	3,307
TD	2·35	3 × 25	3 × 0·053	3·27	680	3,736
TJ	2·15	3 × 16·1	3 × 0·034	1·95	406	2·201
TB	5·25	3 × 24·2	3 × 0·051	7·30	1,518	8,080
	11·90			15·50	£3,224	17,324

The loss in the transformers on the above assumption will be 15 per cent. × 470 = 70·5 kw. With this disposition of sub-stations no track feeders are needed, and secondary trolley feeders can also be dispensed with, as the trolley wires of usual size will not drop more than 10 volts average all over the system, the worst point being H, where the drop will be 32 volts. The trolley wires leading east of G, from T to E, and B to C, will be somewhat heavily loaded, and for reliability of service it might be well to use some auxiliary feeders, or heavier trolley wires on these sections, but this will not be necessary for distribution efficiency.

The distribution losses will then be :—

	kw.	
In high-tension cables	17·3	
In transformers	70·5	
In trolley wire	8·55	
		96·35

and the generating plant must be able to give out 524 kw. Overall efficiency of the system being thus 427·5/524 = 81 per cent. nearly. This is a little higher than Mr. Parshall's figures for Dublin. No addition has been made to the cable losses for power factor being less than unity, and it appears probable on the rather scanty information obtainable in this country that full justice is done to current practice in the above result. To obtain the annual cost of this distribution, proper charges on the transformers, including attendance, have to be estimated. This again is not easy, for the prices of such plant are are not readily obtainable, but for the present purpose market prices are not essential. There is good authority for the statement that for smaller sizes than 200 kw. motor generators perform better than static transformers and rotary transformers, therefore motor generators are assumed in the following figures :—

Motor generators to capacity of 705 kw. at £15 per kilowatt with switch-gear	£10,575
Four sub-stations and sites at £80 each	320
	£10,895
Interest, depreciation and repairs, 12½ per cent. on £10,575 and 2½ per cent. on £320	1,329
Attention to each set, say 3s. per week or £7. 16s. per annum, 15 sets	117
Oil, brushes, and sundries, say £2. 10s. per annum, per set ...	37
Total per annum	£1,483

The distribution costs then work out as follows :—

High-tension conductors, C²R loss value 17,324/58 45	£295	
Interest on cables (cost £3,224)	290	
Loss in transformers 70,500/58·45	1,205	
Loss in trolley wire, 8,550 at 48·5 per £1	176	
Interest and attention and stores on transformers ...	1,483	
		£3,449

This sum amounts to 0·352d. per unit delivered to the cars, making the cost of the power there 1·102d. per unit, or £10,875 annually. This is 0·217d. per unit, or £2,124 per annum in excess of the two-station direct supply, and £939 in excess of the one-station direct supply, as will be shown by the tabulated results below.

Obviously a high-tension station cannot generate at a lower cost per unit than a low-tension station on the same site, but the result of this investigation goes to show that if in the neighbourhood a site exists with such advantages that the cost per unit of the power generated there and delivered to T, or equal point, will be under 0·53d., instead of 0·75d., there will be an advantage in using the transformer system. In other words, this calculation shows what saving in generation costs is required to justify the use of a transformer system and a high-tension station.

The capital expenditure is not much reduced, as the total for cables and transformers amounts to £14,119, which lies between the costs of cables and boosters in the two low-tension systems discussed. There would be also a considerable saving in cable-laying expenses, due to the lighter cables and smaller number of ways needed. This point and the difference between the capital outlay in the stations are foreign to the present subject, but must of course be keenly studied in practical designing. It should, however, be noted that the load factor is of great importance, and that the assumed conditions are rather more favourable to a transforming system than the conditions usually found in practice, for the reason that the losses in transformers are largely independent of the load, and that sufficient transformer capacity must be kept in use to provide for the maximum demands during any given period. The device of dividing into small sets and putting them in as needed cannot be carried far for several reasons. Hence the losses are more nearly those due to the maximum than to the average load over any given period. Cable losses, on the other hand, vary with—and as the square of—the actual load, consequently a poor load factor tells much more against the efficiency of transformers than of cables.

The small proportion of the total losses due to the high-tension transmission indicates the small effect of distance on the overall efficiency, so that the radius within which the advantages of a specially favourable position for a generating station may be utilised is not severely limited. For lines on which multiphase motors and the consequent increased number of overhead wires are practicable, it is apparent that the advantages of this system are very great. Only static step down transformers being required, the overall efficiency can be kept high, and attendance at sub-station made very trifling. This is hardly a live subject in this country yet, but the economies of distribution on such a system can be worked out on the same lines as here put forward when occasion shall arise and the regulations to be complied with shall be known.

The principal figures in the three schemes above worked out are here tabulated for comparison :—

—	Low tension.		High tension.
	1 station.	2 stations.	1 station.
Distribution costs, annual	£2,510	£1,325	£3,449
Ditto per unit at car	0·266d.	0·135d.	0·352d.
Generation and distribution, annual ..	£9,936	£8,751	£10,875
Ditto per unit at cars.....	1·016	0·885d.	1·102
First cost cables and transformers ...	£16,593	£8,788	£14,119
Miles of cables	25·64	22·87	11·90
Miles of trenching	12·025	13·85	9·55

APPENDIX No. I.—Calculation of Most Economical Current Density.

Rate of ohmic loss. C^2r watts, where C = current in amperes and r = resistance in ohms.

Rate of interest and depreciation loss in £ sterling per annum. = (R/100) pma + constant. Where R = rate per cent. per annum of interest and depreciation ; p = price in £ per ton of copper in the form of cable, m = tons of copper per mile of conductor of 1 sq. in. cross section ; a = cross-section of conductor in square inches, so that $m\,a$ = tons of copper per mile; and the constant represents such costs of laying and other expenses as are practically dependent only upon the length of cable laid and independent of its size. To add these losses they must be equated for definite conditions of load and period of use. For this purpose, assume the period to be one year ; the load to be steady and lasting for a certain fraction of every day = $h/24$. A certain cost per Board of Trade unit delivered to the conductor = n pence. Then £1 per annum is the cost of $240/n$ Board of Trade units wasted per annum, and the rate of waste in watts which gives such a loss is $240{,}000/(hn \times 365)$, or $657{\cdot}5/hn$. Call this w. It is the number of watts which, wasted during all the working hours in a year, will cost £1. Then (R/100) $wpma$ is the interest cost of the cable expressed as a loss in watts during working hours, and the total rate of cost of distributing the current C through the cable is $y = C^2r + (R/100)\,wpma$. The resistance of the conductor obviously affects the value of the two quantities making up the total loss in opposite ways, and the problem is to find the value of r which makes y least. Consider a cable of one mile in length. If the resistance of one mile of copper conductor of 1 sq. in. cross-section is 0·045 w, then $a = 0{\cdot}045/r$, and the second item of the total

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cost $= Rwpm\ 0{\cdot}045/100r$. Since this has been equated to a rate of loss in watts, it may be written

$$C_2^2r^2/r = t^2/r, \text{ where } t = C_2r,$$

C_2 being such a current as would produce the required loss in watts on traversing the resistance r. We then get

$$y = C^2r + t^2/r, \text{ whence } dy/dr = C^2 - t^2/r^2,$$

and this a minimum when

$$C^2 = t_2/r^2 \text{ or } r = t/C.$$

This is the Kelvin law, since when this is the case $C_2 = C$, and the two items of cost representing ohmic loss and interest are equal.

The most economical current density therefore is

$$C/a = t/0{\cdot}045, \text{ where } t = \sqrt{(Rwpm0{\cdot}045)/100},$$

and the most economical rate of voltage drop is t volts per mile. If the load is not steady, but varies in a known way, then C^2 = the mean square of the current in respect to time, and C = the square root of that. In the expression for t^2, $Rpm/100$ is the annual cost of one mile of cable of 1 sq. in. copper section—*i.e.*, of 9·1 tons copper weight. Then $Rpmw\ 0{\cdot}045/100$ may be written $0{\cdot}41\ Rpw/100$ or $0{\cdot}0041\ Rpw$, and the most economical current density written

$$C/a = t/0{\cdot}045 = \sqrt{0{\cdot}0041\ Rpw}/0{\cdot}045,$$

and a table of such densities for various values of the product Rpw can be readily formed.

APPENDIX No. II.—Examples and Tables of most Economical Current Density.

Symbols as in Appendix No. I.

$$C/a = t/0{\cdot}045 = \sqrt{0{\cdot}0041\ Rpw}/0{\cdot}045.$$

R = percentage interest charge on cables.

p = cost of one ton of copper in form of cable.

$w = 657{\cdot}5/hn$, where h = equivalent full load hours of use per day, and n = cost in pence of one Board of Trade unit.

For example, let $\left.\begin{matrix} R = 9 \\ p = £200 \end{matrix}\right\} Rp = 1800$

$\left.\begin{matrix} h = 12 \\ n = 0{\cdot}8d. \end{matrix}\right\} hn = 9{\cdot}6$

$w = 657{\cdot}5/9{\cdot}6 = 68{\cdot}49,$

then $t^2 = 1{,}800 \times 68{\cdot}49 \times 0{\cdot}0041 = 505{\cdot}4$, and $t = 22{\cdot}5$ – drop in volts per mile $C/a = 22{\cdot}5/0{\cdot}045 = 500$ amperes per square inch. The equality of ohmic and interest losses is readily shown. One mile of cable of 1 sq. in. section will cost £200 × 9·1 = £1,820, and the interest on it at 9 per cent. will be £164, while the ohmic loss will be $500 \times 22{\cdot}5 = 1{,}125$ watts, worth also £164 per annum: to the nearest £1 in each case. Tables for varying values of Rp and w are convenient, in the following form:—

$Rp = 1{,}200.$

w.	t = drop per mile.	Best density.
40	14	312
50	15·7	362
60	17·2	383

$Rp = 1{,}500.$

40	15·7	362
50	17·6	392
60	19·2	427

$Rp = 1{,}800.$

40	17·2	383
50	19·2	427
60	21·1	469

or a table giving values of t and best density for values of the product. Rpw may be readily made and used.

APPENDIX No. III.—Calculations for "Boosted" Feeders.

The only special factor in these is the correct value of w. Such value should take into account the transformation loss in the booster, and the annual charges on that machine referred to its output. If n is the cost of a Board of Trade unit at the main switchboard, and the efficiency of the booster at its average working load is x/100, the transformed units will cost $(100/x)\ n$ in energy alone. Again, if the machine cost £a per annum in interest and depreciation, and £b per annum for attention and stores consumed per unit of average working output, these charges will add to the cost of the energy $(a + b)\ 240/365 \times h$ in pence per Board of Trade unit, the value of w will then be

$$w = \frac{240{,}000}{\{365h \times (n100)/x\} + 240(a + b)}$$

For example, if a booster cost £15 per kilowatt output, and 12 per cent. is charged for interest, &c., and if it costs 10s. per annum for attention and stores, these costs amount to £2·3, or $a + b = 2{\cdot}3$, then, if the set is in service 15 hours per day $(a + b)\ 240/365\ h = 2{\cdot}3 \times 240\ 0{\cdot}5475 = 0{\cdot}11$ pence.

With $n = 0{\cdot}75$d. and efficiency 75 per cent., the cost per unit transformed becomes $(0{\cdot}75 \times 1{\cdot}33) + 0{\cdot}11 = 1{\cdot}11$ pence; and $w = 240/(1{\cdot}11 \times 5{\cdot}475) = 39{\cdot}5$ The values of w so found should be used in calculating the best density of current in the "boosted" feeders. It must be noticed that where boosters are used, as on trolley feeders, to keep the drop within certain limits, the boosters have only to supply the difference between the permitted drop and that which occurs in the feeders, and the current density found as here explained is that which should prevail in the corresponding distance beyond the point at which an unboosted feeder will give the limiting drop. Hence the total drop in the boosted feeder should be the sum of the limit, and that in the length beyond at the density here found, and the actual section of the feeder should be such as to give that drop on the actual feeder length. Thus, if the limiting drop is 50 volts, and that is given by an unboosted feeder 3 miles in length; whilst a boosted feeder is 4½ miles long, and should drop 15 volts in the 1½ miles excess, the proper uniform density in the whole 4½ miles should be such as to give 65 volts drop. Unless supply is given much beyond the limiting drop distance the decrease in current density as compared with that found for direct feeders will not be large. In track feeders, however, the "boosted" density is practically correct, as the permissible drop is always much exceeded. The best density for secondary feeders supplied from transformers is found in the same way as for track feeders.

APPENDIX No. IV.—Calculation for Track Feeder, East of T.

Rail resistance, 0·0289 w per mile.
Drop allowed, 5 volts.
Amperes × miles constant for 5 volts = 173.
Current per car, 15 amperes. Cars passing in pairs.

From T Eastwards.

Cars.		Amp. miles. Product.	Sum.
T to F, 5 cars, 0·9 mile.	1st pair	30 × 0·3 = 9	
	2nd pair	30 × 0·6 = 18	
	1 at F	15 × 0·9 = 13·5	
	2 on line DF	30 × 0·9 = 27	67·5
F to G, 4 cars, 1·25 miles.	1st pair	30 × 1·21 = 36·3	103·8
	2nd pair	30 × 1·83 = 54·9	158·7
	2 on line NG	30 × 2·15 = 64·5	223·2

As the sum is brought over the constant by the current flowing in at G from branch NG, G should be a point of change of direction. The product of amperes × miles on branch NG is 15 × 1·1 = 16·5. This added to the 158·7 at G = 175·2, a little over the limit. Hence the whole of the 30 amperes from branch NG should flow east, and the integral of ampere miles from G to feeding point should be 173 – 16·5 = 156·5, to keep N at 5 volts.

Then from G Eastwards. Section GO, 4 cars.

1·5 miles long. Current flowing east 30 amperes from branch NG.

Cars.	Amp. miles. Product.	Sum.
At G	16·5	
G to 1st pair	30 × 0·375 = 11·25	27·75
1st pair to 2nd pair	60 × 0·75 = 45·00	72·75
2nd pair to O	90 × 0·375 = 33·75	106·50

H being terminus, and only 2 cars between H and O, it is obvious that feeding point should be west of O, so sum westwards from H. H to O 1·7miles.

Cars.	Amp. miles. Product.	Sum.
1st pair to O	30 × 0·85 = 25·5	
O to 2nd pair GO	30 × 0·375 = 11·25	36·75
2nd to 1st pair GO	60 × 0·75 = 45·00	81·00

Feeding point will thus be between the 1st and 2nd pair of cars east of G. It should be exactly 0·825 miles east of G. The product from this point will be 54·75 to the terminus H and to N, corresponding to 1·58 volts drop. Hence the feeding point may be 3·42 volts above earth.

The track feeder will have to carry back 120 amperes, and be 2·975 miles long. Section should be 0·39 sq. in., and the drop in it will be 15·06 × 2·975 = 45 volts. But as its end may be 3·42 volts above earth, the booster will have to give only 41·58 volts, and have an output of 41·58 × 120 = 5,000 watts, say.

Track Feeder No. 2.

From T Westwards.—It is obvious to inspection that some current should return viâ D and some viâ J. The dividing points should be those at equal distance from T by each route. On the branch DJ this point is practically at the centre of its length, hence half the total current is taken as flowing each way. On the circuit TDCIJT it is very close to the junction I. Hence the current returning by J will be half that on the branch DJ, and the whole of that on branches from J to I, K and L respectively, making altogether 8·5 × 15 = 127·5 amperes, which gives at once the section of the track feeder from T to J. It also follows that the potentials of points D and J should be kept equal. Find feeding points, &c., as before. T to D, 7 cars 2·35 miles. Branch CM, 4 cars = 60 amperes at 0·35 miles from T. Assume 1 car at D, the other 6 in pairs at 0·59, 1·18 and 1·77 miles respectively from T.

Current Eastwards towards T.

Cars.	Amp. miles. Product.	Sum.
T to C	60 × 0·35 = 21·00	
T to 1st pair	30 × 0·59 = 17·70	38·7
T to 2nd pair	30 × 1·18 = 35·40	74·1
T to 3rd pair	30 × 1·77 = 53·10	127·2
T to D	15 × 2·35 = 35·25	162·45 = 4·7 V.
T to O, part current from branch DJ	4·4 × 2·35 = 10·5	173

giving 5 volts at D.

Current Westwards from D.

D to C, 1·65 miles, 6 cars, passing at 0·41, 0·82, 1·23 miles from D, 33 amperes from branch DJ also—

Cars.	Amp. miles. Product.	Sum.
D to 1st pair	33 × 0·41 = 13·53	
1st to 2nd pair	63 × 0·41 = 25·83	
2nd to 3rd pair	93 × 0·41 = 38·13	
3rd to C	123 × 0·41 = 50·43	127·92 at C

Count back from A to find equal point.

A to B, 2 miles, 3 cars, assume 1 at A, 2 in middle.

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CURRENT EASTWARDS FROM A.

Cars.	Amp. miles. Product.	Sum.
A to 1st pair	15 × 1 = 15	
1st pair to B	45 × 1 = 45	60

B to C, 1·1 miles, 2 cars, assume in middle, current of one car from branch BJ. Continue summing from A.

Cars.	Amp. miles.	Product.	Sum.
B to middle	60 × 0·55 = 33		
Middle to C	90 × 0·55 = 49·5	.....	142·5 at C.

This indicates feeding-point a little west of C, but as 60 amperes more enter from branches north and south of C, and C is the meeting place of four tracks, it is clearly the proper place for the feeder to tap the rails. If this point be kept at earth potential, A, the point farthest from T will be at 4·1 volts above earth. The feeder will be 4 miles long, have to carry 273 amperes back, have a section of 0·89 sq. in., will drop 4 × 15·06 = 60 24 volts, and booster must give 273 × 60·24 = 16,445, say 17,000 watts.

TRACK FEEDER No. 3.

Inspection of the diagram suffices to show that J must be the feeding point for this. The greatest drop thence will be on branch JK, 2·2 miles long with two cars. Assume one at K and one half way, then ampere miles KJ will be 41·25 or 1·2 volts. J must then not be more than 3·8 volts above earth. This is lower than D, so that more than the half current on line JD will return by the feeder viâ J. *Per contra* part of the current from branch IJ will go viâ IC. The assumed distribution could be obtained by splitting the feeder at J, and connecting the branches at proper points on the three lines JL, JK, JI. No practical advantage would result, as in working the load on each feeder is regulated to keep the pilot wire indications within proper limits, by control of the booster E.M.F., and it is quite certain that the actual load and its distribution will vary widely and rapidly in any given case from any assumed distribution, consequently in a network requiring a number of track feeders it is sufficient to ensure that they shall be provided of needful section and number to enable the P.D. on the rails to be kept within limit, and refined investigation of the current distribution is likely to be labour lost. Hence No. 3 feeder may be safely taken as tapping rails at J. It will be 2·15 miles long, carry 127·5 amperes, have a section of 0·415 sq. in., drop 32·4 volts, and require a booster to give 32·4 × 127 5 = 4,130, say 4,200 watts.

DISCUSSION.

Prof. ANDREW JAMIESON said he was at Cape Town the other day, and had found a drop of 30 volts between the end of the line and the power house.

Mr. A. M. TAYLOR said that polyphase working, which had been referred to in the last section of the Paper, was especially interesting from the fact that it would be necessary to consider in the immediate future whether light railways, as well as tramways, could be worked economically by this system. As it had occurred to him that its advocates would probably try to reduce Mr. Sayers' figure for the distribution costs—viz., 0·352d. per unit delivered to the car—he had calculated how much it would be possible to do so. Some might claim that reduction could be made in the losses in the motor generators; but even supposing, for the sake of argument, an efficiency of 92½ per cent. were taken (which would be an extremely high value and could only hold where static transformers and rotary converters were employed, and hardly then), this item would only be changed to 0·292d., which was something like one-third of a penny on every unit turned out by the sub-station. In the case of a long, straight line, with a comparatively infrequent service, the conditions would be quite different. He considered Mr. Sayers had favoured the multiphase system by allowing such a small amount for attendance at the sub-stations—viz., 3s. per week per set, or 9s. per week per sub-station—and he did not quite see how it was going to be managed. On the other hand, as he had already mentioned, a rather high value for the losses in the motor generators was taken by the author. The results obtained by him (Mr. Taylor) in the matter of the cost of distribution on a multiphase system were, under the most favourable conditions for the same size system as that considered by Mr. Sayers, about 0·292d., and under the least favourable conditions, about 0·378d. Taking the case, already mentioned, of a long, straight line of single track, with a sub-station working three miles on either side of it—say with a half-hour service—they would have 20,000 motor car miles per annum for each mile of line, or a total of 120,000 car miles per annum. The cost of distribution came to 0·56d., or with a 20-minute service 0·44d. for every unit delivered to the car, and whether this was a practicable amount to have to pay as an extra item for the cost of distribution was, of course, questionable. There were two statements in the early part of the Paper which were rather important—viz., that the distance to which it was possible to distribute economically was not limited by the density of the traffic, and that the cheaper the cost of power the *shorter* the range of economical distribution. The first point seemed a little strange, and one might think of the gradients and how they would affect the distance. But it seemed that these did not affect the limit at all. The reason of the second statement was that Mr. Sayers' formula led him direct to a particular current density for each case, which was higher as the cost of power was cheaper. Hence, having fixed his drop at 50 volts for every case, as a limit, that limit was reached at a less distance when the density was higher—*i.e.*, when the cost of power was cheaper. His last point referred to boosters, and in this connection he could not understand Mr. Sayers' figures. It appeared that he proposed to allow 3·16 miles to go unboosted, and then to use a booster to supply the part beyond that limit and only boost for the voltage that was beyond that 3·16 miles. He thought Mr. Sayers would see on reflection that it would be necessary to boost for *double* the number of volts he proposed—the 50-volt limit of drop having been reached at 3·16 miles. The drop in the trolley wires, or distributors, working back from the point of connection with the feeders, must be taken into account as well as the drop in the feeder itself.

Mr. EUSTACE THOMAS considered Mr. Sayers' Paper of considerable interest and importance in that it strongly advocated the laying out of feeder systems with a view to securing the greatest possible economy in working. As a general rule the first cost of the cables has been the determining factor, and as a result, very few lines in the country are working under the conditions of Lord Kelvin's law. Two years ago he had worked out a modified method of applying Lord Kelvin's law which had brought the whole question straight to the cable price list and gave more accurate results than other methods in that it took into account the variation in the cost of insulation as well as in the cost of copper. The method will be found to have the further advantage of being very rapid in application. Let C = current conductor has to carry, L = length of conductor in feet, £ = cost of B.T.U. in £, p_1 = cost in £ of one mile of a given size of cable. p_2 = cost in £ of one mile of the next size of cable *larger*. H = number of hours per annum the current C will flow, r_1 = resistance of one size of conductor per mile, r_2 = resistance of next size of conductor per mile, I = rate of interest allowed on capital, allowing for maintenance and depreciation.

(1) Resistance of first conductor $= r_1 \times L \div 5{,}280$,

and watts lost $= C^2 r_1 L \div 5{,}280$;

$\therefore$ B.T.U. lost per year $= \dfrac{C^2 r_1 L \times H}{1{,}000 \times 5{,}280}$,

$\therefore$ Cost of energy wasted $= \dfrac{C^2 r_1 LH \times £}{1{,}000 \times 5{,}280}$

Similarly for r_2 cable $= \dfrac{C^2 r_2 LH \times £}{1{,}000 \times 5{,}280}$;

$\therefore$ Saving by using r_2 cable $= (r_1 - r_2) \times (C^2 LH \times £)/(5{,}280 \times 1{,}000)$

(2) *Cost of Cable.*

Cost of one mile $= p_1$.

,, L feet $= p_1 L/5{,}280$.

Annual cost for interest, &c. $= p_1 L/5{,}280 \times I$.

Similarly per second cable:—

Annual cost for interest $= p_2 LI/5{,}280$.

$\therefore$ Extra annual expense through using second cable $= (p_2 - p_1) LI/5{,}280$.

The two cables will be equally economical, and be the best possible as regards economy of transmission, if above saving = corresponding increased expenditure.

i.e., if $(r_1 - r_2) C^2 LH \times £/1{,}000 \times 5{,}280 = \{(p_2 - p_1) LI\}/5{,}280$,

i.e., if $$\frac{p_2 - p_1}{r_1 - r_2} = \frac{C^2 LH \times £}{LI \times 1{,}000} = \frac{C^2 \times H \times £}{1{,}000 \times I}.$$

Now the ratio on the left can be embodied in a price list, since it is dependent on the cable only. The following is an example of this:—

Size.	r.	p. $\dfrac{p_2 - p_1}{r_1 - r_2}$.
19/16	0·7013	270
19/15	0·5565	330 > 406
19/14	0·4507	396 > 624
19/13	0·3409	520 > 1,130
19/12	0·2656	650 > 1,885

Hence for the above conditions we determine the value of

$$\frac{C^2 H \times £}{I \times 1{,}000}.$$

Find the nearest value in the table in the last column and select the corresponding cable as the most economical.

It is important to note that the cost of producing *extra* energy only should be considered. This ought to be considerably less than the average cost of producing the whole energy supplied by the station. Also the amount reckoned for interest would be 2 or 3 per cent. perhaps in the case of a Corporation borrowing money at low rates, while it might be 5 to 10 per cent. in the case of a company paying the corresponding dividend. It is to be noted particularly that in most cases cables cannot be worked at their most economical current density as this would result, where long and short feeders are used in the same system, in a great variation of voltage at the feeding points. If Mr. Sayers' assumptions are examined it will be found that the shortest feeder would have a drop of only about five volts, whereas the next longer feeders would have a drop of about 30 to 37 volts. In actual fact the current density in the short feeder would be increased considerably above Mr. Sayers' figures, as with the feeders shown it would not be possible to section the line completely. This would probably make some variation in the feeding system advantageously, and this would affect the comparative cost of this system.

Mr. B. JENKIN was of the opinion that this Paper should not be taken as in any way comparing the relative merits of a system worked by one station as against a system worked by two stations or comparing again these systems with multiphase systems. It was extremely interesting as a calculation of a *particular case*, but they could not generalise in any way from it, and this should be borne in mind very closely. Another point was Mr. Sayers' statement that feeders should be run to separate sections, and it would be interesting if the author gave more information on this matter. It appeared to him that it must depend entirely upon the

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number of cars on the line and the nature of the line. Very likely with few cars it would be possible to use the copper very much more economically by connecting the feeders to a number of places on the trolley wire, otherwise there might be several sections lying idle without any car getting current from them, whereas if the feeders were connected in parallel with the trolley wire as he had just suggested, the whole of the copper would always be usefully employed.

Mr. E K. SCOTT said that the multiphase system would work very much better if Mr. Sayers had taken, instead of a primary voltage of 2,500, about double that.

Mr. JAMES SWINBURNE said he always had some fear, in reading a Paper like this, that accuracy was sacrificed for simplicity of calculation. Kelvin's law was Kelvin's law as long as it was simple, but as soon as real circumstances were dealt with, there were all sorts of things which came in. The first and most obvious difficulty in applying anything at all like Kelvin's law was the question of insulation. Of course the insulation did not vary as the cost of the copper, and it went up with the pressure and so on, so that this gave at once one large departure. Another question of cost which he did not think traction people had considered sufficiently, was the eating of pipes. Of course generally the pipes were not theirs, and the cost need not be included. He did not know whether the tramway companies fully understood the English law on this question. As he understood it, it seemed that a private individual was liable to damages if he ate anybody else's pipes but that by working under an Act of Parliament they could eat as many pipes as they liked provided they took the ordinary precautions and did not eat more pipes than they could help. The Board of Trade was supposed to keep down the consumption of pipes, and generally, if they followed the Board of Trade, they were supposed to get off scot free. But speaking seriously, he thought this question of the corrosion of pipes was going to be one of the greatest difficulties in electric traction work, and there was one method which had not been sufficiently considered in this country, viz., the three-wire system. The ordinary three-wire system was applied to almost every case except electric traction. The Board of Trade rules at present would not allow the three-wire system at all, and if it was to be used they would have to be altered. The question had been discussed before their Institution once or twice, but perhaps the real reason that it had not been adopted was because some American had once said it was not used over in America, and therefore nobody had ever thought of applying it over here. Drawing a sketch of the three-wire connections on the blackboard he said that, although in electric lighting on this system the load could be balanced fairly well, in electric traction work this was very much more difficult, and the difficulty in this direction was accentuated because they had to begin on a small scale, and, therefore, might have a lot of cars in one street and none on the other. If they had a block, for instance, all the cars would collect in one street, and there would be very great difficulty in balancing. But surely the booster system was perfectly applicable to the three-wire system of traction work? A comparatively small booster on a three-wire system would do all that was wanted, and the bigger the system the easier it was to manage. On the other system the bigger the installation the worse it was to keep going. He could not help thinking that, especially for very large districts, the three-wire system with a booster on the middle return was very well worth consideration. Otherwise, the only other method of getting rid of electrolysis was to have boosters on the pipes.

Mr. P. V. McMAHON, the engineer to the City and South London Railway, said this line was on the three-wire system, and that balancers with battery sub-stations were used instead of boosters.

Mr. SWINBURNE said Mr. McMahon was speaking of electrolysis where they could control the two sides to some extent. He was speaking of tramways where there was an earthed return and consequent electrolysis of pipes.

Mr. McMAHON thought balancers came very well within the present Board of Trade regulations.

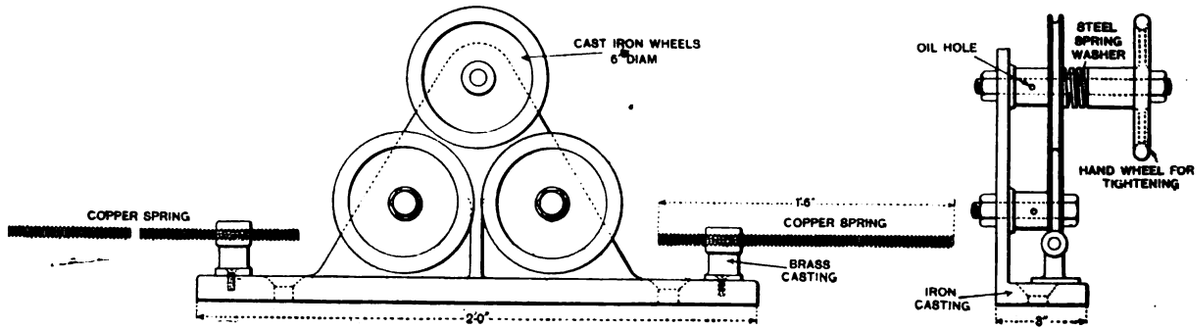
Mr. R. C. QUIN fully agreed generally with all that Mr. Sayers had said, but there were one or two points on which he differed. In the first place he did not agree with the use of drawn-in cables. He had used both systems, and the conclusion he had come to was that if drawn-in cables were used they would soon have to be drawn out again. It was far cheaper to lay cables on the buried or solid system.

Maj.-Gen. C. E. WEBBER remarked that when "Galileo said the earth was round" (*sic*) and his opponents were certain it was flat, Galileo gave his reasons for considering it round and the others did not. This occurred to him when the last speaker said he was quite certain the drawn-up system of cables was bad. He had observed a great deal of tramway construction lately, and it had occurred to him that both as regards the laying of cables and the erection of poles, tramway engineers had something to learn from those who preceded them 20 or 30 years ago in connection with telegraph work. The large quantities of telegraph cables that were fixed in the ground had to be taken up within a very few years, and the drawn-in system was universally adopted. He would, therefore, like to hear Mr. Quin's reasons for objecting to the system.

Mr. H. M. SAYERS, in reply, said he felt happy that his Paper had not met with much contradiction or destructive criticism. Probably Mr. Taylor was right in thinking his estimated cost of attention to motor generators was low. He had not had an opportunity of finding what it actually was in practice, and had not wished to take too high a figure. Mr. Taylor was quite right in saying that the grades and densities of traffic did not affect the limit of distribution; it affected the size of the feeders to different points. With regard to the question of boosters, he pointed out that for brevity he simply took one feeder to the centre of gravity of the district beyond the limiting distance, and it was supposed that all the boosted current was taken there. Mr. Eustace Thomas had given a valuable method of comparing two conductors for a given load, but his own method was more general, and if one took a considerable range of conductors one got a general expression for the most economic density. Mr. Jenkin's remark that his Paper must not be taken as a comparison of different systems was perfectly true. Mr. Jenkin also objected to the suggestion that feeders should be run to separate sections; evidently this had conveyed the idea that each feeder should only feed the trolley wire at one point. But this was not assumed or intended. It was found to be best in practice in a large system, however, to separate the trolley wires at various points and to feed each section of trolley wire with one feeder. On a busy system, if loss occurred through this, many advantages accrued. Mr. Scott wanted to know why he did not estimate for 5,000 volts for the high-pressure multiphase system: but it would make very little difference to the costs. He had worked them out, and in practice he should prefer to work with 2,500. Mr. Scott was quite right, however, as to the great difference in the expense of the system if multi-phase motors were used on the cars, and he had pointed this out himself in the penultimate sentence of his Paper. He agreed with Mr. Swinburne that the three-wire system was worthy of consideration, as there were many cases where it would seem to afford a way out of difficulties now experienced. The difficulty was to find anybody to put the money down for the experiment, because it would be an experiment, as there were many details to be worked out. The difficulty in having two trolley wires was quite imaginary, and, of course, a balancer was what one would use to keep up the voltage on the two sides.

TENSION APPARATUS FOR WIRE WINDING.

Messrs. Mavor and Coulson have recently made a simple apparatus for maintaining the tension on the wire when winding bobbins for electromagnets and similar apparatus, and they inform us that it has been found very useful in their own shops. By the ordinary method of simply winding off a braked drum, there is a risk of the wire being damaged if it fouls or is bent sharply during winding. The present device, shown in the figure, consists of three grooved pulleys, placed triangularly on an iron frame, and two spiral spring guides, the wire passing round the former and through the latter. The upper one of the three pulleys is braked by an adjustable spring washer bearing against its boss, the pressure of this spring being regulated by a hand wheel. The guide tubes consist of spiral springs held in the position shown in the illustration. As the wire passes through the spring, the latter will approximately conform to any bends or slight kinks in the wire and tend to straighten them out; but should it fail to do so, it will merely become compressed as the wire continues to be wound on the bobbin, and the tension on the wire will increase gradually instead of suddenly, giving the operator an opportunity of observing that something is wrong and of stopping the machine before the wire is damaged.



Mavor and Coulson's Tension Apparatus for Wire Winding. Scale: One-eighth.

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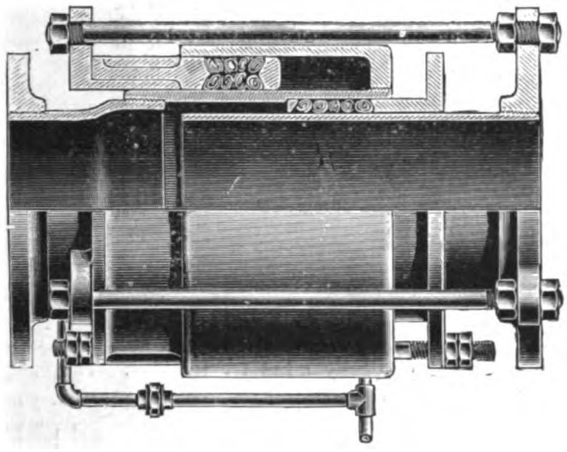
A BALANCED EXPANSION JOINT.

In the balanced expansion joint, shown in the illustration, an annular chamber, provided with a special packing box and piston surrounds the shell in which the sliding pipe works, the areas of the annular piston and sliding pipe being equal. The connections between the pipe and annular chamber are such that the pressure is the same in both, and tends to move the sliding pipe and piston in opposite directions. These forces balance, and the pipe is there-



fore free to slide in or out of the expansion joint without regard to the pressure inside it. The manufacturers of this neat device are Messrs. Brown and Co., 49, Deansgate, Manchester.

IMPERIAL TELEGRAPHIC COMMUNICATION.

In our issue for May 25 we gave a very full abstract of the debate in the House of Commons on May 22, on the motion of Sir E. A. Sassoon, asking that an inquiry should be held "into the commercial and strategical defects of Imperial telegraphic communication." The mover of the motion and the seconder (Sir Charles Dilke) practically dealt with the question from two points of view, the former from the commercial and the latter from the Imperial. Mr. Hanbury, Secretary of the Treasury, in his reply, dealt with more than usual completeness with the whole subject, and on behalf of the Eastern and associated companies a verbatim report of the debate has been circulated, together with the following notes in reply to the various points raised in the course of the debate :—

Winchester House, 50, Old Broad-street,
June 1, 1900.

The debate may be described as the outcome of the various attacks which for some time past have been directed against the British companies owning the submarine cables of the world. In his opening speech Sir Edward Sassoon, like all the subsequent speakers, acknowledged that the British Submarine Cable Companies, by extending British influence throughout the world, had accomplished a great work, as by it Great Britain had been placed in an eminently favourable position. The charges against the companies may be divided into four categories, viz. :—

(*a*) Excessive tariffs.

(*b*) Cables inefficiently maintained.

(*c*) Cables being subsidised by the Imperial and Colonial Governments, the companies do not carry out their contract obligations.

(*d*) Companies hold practical monopolies throughout the British Empire.

1. **TARIFFS.**—In comparing interior with international telegraph tariffs, the fact was apparently lost sight of that the former are fixed by States for messages which have to pass entirely over landlines, or very short cables, and are necessarily fixed at a low figure. These rates have to be arrived at by taking the average distance traversed by each telegram against the average cost of each telegram, whereas the cost of international telegrams has always, more especially when transiting submarine cables, to be based on the transmission over an entire length of line.

Mr. Hanbury referred to Great Britain, and this country may be taken as an example. The average distance traversed by each interior telegram is something like 100 miles, for which one halfpenny per word is paid ; this makes the rate in Great Britain 5d. per 1,000 nautical miles, as compared with the following cable rates of the companies :—

Gibraltar		2·4d.
Malta		2·3d.
Egypt		5·35 l.
India	4s. 0d.	5·96d.
	2s. 6d.	3·72d.
South Africa—Capetown		5·63d.
Ditto Durban		5 32 l.
Australia		3·68d.
New York		3·4d.

It is urged that a rate between India and Europe of 1s. per word should be established, which would equal 1·49d. per 1,000 nautical miles. With regard to such a rate, the following calculation may be of interest.

A new cable between England and India would cost about £1,500,000. The annual cost of this may be estimated as follows :—

Working expenses, including ship	£43,471
Amortisation to replace capital in 30 years	31,529
or	£75,000

without making any allowance for cable used on repairs.

In order to carry traffic expeditiously the cable could only be occupied for, say, 14 hours per day. This would represent, at 7½ paying words per minute, 2,299,500 words per annum, which at 1s. per word, less outpayments, would be equal to £99,000 per annum, giving a profit of £24,000, or 1·6 per cent. on the capital, and it is hardly likely that the public would subscribe money for a company with such a poor prospect.

It is alleged that the tariff between Europe and India has been maintained owing to the astuteness of the Eastern Telegraph Company in arranging, in 1877, a joint-purse agreement with the Indo-European Telegraph Company, and much mystery has been made over this joint-purse agreement.

The facts are very simple. In 1877 the Indo-European Company's line was interrupted for some considerable time owing to the war between Russia and Turkey, and in the interests of their shareholders the directors of that company thought it desirable to enter into a joint-purse arrangement with the Eastern Telegraph Company. The latter company, on its side, was desirous of strengthening its communication with India by having the right to use an alternative route in case of interruption, and a joint-purse agreement was therefore arranged. Six months afterwards the Indo-European Telegraph Department of the Indian Government, who own the line between Teheran and Kurrachee, became a party to the joint-purse, with the object of conserving their revenue.

It was also stated that if the Treasury guaranteed one-third of the loss on a 1s. tariff to India, the utmost that they would be called upon to pay would be £22,000 per annum. The actual facts are as follows :—

The loss on a 1s. tariff between India and Europe, without increase of traffic, would be £270,000 per annum. If the companies took two-thirds of this loss, the Indian Government and the Treasury between them would have to make up £90,000.

Finally, with regard to a general reduction of tariffs, reductions can only conveniently be made during the periodical International Telegraph Conferences, when the representatives of the various interested parties are assembled.

As long ago as August, 1899, the Eastern Company, on its own initiative, informed the British Government that they were quite prepared to negotiate for reductions to and from all British possessions on the basis of standard revenues, combined with a given cable-carrying capacity. The Conference to be held in London next year will, it is to be hoped, provide a favourable opportunity for completing these negotiations. Reductions for South Africa, Australasia, and India have already been agreed to on similar bases.

2. **WORKING.**—Some startling figures were used with reference to the working of the South African cables.

The following, however, are the facts :—Since the cable between Aden and Durban was laid in 1879, it has been interrupted 578 days, or 7·75 per cent. of the total period. Since the laying of the cables in 1839 on the West Coast of Africa, they have been interrupted 663 days, or a total of 17·04 per cent. During the period that two lines have been working with South Africa, simultaneous interruption of the two routes has taken place on 37 days only, or a percentage of 0·92 for the eleven years. Taking the six months ended January this year, the period just prior to the laying of the third cable, the following are the figures :—

East coast cables	50 days	...	or 27·5 per cent.
West coast cables	10 days	...	or 5·43 per cent.
Both cables simultaneously			Nil.

It is customary for the company to keep one repairing ship at Aden, another at Zanzibar, Mozambique, or Delagoa Bay, and a third ship on the West Coast.

Immediately on the outbreak of hostilities, in October last, a ship was sent through the Suez Canal, which took the place of the Aden ship, the Aden ship was sent to Zanzibar, and the ship then at Zanzibar was sent to Delagoa Bay, the ship sent through the Suez Canal being replaced by a ship from London. In this way, ships were at ports within three or four days' steaming distance of any place where an interruption could occur between Aden and Durban, and this operation was carried out in seven days. If the Government had owned the cables, greater precautions could not possibly have been taken to ensure their maintenance.

It must also be remembered that although delays have occurred between South Africa and Europe when single cables have been interrupted, such delay has almost invariably been caused by large Government traffic. In no case have Government telegrams been unduly delayed. The third cable, however, recently opened to the Cape will greatly strengthen the service.

3. **SUBSIDIES.**—It was stated that the Eastern and subsidiary companies had received no less a sum than £3,700,000 for subsidies during the last 20 years. It should, however, be remembered that cable communication was established with the British possessions of Gibraltar, Malta, Aden, Perim, India, China, and Australia, without any subsidy whatever from the Imperial or Colonial Governments. This fact was emphasised by Mr. Hanbury, but is almost always ignored by the companies' critics.

The first substantial subsidy arranged was paid by the Australian Colonies for a *duplicate* cable between Australia and Penang. This line was not required for increased traffic, but was laid in order more effectually to maintain a continuous service. At the time this duplication was arranged, the whole value of the Australasian traffic to the Eastern

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Extension Company was only £84,000. The estimated annual cost of the duplication was £64,500, towards which the Australian Colonies agreed to give a subsidy of £32,400 per annum for 20 years, the company itself taking the remaining liability.

Since the laying of the second cable, telegraphic communication with Australasia has only been totally interrupted 41 days in 20 years, or 0·56 per cent. of the period. In 1889 the company, without any extra subsidy, laid a third cable, connecting Western Australia, at a capital cost of £120,000.

It should also be remembered that for the above subsidy the Australian Governments were granted half rates for their official messages over the Eastern Extension Company's lines, and this privilege was also granted to the Imperial Government, although they did not contribute anything towards the subsidy.

The next subsidy granted to one of the associated companies was for connecting Aden with South Africa. This was for £55,000 per annum, made up by contributions from the Imperial Government of £35,000, Cape Colony £15,000, and Natal £5,000. But there is no doubt whatever that in 1879, when this line was opened, no cable company could have been induced to lay a cable to South Africa without substantial Government assistance. The cable, being urgently needed, was laid very expeditiously owing to the Eastern Extension Company allowing their already manufactured Australian duplicate cable to be used for the purpose. For the first five years the annual revenue from the cable only averaged £85,000, whereas the cost of working, including interest and sinking fund on debentures, was £57,000, leaving £28,000 for interest on capital, without any allowance for reserve.

The South African subsidies have amounted, during the 20 years that they have been paid, to £1,100,000, and it should be borne in mind that the company, without any additional subsidy, arranged a duplicate line to South Africa by the West Coast.

Another subsidy has been paid by the Imperial Government for communication with Seychelles and Mauritius, of £28,000 per annum, and it is quite certain that the Imperial Government would not have agreed to pay this subsidy to the Eastern Companies if they could have obtained the cable on more favourable terms elsewhere. Had the cables between Zanzibar, Seychelles, and Mauritius been subjected to many interruptions the amount of revenue earned, including the subsidy, would have been entirely inadequate.

The African Direct Company also receives a subsidy from Great Britain for connecting the West Coast of Africa, and when it is considered that the English Government has six British stations connected for £19,000 a year, whilst the Portuguese Government are guaranteeing £41,000 per annum for five stations, it cannot be said that for a strategic line of this character the taxpayer of Great Britain has anything to complain of.

No subsidies have been granted by the British Government without conditions limiting the time for repairs, maximum tariffs, and giving the British Government half rates for their official telegrams.

4. **MONOPOLIES.**—As stated by Mr. Hanbury, the Eastern Associated Cable Companies have no absolute monopoly in any British possession. They have a preferential right in Egypt, and preferential rights in connection with the Hong Kong-Labuan-Singapore cable, but these privileges may be terminated at any time by the purchase of certain cables. The Eastern Company has monopolies in some foreign countries, but surely this is to the benefit of British commercial enterprise.

For the 30 years during which the cables of the associated companies have been gradually extended to every part of the world, not a single cable has been laid to any British possession in opposition, although, as has been pointed out, no monopoly of landing rights is held by the companies. It is therefore difficult to understand why, because the business has been carried on successfully with British capital, and because no other association has thought it worth their while to compete on commercial grounds, the Imperial Government should now be called upon to compete by laying cables of their own, guaranteed by the taxpayers' money, against cables that have been laid purely from a commercial point of view, without subsidies and without monopolies. But even if this happened the companies would not claim compensation provided that fair tariffs were established, and they were accorded equal rights and facilities for dealing with their traffic as might be enjoyed by Government or other competing cables ; they would certainly claim compensation if Government cables were laid and worked at a loss and taxpayers' money used to make up deficiencies.

Some supporters of the proposed Government Pacific cable maintain that all traffic intended for the existing companies' cables should be controlled by the Governments interested in that cable, and that the companies ought not to be allowed to deal with their own traffic in Australia in a similar manner to that prevailing in Great Britain and Canada, otherwise the Pacific cable would become a financial failure. This objection, however, is scarcely consistent with the ostensible objects of the Pacific scheme—namely, the breaking up of the companies' so called monopoly, and the cheapening of the tariffs to Australia.

The statement that the British Government is losing about £90,000 per annum, owing to having surrendered its terminal rate, is not correct. The British Post Office, under the Telegraph Act of 1868, allow the cable companies to deal direct with the public in Great Britain, and for this purpose the companies pay to the Post Office a rental for the landlines from their cable landing stations to the very large centres of trade in the country. They also bear the cost of collection and delivery of telegrams at these centres, and on telegrams dealt with by the Post Office, pay the ordinary inland tariff ; consequently they naturally retain the British terminal rate which is inscribed in the International Tables as belonging to Great Britain.

As far as the companies are concerned, they are quite willing, *if their customers desire it, and all private companies are treated in the same manner*, that the Post Office should undertake all the collection and delivery in this country.

A graceful reference was made during the debate to the companies concessions during the present war. They may be briefly summarised as follows :—

1st. All inquiries, and the replies, with regard to wounded officers and men serving in South Africa, are sent *free*, provided they are certified by the War Office.

2nd. Any social telegrams desired to be sent between the officers and men serving in South Africa and their friends in Great Britain or the British Colonies, are transmitted as Government telegrams at Government rates, these telegrams being collected and delivered by the Government authorities.

3rd. Telegrams relating to the various funds which have been started in Great Britain and elsewhere are also transmitted *free*.

With regard to strategic cables, it may be pointed out that in the companies' opinion, cables could be cut in deep water practically as easily as in shallow water, and that the safest position for submarine cables is to lay them along trade routes where men-of-war would have to be stationed in time of disturbance, and that communication should be opened with every place by as many different routes as possible.

As to the suggested purchase of the submarine cables, it may be remarked that cables in moderate depths can now be repaired with comparative ease, and long lengths of new cable are from time to time inserted where required, so that a large proportion of the companies' lines are now in practically as good a condition as when they were originally laid.

A great point was made by all the speakers of the fact that immediately competition viâ the Pacific was definitely agreed upon by the British Government the companies proposed to lay the Australia-Cape-Great Britain cables without subsidy, and at the same time reduce the tariff, although they had previously asked for subsidies. The facts are as follows :—

A subsidy of £20,000 per annum for 20 years was asked for for an all-British cable between South Africa and Great Britain, and this condition has never been withdrawn, but the company was quite willing to lay a commercial line viâ St. Vincent without subsidy, and this has been done, and the Government has acknowledged the justice of a subsidy for an all-British cable by agreeing to give £4,500 per annum for 20 years for a portion of the all-British cable to be laid between Sierra Leone and Ascension.

For the cable between South Africa and Australia a subsidy of £5,000 per annum was required for connecting the British islands of Rodriguez and Cocos, together with a continuation of the Australian duplicate subsidy of £32,400 for 10 years, this latter being equal to £18,577 for 20 years.

This proposal was made more than three years ago, but owing to the large increase of Australian business, almost entirely due to gold speculation in Western Australia, the companies now find themselves in a much stronger financial position than was anticipated, and are, therefore, able to undertake the large expenditure of £1,750,000 unaided by Government, which they were not in a position to do at the time the original offer was made.

CORRESPONDENCE.

LONG DISTANCE TRANSMISSION OF POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The President of the Institution of Electrical Engineers has taken the trouble to write two letters in one number of your journal in support of statements which he made when discussing a Paper by an ordinary member, read at the Institution. If these criticisms be erroneous, and if the member dislikes to take part in a controversy of a personal character, yet even then the rules of courtesy demand that he should take some notice of the honour bestowed on his work by the criticisms of one occupying so prominent a position.

With these preliminary observations I will, with your permission, make a few impersonal remarks regarding a Paper on electric power transmission lately read by me before the Institution of Electrical Engineers.

1. If anyone imagines that he cannot get a worse efficiency than 50 per cent. in a transmission line, let him try it (it is easily tried in the laboratory), and he will find that he can get any efficiency between 0 and 100 per cent.

If he prefers to think it out, and gets puzzled by not noticing that the speed of the motor at the receiving end can be reduced to any amount by increasing the mechanical resistance, let him consider the case where incandescent lamps are used instead of a motor. Let him use 400-volt lamps, and so many in parallel as to give 200 amperes. Then, if the generator delivers 1,000 volts to the line, and if the line has 3 ohms resistance, he will have no difficulty in realising that the efficiency of transmission is only 40 per cent. *In no sense* is it true that the efficiency cannot be less than 50 per cent.

2. On looking at Table II. of my Paper referred to above, and using 0·12 efficiency, it will be seen that 8·27 H.P. must

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be generated for every horse-power delivered at the end of a booster line of two sections, and 2·88 H.P. must be delivered at the end of the first section. It will also be seen in the table that the copper in the two sections together is 0·504 tons, and it is 0·374 tons for the first section, at the end of which section 2·88 H.P. is delivered with an efficiency 0·8464.

Now, if anyone, when attempting to prove my tables wrong, should be so careless as not to notice these facts, and if in consequence he were to assume that the weight of copper in the first section was only half of that in the two sections, and that only 1 H.P. instead of 2·88 H.P. was delivered at the end of that first section, he would inevitably be led to the erroneous conclusion that, "with the very same conductor and same generator voltage" he could "deliver the same power with an efficiency of 0·6536 or more" (in fact, 0·67), "through that section." But the tables given in my Paper would be none the worse for his criticisms.

3. The advantages of the booster method become most important only in special cases of unlimited cheap power, long distance, and no excessive voltage. I have no desire that everyone shall adopt the methods that I adopt for planning transmission schemes; and I do not propose at present to explain any further the methods which I adopt in special cases in practice.

I have to-day departed from my rule of refusing to take notice of imperfectly-considered criticisms. I have done so only in deference to the prominence of the position held by Prof. Perry. But whilst I shall decline in future as I have done in the past to waste my time and your space in useless personal controversy, I shall at all times be pleased to acknowledge in your journal any real error in my work that your correspondents may point out. The tables published in my Paper before the Institution of Electrical Engineers have been checked by four computers, and you may rest assured that they are correct.—

Yours, &c., GEORGE FORBES.

Westminster, June 5, 1900.

ELECTRIC BOATS FOR THE THAMES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your note in the current issue puts many points in favour of an electric passenger service in a definite manner, and should help to gain financial support for such a scheme. I would like to supplement what you say by a few actual figures based on results obtained with the Callow-Eck system of electric launches.

For a service on the Thames between Greenwich and Battersea, at five-minute intervals, in large and safe boats, the cost per passenger mile, including all charges (*i.e.*, rents, salaries, depreciation, and maintenance, as well as generating and navigating expenses), allowing for the boats to be on the average only one-fifth full, would be 0·16d., so that for a penny fare either way from London Bridge passengers could be carried at a profit provided there were no pier dues. Taken that the boats were only one-fifth full on the average, such a service would produce over 10 per cent. on its capital, or if this were divided into a secured debenture and ordinary shares the latter would receive over 15 per cent. The problem is, therefore, quite in the region of practical economics, and will, I trust, be put into working long before the London County Council get powers to establish a river service.—

Yours, &c., JUSTUS ECK, M.A., M.I.E.E.

London, S.W., June 6.

LEGAL INTELLIGENCE.

Crow (District Surveyor) v. Whitechapel District Board of Works.

At Thames (London) Police Court last week, the magistrate, Mr. Dickinson, delivered judgment in a summons by Mr. Arthur Crow, district surveyor, against the Whitechapel Board of Works for executing certain work in Great Prescott-street, without serving a building notice, in accordance with the London Building Act. It appeared that the board have been engaged laying electric lighting cables and inspection chambers under the footway. The chambers were brick built, with iron joists for the roof, and no notice had been given of these works. The chambers were provided to facilitate handling the cables in case of necessity without disturbing the paving.

Mr. DICKINSON said it was a summons taken out by the district surveyor against the Board of Works, for not having given him (the district surveyor) notice before certain works, viz., the construction of boxes or chambers under the street for the purposes of electric lighting were begun. For the defence, it was contended that it was not necessary to give such notice, first, because the London Building Act, 1894, did not apply, the boxes being constructed under the provisions of the Electric Lighting Orders Confirmation Act, 1892, a special Act which was not consistent with the general Act, and therefore overrode it; and, secondly, because even if the general Act did govern it, those boxes were not "buildings, structures, or works" within its meaning. By sec. 72 of the London Building Act, 1894, it was enacted that any construction under any public way should be constructed in such manner as might be approved by the district surveyor; and by sec. 145 where any "building, or structure, or work," was about to be begun, a building notice respecting it must be served on the district surveyor. In the 1892 Act the clauses relied on by the defence were clauses 11 and 12. Clause 11 gave power to undertakers (*i.e.*, the Whitechapel Board of Works) to "construct" boxes in the streets. The third paragraph of that clause enacted that every such box should be constructed in such manner as not to be a source of danger by reason of inequality of surface (*i.e.*, to the public using the street), or otherwise. Who was to be the judge whether there was any such danger? Probably not the undertakers themselves, but the duly appointed officer under the Building Act, whose duties were imposed by sec. 72 of that Act. Clause 12 required a notice of the works, with plan, to be served on the Postmaster-General and also upon the London County Council: on the Postmaster-General on account of the exigencies of the Post Office, and on the London County Council because if the street was repairable by them the other provisions of the section should, with the necessary modifications, apply to them in like manner as to the Postmaster-General. It appeared to him (the learned magistrate) that the 12th clause only dealt with the notices to be given to the Postmaster-General and the County Council for the purposes he had mentioned, and had nothing to do with the notice required to be given to the district surveyor where any structure was to be made under any public way, that he might look after and guard the safety of the public using the way. It was asked, "Why give notice to the district surveyor?" who "had nothing to do with the streets." The answer to that was the 72nd section of the Act. The principle which had to guide him in coming to a decision on that point was, Is there anything in the special Act of 1892 so inconsistent with the general Act of 1894 that they cannot stand together? If such inconsistency did exist the provisions of the special Act must override those of the general Act, and it had been held in the "City and South London Railway Co. *v.* London County Council," and "London County Council *v.* School Board for London," that such inconsistency did exist. But if the provisions of the two Acts were reconciliable, the cases of "Uckfield Rural Council *v.* Crowborough District Water Co.," and more recently the "London County Council *v.* the Wandsworth and Putney Gas Co." decided on April 2, 1900, show that the provisions of the general Act must prevail. He was unable to see any inconsistency there. The undertakers, who were by statute given powers for interfering with the streets, had to give notices (for certain purposes) to the Postmaster-General and to the County Council, but that liability was quite consistent with an obligation to give notice to the district surveyor (as they would have had to do had they been doing any similar work not under any statutory powers) in order that he might see that the work was properly done for the public safety. Further, upon the question of whether the Building Act applied, it was important to look at sec. 201, the exemption clause, which did not include electric lighting, though it specially mentioned railway, dock, and gas companies; but there was a section (203) which did specially mention electric supply companies, and exempted certain buildings (those boxes or chambers not being amongst the number) from the general provisions of certain parts of the Act, the inference to be drawn therefrom being that the other buildings of such companies were to be subject to the provisions of the Act. Upon the second point, whether those boxes or chambers, which were admittedly of varying size, were "buildings or structures or works" within the meaning of the 145th section, he was of opinion that they were. They were the artificial work of man, excavated, and then specially constructed with bricks and mortar, and used for a definite purpose. He could see no reason why the terms should not apply to buildings below as well as on the surface of the ground, which, indeed, was the view expressed by the judges in "Thompson *v.* Sunderland Gas Co." He found that in the case of "The Mayor and Corporation of Tunbridge Wells *v.* Baird," Lord Halsbury, Lord Herschell, and Lord M'Naughton spoke of a convenience which the Corporation had made in one of the streets, sunk to a depth of 9ft., and lighted by skylights on a level with the surface of the street, as "a building, the erection of which is complained of," "construction of this underground chamber," &c. As a matter of fact and of law, then, he found that those boxes or chambers came within the 145th section. He, therefore, imposed a nominal penalty of 1s., and £10. 10s. costs, and agreed to state a case.

Sanding Tramway Tracks.—An appeal was heard on Tuesday and Wednesday, in the Queen's Bench Division, Dublin, from the finding of Mr. Swifte, divisional police magistrate, in December last (see *The Electrician*, Vol. LXIV., pp. 89, 200 and 271), as to the party liable for the sanding of tramway tracks in the case where an electric line is in operation. It will be seen that Mr. Swifte's decision involved the Dublin United Tramways Co. in this liability. The appeal was brought to set aside this decision. After the hearing of arguments the Court, consisting of the Lord Chief Baron, Mr. Justice Andrews, Mr. Justice Madden, and Mr. Justice Boyd, reserved judgment.

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GLASGOW TRAMWAY TENDERS.

(By Telegraph.)

[FROM OUR OWN CORRESPONDENT.]

GLASGOW, *Thursday, June 7.*

At a meeting of the Glasgow Town Council to-day (Thursday) the Tramway committee recommended that as the electric car equipments did not comply with the specifications, the offer of Messrs. Dick, Kerr & Co. for additional car equipments be cancelled, and that additional car equipments be advertised for.

Mr. PATON moved the approval of the minute and Mr. OATTS seconded.

Bailie KING moved that the minute be taken back for re-consideration. He narrated the negotiations with Messrs. Dick, Kerr & Co. and the Westinghouse Co. in regard to their respective offers for car equipments, and alleged that a preference had been shown by Mr. Young, the manager, for the Westinghouse Co. If it was desired to give this order to the Westinghouse Co. let it be done openly. He was satisfied that great damage was being done by the action of the Corporation in this matter. He had noticed in American and other papers that on this subject the Glasgow Corporation tramways department was quoted as against Glasgow manufacturers. He did not know that their experience of American work was such as to cause them to show this preference. The American engines at Springburn were causing great anxiety to the men working them. He might also remind the Council that the American firms received a former order because they were the lowest, and now they were to receive another order because they were the highest, so that there was evidently a desire to give a preference to the American firm. In fact, he believed the real complaint against Dick, Kerr and Co. was that they had rubbed Mr. Young the wrong way.

Bailie W. F. ANDERSON said after the remarks of Bailie King he wished a categorical answer to two questions: Were the Westinghouse Co. permitted to amend their offer after the contracts were opened? Did the Westinghouse Co. get an order for so many car equipments, and, did the Council pass an order for one kind of car equipments to Dick, Kerr and Co.?

The DEPUTY-CLERK (Mr. Monro) read the minute of the Tramway committee of Feb. 20, which stated that car equipments were ordered from three firms, one order being for 100 car equipments from Dick, Kerr and Co.

Mr. PATON said he thought the matter had been settled, because it had received a great deal of consideration in committee, and they came to a conclusion in which everybody was satisfied, with the exception of Bailie King. The motor was probably, with the exception of the engines, about the most important thing in connection with the working of the cars. There was no question in this matter of America versus England, because he believed that both the companies concerned had shareholders in England. In connection with the Springburn route they got motors from the British Westinghouse Co., and these were tested by Mr. Young and found thoroughly satisfactory, and they were working on the Springburn route at the present moment. Motors were also got from Dick, Kerr and Co., and were reported to be unsatisfactory. In the present case a large order for motors had to be placed, and the question came to be where they were to get the best motors for the work. They got offers from the Westinghouse Co. and from Dick, Kerr and Co. Mr. Young reported that there was no difficulty in accepting the Westinghouse Co.'s motors, simply because they had tried and tested them in every way and found them to be satisfactory. He hoped no one would be led away by Bailie King's talk about prejudice on the part of their officers. He acted simply on public grounds, and his desire was to do the best in the public interest, and he could say that as definitely for Mr. Young. Mr. Paton then read a long report by Mr. Young dealing with the respective motors of the Westinghouse Co. and Dick, Kerr and Co., and proceeded to say that it was not until Bailie King came into the field, and gossip got about outside of the committee through Bailie King, that Dick, Kerr and Co. declined to proceed with an arrangement which they had previously agreed to.

The LORD PROVOST said Mr. Paton was not in order in attributing motives to a colleague.

Mr. PATON said he believed he had stated the facts. He had the authority of Mr. Young for saying that the representative of Dick, Kerr and Co. agreed to supply six motors. It was about this time that Bailie King began to take a great interest in the matter, and very shortly afterwards Dick, Kerr and Co. withdrew the offer to supply these six motors. The committee next got Dick, Kerr and Co. to supply them with drawings, and after a good deal of trouble they got these drawings, and had a report from their three engineers agreeing that the drawings submitted would not do the kind of work they were required to do, and, he asked, was it fair and reasonable to accept offers for motors that would place them in a position that might mean disaster. He hoped the Council would do nothing of the kind; that they would depart from the contract for these 100 motors, and re-advertise, when Messrs. Dick, Kerr and Co. might have an opportunity of again offering.

Bailie W. F. ANDERSON asked if it was the case that the Westinghouse Co. were allowed to amend their offer.

Mr. PATON said it was not the case.

Bailie KING said it was not the case that Messrs. Dick, Kerr and Co. offered to supply six motors.

Mr. PATON: I have given you my authority.

Bailie D. M. STEVENSON asked Bailie King to withdraw his amendment. He had fought very well for Messrs. Dick, Kerr and Co. and he should withdraw.

Bailie King then withdrew his amendment.

Another question of contract arose on the minute of the Tramway committee recommending that the offer of Messrs. John Green and Co. for the brickwork of the Pinkston power station should be accepted. The price was £56,835. 12s. 2d.

Mr. PATON moved the approval of the minute.

Mr. WILSON BUCHANAN took exception to this minute. This offer had been accepted irregularly. The offers for this work should have been received by 5 o'clock on May 21. They were opened at 11 o'clock on May 22, and three hours later—or 21 hours after the time specified—this offer was received.

Mr. PATON said that Mr. Buchanan agreed in committee to allow the decision to be unanimous, and he appealed to him in the public interest not to raise the question.

Mr. BUCHANAN declined. They received tenders, the lowest of which was £61,000; yet this tender, which came in 21 hours late, was accepted. It was not in the public interest that this method of doing business should be followed by the Corporation.

Treasurer MURRAY asked if it was competent for Mr. Buchanan, who was present at this meeting, to raise this question if the minute was correct.

The LORD PROVOST said Mr. Buchanan was challenging the accuracy of the minute.

Mr. FORSYTH asked if it was true that this contract was accepted 21 hours after the time specified.

Mr. PATON said it was opened about two or three hours after the other offers.

Mr. STEWART moved that the matter be remitted back. Mr. MAXWELL, in seconding, said a gross irregularity had been committed. They had a number of honourable contractors, and if it got abroad amongst them that such actions were possible in the Corporation they could hardly expect the respect they ought to have.

Treasurer MURRAY admitted an irregularity had taken place, but as a protest he would vote for the minutes.

Mr. HUGH ALEXANDER said as a member of the committee he was not ashamed of the action of the committee. He admitted the tenders were to be in at 5 o'clock on the Tuesday, but on the Wednesday there had been a continuous meeting of the Tramway committee for more than two hours and not a single member objected to the opening of the contract. He contended the committee were justified in opening and accepting the offer.

Mr. PATON admitted an irregularity had been committed. The committee had been sitting continuously from 11 o'clock till 2 o'clock, and when this tender came before them, about 2 o'clock, the committee agreed to its being opened. It was from a first-class man, and it was found to be £4,165 less than the next offer. Had it been a matter connected with their own private business not one of them would have considered it dishonourable to accept it. He could, however, assure the Council that the committee would in future be more careful.

Mr. Stewart withdrew his amendment, and the minutes were then agreed to.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Blackburn.—The first annual report of the Blackburn tramways since their municipalisation shows a net loss of £4,500. Upon one-half of the line electric traction has been substituted for steam. The deficiency is mainly due to the reduction in fares, increase in wages, and the increased cost of coal.

Bootle.—The electric tramway service on the Stanley-road route commenced running on the 27th ult. There is an outstanding dispute between the Corporations of Bootle and Liverpool in regard to the tramways now before the Board of Trade.

Buenos Ayres.—It is announced that the City Council, who some time back granted a concession for the working of an electric tramway down the extensive Calle Cordoba—which line is already working—has lately given permission to a company using horse traction to run their cars over the electric lines. The mayor has, however, vetoed this latter permission, and a project is before the Buenos Ayres Congress to abolish the City Council, whose action in connection with electrical enterprises has proved mischievous and retrograde.

Clevedon.—The Council are about to advertise for tenders for public lighting for one, two, or three years.

Colchester.—The Corporation have resolved to apply for a tramway provisional order. A scheme for wiring premises on the easy payment system has been prepared by the Electric Light committee. The chairman (Councillor Barritt) stated that intending consumers are to have the services of the borough electrical engineer, who will inspect the premises and prepare specifications for wiring and fitting. Tenders are then to be obtained from local tradesmen and submitted to the consumer. The work will be executed under the supervision of the electrical engineer, and a small charge of £1 on the first £10 outlay, and 10s. for every £10 or fraction of £10 afterwards will be made. The consumer will pay 10 per cent. of the total cost on completion of the installation, and the balance by 20 equal quarterly payments. The Electric Light committee anticipate a large demand for current during the coming winter.

Cradley Heath.—The electric tramway now being constructed by the British Electric Traction Co. connecting Cradley Heath, Old Hill and Dudley, will be opened for traffic about the middle of July.

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Dewsbury.—The Corporation has notified the Yorkshire Electric Power Co. that they will not be prepared to take supply of electricity in bulk under the company's power scheme for the manufacturing portion of the West Riding.

Dudley.—The Tramway and Electric Lighting Committee recommend the free wiring of all consumers' premises and the borrowing of £10,000 for this purpose. Further, that customers be charged 6d. per unit for the first two hours and 1½d. afterwards, or 5d. per unit throughout, at their option. Meter rents to be abolished. It is proposed to light the Town Hall buildings electrically and to purchase from the British Westinghouse Co., for £1,360, the engine and dynamos at present hired by the Corporation.

Durham.—The British Electric Traction Co. have notified the City Council of their intention to apply for powers to construct electric tramways in the district.

Ealing.—Sanction is being sought for a loan of £10,000 for electric lighting extensions. The District Council has resolved that all applicants for a supply of electric current beyond 60ft. from the mains shall be called upon to pay the cost of connections at the rate of 6 per cent. per annum upon the additional outlay involved.

Edinburgh.—An unsuccessful attempt was made by treasurer Cranston, on Tuesday, to induce the Corporation to rescind the resolution passed at the previous meeting fixing the charge for electric current for next year at 3½d. per unit.

Electrical Enterprise in Italy.—The city of Genoa is now well supplied with electric tramways. During 1899, 6,417 metres of line were laid, bringing the total up to 49,383 metres, over which 61 cars run daily. There are, in addition, the funicular railways, these lines together carrying in 1899 over 14,500,000 passengers. Electric lines are now open from Genoa to Nervi and on to Pegli. An extensive range of customs and bonded warehouses is being erected at Genoa by an Anglo-Italian joint-stock company, the first block of buildings being estimated to cost £225,000. Seven electric lifts have already been supplied by a Milan firm, and the electric light and power generating plant and nine electric cranes by Messrs. Siemens and Halske, of Berlin.

At the great ironworks and shipbuilding yards of Messrs. G. Ansaldo and Co., of Cornigliano and Sestri Ponente, some of the largest tools in the world have been erected, and are mainly driven by electric power. At this company's steel works, also at Cornigliano, plant is being put down for the construction of electric machinery, apparatus and accessories of every kind, and a large electricity generating station has been equipped to provide power for lighting and driving the company's extensive works and yards in this district. This firm is one of the most enterprising in Italy.

At Spezzia, public and private lighting was inaugurated in September last, and is making good progress.

Fenton (Staffs.).—The cost of erecting and equipping electricity works by the Council is considered to be too great to justify the establishment of an undertaking of this character for the present. The Council obtained its provisional order in 1899.

Freiburg (Baden).—This town is to be electrically lighted. Messrs. Siemens and Halske, of Berlin, have secured the contract for the erection and equipment of electricity works.

Glasgow.—The gross receipts of the Corporation tramways department during the year ended May 31 amounted to £464,763. 13s. 4d., compared with £433,128. 0s. 6d. in the preceding year, an increase of £31,635. 12s. 10d.

Grimsby.—The electricity works in this town are approaching completion. It has been decided to fix the charge for current at 5d. per unit for private consumers. Prof. A. B. W. Kennedy has been asked to prepare specifications for the additional plant required to supply the demand of the local tramways company, who are taking current from the Corporation mains.

Halifax.—In the statement submitted by the Finance committee at the Council meeting on Wednesday, the profit on the working of the electricity department for the past year was put at £5,489, and on the tramways £3,117.

Hampstead (London).—For some time past there has been friction between the Vestry and Messrs. W. T. Glover and Co. on the question of liability for making good certain cables which were laid about five years ago, and which have proved defective. A satisfactory arrangement has been come to between the parties, and a recommendation made by the Lighting committee that an offer from Messrs. Glover and Co. should be accepted has been approved.

Hereford.—The report of the Electric Lighting committee just issued states that the net loss for the past quarter on the electricity undertaking was £36. The demand for current is growing at so satisfactory a rate that further plant will be required to meet next winter's load. The gas undertaking has in no way suffered by the competition of the electricity department.

Howth and Sutton (Dublin).—The clerk of works of the North Dublin Rural Council (Mr. Morris) has been instructed to submit estimates for lighting the district by electricity, gas, or oil.

Hunstanton.—The Council will apply for a provisional order, and a special meeting is to be held in August for passing a formal resolution.

Lecture.—Prof. O. J. Lodge delivered a lecture on "Electrical Vibrations" on Saturday last, at University College, Liverpool. The lecture was illustrated by a number of interesting experiments.

Leeds.—The York-road section of the electric tramway was opened on Wednesday.

Leith.—A report on the proposed extension of the electric light mains to Newhaven and Trinity has been prepared by the late burgh electrical engineer (Mr. W. A. Bryson). It is estimated that the income from public lighting and 40 private consumers in the district would amount to £700 per annum. The sinking fund and interest on the capital expenditure (£10,687. 4s. 3d.) would be £748. An alternative shorter route for the mains is set out, involving a present expenditure of £5,495 and an estimated revenue of £400. Mr. Bryson concludes his report as follows: "As there seems to be a feeling in the minds of several members of the Electric Light committee that I have deceived or misled them regarding the capacity of the cables throughout the burgh, I would respectfully point out that my instructions were to lay down an installation, including engines, boilers, dynamos, mains, &c., for 12,000 8 c.p. lamps, which is practically the scheme accepted by you in Prof. A. B. W. Kennedy's report. I think it must be patent on reflection that it is rather too much to expect that the feeders designed for 12,000 8 c.p. lamps can carry 20,000 8 c.p. lamps, which is our present satisfactory condition."

Bailie Manclark reported on Tuesday that the number of customers of the electricity department had increased from 76 in May, 1899, to 210, with a total equivalent of 18,088 8 c.p. lamps. The income for the 10½ months of last year amounted to £3,370, and the working costs to £2,348, showing a gross profit of £1,071. Interest and sinking fund amounted to £1,721, which left a net deficit of £649, to cover which £1,000 was borrowed from the Burgh General Assessments, and of this £350 had been carried forward. Included in the £1,721 was a sum of £604, repaid to the Public Works Loan Board. Adding this to the £350 they had a total of £954, and taking this from the £1,000 borrowed from the General Assessments they had a deficit of £45 for the first 10 months' running. The statement showed that they were on the right lines, and he thought that before twelve months were up they would have a surplus on hand.

Light Railways.—The Light Railway Commissioners held an inquiry at Mansfield, last week, into the application of the Mansfield and District Light Railway Syndicate for power to construct an electric tramway between Sutton-in-Ashfield, Mansfield, and Mansfield Woodhouse. It was stated that the promoters had agreed not to use or take electricity for use on the line except from the mains of the Mansfield Corporation supposing that Corporation were able and willing to give such supply, and in the event of the Councils of Sutton and Mansfield Woodhouse having powers to generate and supply electric current, the current required for working the tramways in these parishes should be supplied by the respective Councils. The syndicate further undertake to attach overhead wires to buildings along the route of their line should the Mansfield Corporation so require. The Corporation has power to purchase such of the tramways as lies within the borough of Mansfield after 30 years, and in the event of the Sutton and Mansfield Woodhouse Councils not desiring to purchase the syndicate will retain powers to run over the Mansfield lines in the event of the Corporation exercising their option of purchase, the purchase price to be 10 per cent. on the capital outlay. The total cost of the line was estimated at £77,533. Mr. C. H. Gadsby gave evidence that the curves and gradients on the line were easy, and no engineering difficulties were likely to be met with. The trolley system could, he said, be successfully applied in the Mansfield district. Mr. J. H. White, deputy town clerk of Mansfield, said the Council had obtained a provisional order, and intended to construct electricity works in Mansfield as soon as they knew the grant that would be required. Other representatives of the local authorities gave evidence in support of the scheme. The Earl of Jersey, who presided at the inquiry, notified that the Commissioners would recommend the Board of Trade to grant the application subject to a slight amendment in the clauses.

The Glossop Town Council have been asked to favour a scheme for the construction of a light electric railway between Glossop, Hyde and Stalybridge.

The Crewe Town Council have decided to apply for an order to construct a light (electric) railway in Crewe and district. The Cheshire County Council and the Nantwich Rural Council have been asked to sanction the scheme.

Ald. A. Thomas has resigned his position on the Swansea Electric and Tramways committee in order to oppose the Corporation light railway scheme at the forthcoming inquiry.

Malton.—In the electric lighting provisional order for the Malton district the promoters had provided for the erection of generating works outside the district, and the opposition of the District Council to the order was caused by this proviso. The promoters have agreed to erect the works within the district and the opposition of the Council has now been withdrawn.

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Manchester.—As the outcome of the debate at the Corporation meeting last week on the position of the electricity department, the Electricity committee have appointed a sub-committee, consisting of Ald. Doyle and Councillors Batty, Bowes, Boyle, Dr. Bishop, Lambert and Phythian, to inquire into and report upon the entire administration of the department.

Manila.—It is reported that the electric lighting of this town, which is conducted by a Spanish joint stock undertaking, is carried out on first-class lines. Considerable extensions to the plant are now being put down, and Manila will shortly be one of the best lighted towns in the East. The telephone service is also in Spanish hands, and is, it is stated, admirably conducted. According to all reports splendid opportunities for the employment of capital and talent offers at Manilla and other parts of the Philippines.

Monte Video.—We dealt recently with the proposals before the local authorities in Monte Video for the conversion of the horse tramways into electric lines. The *Monte Video Times* states that these negotiations have fallen through.

Middleton.—The Corporation and the British Electric Traction Co. have come to terms as to the supply of electric energy by the Corporation for driving the company's tramways now being laid between Chadderton and Manchester, viâ Middleton.

Municipal Corporations' Associations.—An important gathering of the Association of Municipal Corporations was held in the Royal University Buildings, Dublin, on Saturday last, at which a very large number of English and Scotch municipal representatives were present, including the Lord Mayors of Dublin, York, Manchester, Belfast and Cork; Sir J. Savory, M.P., ex-Lord Mayor of London; and the Mayors of many of the principal towns in the kingdom. After the Lord Mayor of Dublin had introduced the proceedings Sir Albert Rollit, M.P., President of the Association, took the chair. He gave a general review of the proceedings before Parliament, which chiefly affected municipal bodies, after which a series of resolutions were submitted. The first dealt with the expediency of shortening the procedure and curtailing expense in connection with the promotion of municipal private bill legislation in Parliament, and this resolution was unanimously adopted. The Town Clerk of Huddersfield moved the following resolution in connection with municipal tramway enterprise:—

That in the opinion of this Association it is expedient that the Tramways Act, 1870, be amended so as to empower the Board of Trade, on the application of local authorities, to settle and make provisional orders for the construction and working of tramways beyond the districts of such authorities, provided that such tramways will form a connection with any tramways of such local authorities within or beyond their districts.

The President, speaking to this resolution, said the present House of Commons was by no means a favourable one to the rights of municipalities, who were not going to have their rights, whether in reference to electric light, electric power, tramways, or telephones, restricted simply and solely within the limits of their boundaries. If the community were in favour of the extension of the limits, who were so well able to determine what was for the interests of the community as the people who lived in that community, and when the assent and the consent of the surrounding districts were received why should Parliament interfere?—The resolution was adopted.

A resolution urging the promotion of legislation to carry out the recommendations in the report of the Water Gas committee of 1899 was then adopted.

Resolutions on the subject of the easier acquisition of land by local authorities, the simplification of the law relating to the creation and issue of stock, and for the amendment and consolidation of the Public Health Acts having been approved,

The PRESIDENT moved—

1. That enterprises which have hitherto been entrusted by Parliament to municipal corporations, such as gas, water, tramway, electric lighting and power, markets, docks, piers, and other similar undertakings, have been managed efficiently and economically, and for the general benefit of the inhabitants of the localities, and any abridgment or interference with such powers would, in the opinion of this meeting, be a misfortune to the communities severed by such undertakings and a retrogade step in the principles of local self-government.

3. That municipal corporations cannot exercise any trading or other powers beyond those authorised by the general or local Acts. That it is inexpedient to fix a limit to the powers to be granted in future to municipal corporations, and that each case should be dealt with on its own merits.

4. That having regard to the fact that the town council is a representative body, and that manufacturers and traders are members of such council, or are fully represented thereon, there is no fear that any undue interference with the trading interests of any town will be proposed or carried out.

The Lord Mayor of Dublin proposed as an addition—

"That any legislation which imperils the principle contained in the foregoing resolution be opposed by the association."

He thought that in view of the unfriendly attitude of the House of Commons it would be well to have the proposed rider added to the resolutions. The resolutions were adopted with the addition of the suggested rider.

Nice.—Electric tramways have now been substituted for the old horse-driven cars throughout the tramway service in Nice, the work being carried out by the Thomson-Houston Co. The tram lines have been extended to Villefranche, and will ultimately be extended to Monte Carlo. While the trolley wires for the electric tramways are run overhead on the greater portion of the system, the importance of the main Avenue de la Gare and some other of the main thoroughfares traversed by the huge cars which form a feature of the flower carnival has necessitated the placing of the tramway wires underground. The importance of the Nice carnival from a commercial point of view has been held to justify the municipal authorities in imposing conditions upon the tramway company calling for this modification of the overhead system.

The electric tramway at Cannes, in the same district, has been extended to Antibes and also to Vallauris by a branch at Golfe Juan. The venture has proved a considerable pecuniary success, notwithstanding that the company has had to hand over to the State £2,600 to enable the authorities to overcome the interruption to the telephone system caused by the overhead trolley lines.

Pemberton.—Mr. James Ashurst, chairman of the Electric Lighting and Tramways committee of the Town Council stated at a meeting of his constituents that the Council would shortly become owners of the tramway lines, and unless the company now working them agreed to substitute electricity for their horse-driven cars no renewal of their lease would be granted. He strongly recommended the adoption of electric lighting, for which the Council has recently obtained a provisional order. He hoped that "free wiring companies would be permitted to come into the district and wire buildings for the electric light, or that a local company would be formed to carry out this part of the work."

Pietermaritzburg (Natal).—A bill before the Natal Parliament, introduced by the Corporation of this town, seeks power to construct electric tramways within the borough at an estimated cost of £75,000.

St. Helens.—The Parr-Derbyshire Hill electric tramway route was officially inspected on behalf of the Board of Trade on Wednesday.

Shoreditch (London).—It is fifteen months since the London County Council were requested to grant a loan of £67,783 for the Hoxton generating station of the Vestry, and the local members of the Council are to be invited to exert their influence in facilitating the granting of the loan.

South Africa.—Messrs. Siemens Bros. and Co. (Ltd.) have already shipped 1,000 iron poles to be used in the re-erection of land lines damaged during recent hostilities.

Southampton.—Sanction has been obtained for the borrowing of £50,655, out of £55,000 applied for for electric lighting extensions.

South Shields.—A proposal to increase the salary of the borough electrical engineer (Mr. J. A. Jeckell) from £350 to £400 per annum has been deferred for six months.

Stourport.—An application by the Kidderminster and District Electric Lighting and Traction Co. for the Council's sanction to a provisional electric lighting order has been referred to the General Purposes committee.

Sunderland.—A petition has been presented to the Lighting committee for a reduction in the price per unit of electric current, and to abolish the maximum demand system of charging.

Swansea.—The charge for current for private lighting has been fixed at 6d. per unit for the first 1½ hours' maximum demand, and 2d. after. For motive power the charge for the first hour's maximum demand will be 6d. per unit and 1½d. after, or alternatively a uniform rate of 3d. per unit. The Electric and Tramways committee have also decided to supply current on the prepayment meter system. Meters for 1d., 6d., or 1s. in the slot are to be provided, and the price to be charged for current is to be fixed on such a basis as, if necessary, to cover the amount which would become payable to the National Electric Wiring Co., and also the maintenance of the meter, cost of collection, &c. It is proposed to obtain powers to extend the area of lighting to comprise the whole of the borough.

Tottenham.—At a special meeting of the District Council a motion pledging the Council to oppose the North Metropolitan Electric Power Supply Bill was discussed. The following resolution, passed by the Edmonton District Council, was submitted to the meeting and approved:—

With a view to the economy in the generation of electrical energy for power, heating and lighting purposes, this Council is prepared in the next session of Parliament, jointly with the other local authorities, or with the Middlesex County Council, or both, to promote a Bill in Parliament or a Provisional Order (if the object can be effected in that way), for the purpose of enabling the local authorities in the northern and eastern portions of Middlesex, either jointly by themselves or with the Middlesex County Council, to acquire land and generate electrical energy for the purpose of distributing the same in bulk, and for other purposes in which such local authorities and the Middlesex County Council may have a common interest.

A conference of representatives of Hornsey, Tottenham, Southgate, Wood Green, Friern Barnet, and Edmonton was held yesterday

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(Thursday) to discuss details and to organise the opposition to the North Metropolitan Bill after the promoters' case has been completed before the Parliamentary Committee on the 19th inst.

Tramways in London.—The St. James' (Westminster) Vestry are advised to oppose the proposal of the London County Council to construct tramways from the present terminus, Theobald's-road, to Piccadilly-circus, on the ground that a tramway terminus at Piccadilly-circus would cause great congestion of traffic. Cambridge-circus (near the Palace Theatre) is suggested as a suitable terminus.

Tunbridge Wells.—The Council having received a licence to establish a municipal telephone service a report by the Telephone committee, presented at Wednesday's meeting, stated that No. 5, Calverley-parade, had been acquired as a site for the central exchange. The consulting telephone engineer (Mr. A. R. Bennett) had informed them that he was satisfied the estimate he had submitted was sufficient to establish a telephone service; that the inclusion of Crowborough, Withyham, and Mayfield within the Corporation area and the provision of a service for those villages and the subscribers resident there would necessitate an increase of £1,010; that the great success which had attended the Corporation's canvass for subscribers rendered it desirable that partial provision should at once be made for another 100 subscribers, the cost of which he estimated at another £800, making, with his original estimate of £7,119, a total initial expenditure of £8,929. These recommendations were endorsed by the committee. The area has been extended so as to include the parishes mentioned. The committee recommended the Council to authorise them, provided the amount of the tenders which the Council had given them authority to obtain did not materially exceed the amount of Mr. Bennett's estimate, to accept such tenders and proceed with the work without delay. The committee further recommended that authority to borrow £10,000 be obtained. The report was adopted.

Councillor Robb, in presenting the report of the Electric Lighting committee, said that another £10,000 would be required to meet the additional expenditure for electric lighting. The new chimney at the electricity works was estimated to cost £2,500, the new engine £4,600, boiler £1,600, and £1,300 was required for development contingencies. The profit on last year's working amounted to £748. 14s. 10d. It was decided to consult Sir W. H. Preece, and meanwhile to refer the report back.

Wigan.—The chairman of the Electric Light and Tramways committee (Mr. Worthington) announced, on Wednesday, that electricity supply would probably be available in the autumn.

Wood Green (London).—The Light Railway committee of the District Council has been re-named the Electrical committee and has been instructed to prepare an early report on the subject of electric lighting for the district.

Workhouse Lighting.—The House committee of the Kidderminster Guardians are considering a proposal to substitute electric for gas lighting at the workhouse.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Shoreditch (London) Vestry require tenders for the supply of eight dry-back marine-type boilers, or eight water-tube boilers, with automatic stokers, and sundry ironwork for their new generating station at Whiston-street. Specification may be obtained at the office of the electrical engineer (Mr. C. Newton Russell), Electric Light Station, Coronet-street, Hoxton, N., and a copy of the specification may be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders to Dr. H. Mansfield Robinson, vestry clerk and solicitor, Town Hall, Old-street, E.C., before noon on 19th inst. An advertisement contains further particulars.

Dudley Corporation invite proposals for wiring premises in the district on the free or easy wiring system. Particulars are set out in an advertisement, and specification, &c., may be obtained from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. H. C. Brettell), Town Hall, Dudley, by 15th inst.

The directors of the *Highland Railway Co.* invite tenders for stores for six and twelve months from July 1. The company's requirements include telegraph instruments and fittings, telegraph construction material, copper and brass tubes, screws, galvanised steel and iron wire, &c. Further particulars are set out in an advertisement, and forms of tender may be obtained from the stores superintendent (Mr. C. Kennedy), Inverness. Tenders must be lodged with the secretary (Mr. Wm. Gowenlock), company's offices, Inverness, by Saturday, the inst.

Bury Corporation invite tenders for the wiring of the Art Gallery and Free Library. Tenders to the town clerk (Mr. John Hasham), Corporation Offices, Bank street, Bury, by 18th inst. Particulars are given in an advertisement.

London County Council require tenders for the supply (within three months of order) of about 70 arc lamp standards for the lighting of the Victoria Embankment. Further particulars are set out in an advertisement, and specification, &c., can be obtained after 13th inst. at the engineer's department, County Hall, Spring-gardens, S.W. Tenders to clerk (Mr. C. J. Stewart), by 10 a.m. July 10.

London County Council's Asylums committee invite tenders for the installation of electric lighting and power (except generating plant) and the installation of telephones, tell-tale clocks, fire alarms and call bells at the Horton Asylum, near Epsom, Surrey. Tenders to the committee, 6, Waterloo-place, S.W., by 10 a.m., June 16.

Durban (Natal) Corporation require tenders for overhead equipment for about 16 miles of equivalent single track. Tenders to Messrs. Webster, Steel and Co., 5, East India-avenue, London, E.C., by June 29, or to the town clerk of Durban by mail delivery on or about Monday, July 23.

The Electric Lighting committee of the *St. Mary, Newington* (London) Vestry require tenders for the supply and laying of insulated electric mains, conduits, junction boxes, &c. Tenders to the vestry clerk (Mr. L. J. Dunham), Vestry Hall, Walworth, S.E., by noon 15th inst.

The Vestry of St. Mary Magdalene *Bermondsey* (London), require tenders for the supply and laying of insulated electric mains, conduits, junction boxes, &c. Tenders to Mr. Fred Ryall, vestry clerk, Town Hall, Bermondsey, before noon of June 18.

Glasgow Corporation require tenders for outside coal storage and steel structure for coal handling, and locomotive travelling cranes for outside coal handling, for their Pinkston power station. Tenders to the town clerk (Sir J. D. Marwick) by 5 p.m. on 21st inst.

Kingston-upon-Thames Corporation require tenders for excavations and concrete foundations of boiler house extensions, &c., at the electricity works. Tenders by 15th inst.

Bradford Corporation require tenders for a switchboard, or for alterations to existing switchboard, at the Valley-road electricity works. Tenders to the town clerk (Mr. Frederick Stevens) by June 14.

Stockport Gas and Electricity committee require tenders for two water-tube boilers for their Millgate electricity station. Tenders to chairman of committee by 13th inst.

Blackpool Corporation invite tenders for the electrical equipment of 15 single truck tramcars. Tenders to borough electrical engineer (Mr. Robt. C. Quin) by 18th inst.

Sutton Coldfield Corporation invite tenders for electricity generating plant. Tenders to town clerk before noon of June 21.

Sutton Coldfield Corporation require tenders for the erection of electricity station buildings. Tenders by noon 26th inst.

Bootle Corporation invite tenders for supply and laying of underground electric cables, erection of arc lamps, and the supply of mechanical stokers. Tenders to town clerk before June 16.

Croydon Corporation require tenders for engine foundations and for joists and flooring, and also for coal, at electric light stations. Tenders by 14th inst.

Newcastle-on-Tyne Tramways Committee invite tenders for the erection of the new generating station and chimney shaft. Applications to Mr. B. F. Simpson, 12, Gray-street, by 10th inst.

Nelson Corporation require tenders for a storage battery and a switchboard. Tenders to town clerk by June 12.

Tenders are invited for wiring the *Derby* Infectious Diseases Hospital. Tenders by 9th inst.

Tenders are invited for the supply of 300 tons of copper wire for the *French* Telegraphs. Tenders to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, by 19th inst.

Tenders are invited until July 7 for the concession for the construction of an electric tramway from *Puerta de Hierro* to *Aravaca y Pozuelo* (*Madrid*).

The municipal authorities of *Ribadavia* (Orense), Spain, invite tenders for the concession for the electric lighting of the town for 20 years. Particulars from el Secretario del Ayuntamiento, and tenders by July 2.

The Central Administration of Ports and Lighthouses, *Alexandria* (Egypt) require tenders for generating plant for the electric lighting of the Port Said lighthouse. Tenders to Controller-General by noon, July 1.

TENDERS RECEIVED AND ACCEPTED.

Hampstead (London) Vestry has accepted tenders from Messrs. Siemens Bros. and Co., W. T. Henley's Works Co., W. T. Glover and Co., and the British Insulated Wire Co. for the supply of electric lighting cables at schedule prices. The tender of Messrs. Cooke and Co. for the supply of Bwllfa best coal to the electricity station at 27s. 1d. per ton for nine months from July 1 has also been accepted.

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Southampton Corporation have received the following tenders for the supply of a 300 kw. continuous-current generator, coupled direct to medium-speed vertical compound engine. The speed of the engines in (I.) are all at 180 revs., except the British Schuckert Co. (125) and Mather and Platt (120) :—

(I.)—*Combined Plant with speed limited to 180.*

		Delivery in
Mather and Platt (own engine)	£6,154	5 months.
Crompton & Co. (Browett-Lindley)	6,085	10-11 ,,
†Ditto (Browett-Lindley)	6,070	10-11 ,,
British Schuckert Co. (J. and H. McLaren and Co.)	5,925	6-8 ,,
Ditto (Yates and Thom)	5,125	6 ,,
Ditto (Ball and Wood)	5,035	6 ,,
Ditto (Browett-Lindley)	4,789	7½ ,,
Electric Construction Co. (Ball and Wood)	5,924	7 ,,
†Ditto (Ball and Wood)	5.789	7 ,,
Brush Co. (Universal)	5,585	12 ,,
F. Suter and Co. (Browett-Lindley)	5,575	6 ,,
†Ditto (Browett-Lindley)	5,525	6 ,,
Ashton, Frost and Co. (Browett-Lindley)	5,492	8-10 ,,
†Ditto (Browett-Lindley)	5,282	8-10 ,,
D. Bruce Peebles and Co. (Ball and Wood)	5,480	7 ,,
Ditto (Browett-Lindley)	5,087	7 ,,
Mavor and Coulson (Browett-Lindley)	5,287	8 ,,
*F. Nell (Ball and Wood)	5,088	7 ,,
Witting Bros. (Ball and Wood)	4,724	6-7 ,,
Bow, McLachlan and Co. (own engine)	3,960	4 ,,

(II.)—*Combined Plant at higher speed than 180.*

		Delivery in
Crompton and Co. (Willans engine, 300)	£5,689	10-11 months.
†Ditto (Ferranti, 250)	5,078	10-11 ,,
Electric Construction Co. (Willans, 300)	5,057	6 ,,
†Ditto (Willans, 300)	4,934	6 ,,
F. Nell Ball and Wood, 190-200, Schuckert dynmo)	4,939	7 ,,
†Ditto (Ball and Wood, 190-200)	4,979	7 ,,
S. Z. Ferranti (own engine 250 Crompton dynamo)	4,700	11½ ,,
Ditto (own, 250, Bruce Peebles dynamo)	4,540	7 ,,
‡Ditto (own, 250, Schuckert dynamo)	3,600	4 ,,
British Schuckert Co. (Willans, 300)	4 510	6 ,,
D. Bruce Peebles and Co. (Ferranti, 250)	4,250	7 ,,
C. A. Parsons and Co. (own turbine, 3,000)	3,322	— ,,
Ditto (own turbine, 3,000), with smaller generator	2,706	— ,,

* Plus £85 for spare parts scheduled in specification.
† If not required for charging battery.
‡ Recommended for acceptance, subject to design of Schuckert dynamo being approved by Messrs. Kincaid, Waller and Manville, the consulting engineers.

The following tenders for stores were accepted :—Morgan and Co., Shirley, £1. 18s. 6d. ; Lankaster and Sons, £20. 7s. 4d. and £35. 6s. 7d. ; G. Hutch, £20. 16s. 11½d. ; and F. Shalders, £9. 19s. 5½d. and £26. 11s. 8d.

Shoreditch (London) Vestry have received the following tenders :—

For Three Transformers.	Kilowatts.	Electrical efficiency.	
Electric Construction Co. (*accepted*)	560	Full 91% ¾ 90% ½ 88%	£7,570
D. Bruce Peebles and Co.	600	Full 85% ¾ 82% ½ 78%	7,465
Siemens Bros. and Co.	400	Full 93% ¾ 91% ½ 89%	5,890
For Ducts.			
W. Griffiths (*accepted*)		5s. 10d.	per yard
Reid Bros.		4s. 10d.	ditto.
British Insulated Wire Co.		9s. 0d.	ditto.
Steam Pipes.			
A. J. Stewart and Menzies (*accepted*)			£140
Lloyd and Lloyd			£149

Dundee Gas Commissioners have accepted the following tenders for distribution mains :—

British Insulated Wire Co. (supplying and laying cables on solid system)	£8,523	18	1
Callender's Co. (vulcanised bitumen cables)	2,415	8	0

Dundee Corporation have accepted tenders as follows in connection with their electric tramways :—

Callender's Co. (feeders and joint boxes)	£3,695	18	1
Doulton and Co. (conduits)	801	5	0
Albion Clay Co. (conduits)	873	10	0
Lowdon Bros. and Co. (traction switchboard and instruments)	1,063	5	0

Dundee Corporation have also accepted the tender of Messrs. R. W. Blackwell and Co. for the supply of copper bonds, for the sum of £583. 7s. 4d.

Paddington (London) Vestry has accepted the tender of Mr. A. C. Harnden, Harrow-road, W., for the electric lighting of the public baths, Queen's-road, Paddington, for £155. Eleven tenders, ranging from £795 to the accepted tender, were received.

Keighley Corporation are recommended to accept the following tenders :—

Clayton, Son and Co. (Lancashire boilers, economisers, and pumps)	£2,026	0	0
Tudor Accumulator Co. (storage battery)	1,623	0	0
W. Lucy and Co. (condensing plant)	1,542	10	6
Carter Bros. and Co. (constructional steel work)	1,059	6	0
W. B. Haigh and Co. (steam pipes)	854	0	0

Croydon County Council has accepted the tender of Mr. S. Page for erecting a sub-station adjoining the tramway depôt at Thornton Heath for £317. 10s.

APPOINTMENTS VACANT AND FILLED.

The post of senior demonstrator in the department of electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session. The salary is £150, rising to £200. Applications for the post have to be addressed, in the first instance, to the principal of the college, Leonard-street, Finsbury, London, E.C., by June 29. An advertisement gives some further particulars.

Birmingham Corporation require two lecturers for the electrical and engineering departments of the municipal technical school in September next. An advertisement contains further particulars, and applications must be sent to the secretary (Mr. Geo. Miller), Suffolk-street, by 30th inst.

The Council of the Municipal Electrical Association require a secretary to act under the direction of the honorary secretary. Applications to the president (Mr. A. B. Mountain, borough electrical engineer, Huddersfield), by 14th inst. An advertisement contains additional particulars.

The Council of the King's College, London, invite applications for the post of demonstrator in electrical engineering. Conditions of the appointment can be obtained of the Secretary, and applications must be in by 30th inst. See advertisement.

Whitechapel District Board of Works require a mains foreman and also a plumbing jointer. Particulars are given in an advertisement, and applications must be sent to the engineer, 27, Osborn-street, London, E.

A youth is required as tester on mains and house wiring in the electricity department of the Poplar District Board of Works. Applications to Mr. A. Blackman. See advertisement.

Tottenham Polytechnic committee require a teacher of physics and chemistry for evening classes for 1900-1901 session. Applications by 20th inst.

An assistant master (for physics and mathematics) is required for the Day School of Science, Gravesend. Applications by 21st inst.

A head master is required for the day school of the Birmingham Municipal Technical School. Applications by 30th inst.

A shift engineer is required at Blackburn Corporation electricity works. Applications by 9th inst.

An engineer and manager is required for the Stafford electricity and gas works. Applications by 16th inst.

Mr. J. Gray Scott, borough electrical engineer at Whitehaven, has been appointed to the position of burgh electrical engineer at Leith, in succession to Mr. W. A. Bryson, resigned, by 11 votes to 4. A proposal to re-appoint Mr. Bryson was lost.

Mr. W. T. A. Emtage, Principal of the Wandsworth Technical Institute, has been appointed Director of Public Instruction in Mauritius.

Shrewsbury Corporation have appointed Mr. Stephen Kirkwood of the Lancaster Corporation Electricity Works, chief assistant electrical engineer. Thirty-four applications were received.

Mr. A. Nichols Moore, of the Blackpool and Fleetwood Tramroad Co., has been appointed an assistant engineer of the Sheffield Corporation tramways.

Mr. F. J. Jeffs, a student at Mason College, Birmingham, has been appointed second assistant in the Physics Department, Municipal Technical School, Blackburn.

We announced on May 25 that the applications for the post of burgh electrical engineer at Greenock had been reduced to a short leet of seven. The names are H. Foster (Dover), H. L. Howard (Leicester), E. Marples (Liverpool), J. Gray Scott (Whitehaven), H. R. Forbes Mackay (Edinburgh), W. M. Nelson (Greenock), and R. W. L. Phillips (Bristol). On Monday the Electricity committee further reduced the short leet to the three last mentioned. The appointment will be definitely filled by the Council at its meeting on Monday next.

Scholarships.—Two Bowen Research scholarships in engineering and one in metallurgy, and three Priestley scholarships in chemistry, at the Mason University College, Birmingham, will be awarded in September next. The annual value is £95 each, and applications must be sent to the registrar by June 30.

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BUSINESS NOTICES.

Messrs. W. T. Glover and Co. (Ltd.) notify their new address to be Trafford Park, Manchester.

Mr. T. M. Harvey, whose resignation was announced in our issue for May 25, has rejoined the staff of Johnson and Phillips' Electric Cable Works.

BANKRUPTCIES, LIQUIDATIONS, &c.

Geo. Herbert Bentley, electrical engineer, 63, Cross-lane, and 8, Grafton-street, Earlestown, has been adjudicated bankrupt. The first meeting of creditors takes place 15th inst. at the O.R.'s, Byrom-street, Manchester, and the public examination on July 6 at the Court House, Palmyra-square, Warrington.

A receiving order has been made against W. Hirst (trading as Hirst and Co.), electrical engineer, St. Leonard's-road, West Croydon, on his own petition.

Sale by Tender.—Leeds Corporation are open to receive tenders for two horizontal Fowler engines of 400 I.H.P., two sets of Greenwood and Batley dynamos, one spare armature to fit any dynamo, and a switchboard and instruments, the plant being at present in use in connection with the Corporation's system of electric tramways. Particulars will be found set out in an advertisement elsewhere, and it is notified that the plant will be available for removal about February next. Further information can be obtained from Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W.

Messrs. H. N. Newton and Co. will sell by auction, at Epsom Downs, on Tuesday next, at 12 o'clock, four Jackson 2 H.P. and 4 H.P. electric motors on sliding rails, with nearly new 270 ampere Jackson dynamo, switchboards and fittings, and complete electric apparatus, with arc lamps, &c., used in the business of a collotype printer. Particulars of the auctioneers, 67 and 69, Chancery-lane, London, W.C.

For Sale.—A leasehold factory and about 4 acres of land, situated in Essex, and about 12 miles from London, together with tools and plant and surplus stock, are offered for sale by private tender. Further particulars are set out in an advertisement. Tenders must be sent (by June 19) to Messrs. Sydney Lee and Co. (Ltd.), 9, Furnival-street, Holborn, London, E.C., from whom forms of tender and conditions of sale may be obtained.

Fire.—On Thursday, last week, a fire occurred at 82, Victoria-street, London, S.W., which spread to the laboratory of the Nernst Electric Light Co. (Ltd.), and considerable damage was done. Nearly all the special apparatus was destroyed, and some delay must occur before the company can replace it. The company has, however, already started work again.

B.T.H. Plant.—Circular No. 32 issued by the British Thomson-Houston Co. is devoted to overhead trolley-line construction and materials therefor. A large variety of these goods are dealt with. Circular 65 describes automatic circuit breakers.

"Ark" Lamps and Accessories.—Messrs. Johnson and Phillips have ready an exceptionally well-illustrated catalogue of J. and P. "Ark" lamps and arc lamp accessories. As this firm were amongst the earliest makers of arc lamps, they urge that 20 years' success in this branch of manufacture entitles them to be heard on matters dealing with arc lamp illumination. More than usual attention has been given to the compilation of the particulars included in the catalogue, the whole of which will be found of service to consultants, installation contractors, municipal committees, engineers and others indenting for these goods. A choice selection of lamp pillars and wrought-iron brackets is added. Messrs. Johnson and Phillips in introducing this new enclosed long-burning lamp claim many advantages for it, and inform us they have built and equipped with all the most modern machinery special shops for its manufacture. The lamps are being made in large quantities for every class of illumination where enclosed arc lamps are suitable, thereby effecting economies in the cost of manufacture which will enable the makers to place the lamp on the market at prices calculated to meet the severe competition of both home and foreign-made lamps. Most of the lamps and accessories here illustrated are of special design, and the illustrations are in many cases in colours, from photographs direct from the lamps. Accompanying the catalogue is a lengthy list of testimonials from installers and users of J. and P. "Ark" lamps, all of which are of a most flattering character. We illustrate in Fig. 1 a J. P. "Ark" lamp fitted with a strong black japanned case; in Fig. 2 the lamp with case removed, showing entire absence of clockwork, rods, levers, chains, telescoping and other contrivances, and in Fig. 3 the inner globe of simple, inexpensive form. We have selected the lamp shown in Fig. 1 because it is that designed for general use. Some of the other lamps shown in the new catalogue are of more artistic exterior.

J. & P. "ARK" LAMPS.

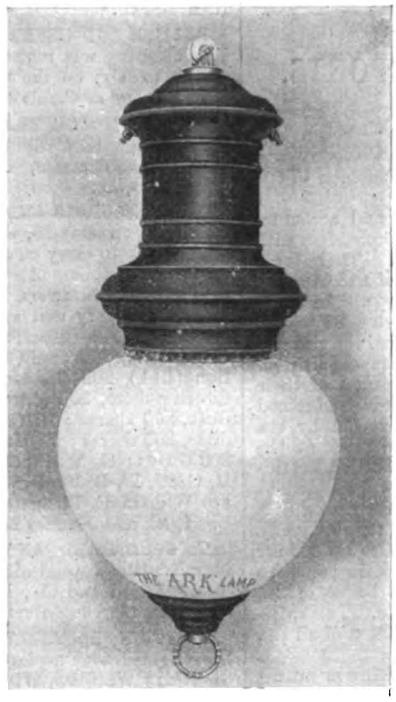

FIG. 1.

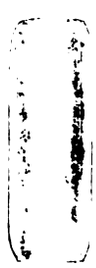

FIG. 3.

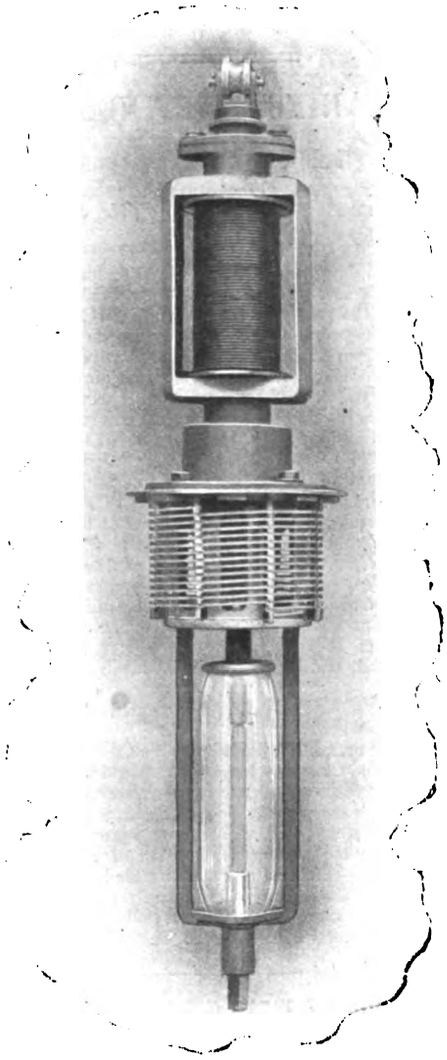

FIG. 2.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 30 to June 6, with the ports of destination:—

Africa—Alexandria, £257; Beira, £101 (telegraph material); Cape Town, £55; Casa Blanca, £135 (telegraph material); Chinde, £124; Durban, £538 (including £101 telegraph material); Port Elizabeth, £63. *Argentina*—Buenos Ayres, £217. *Australasia*—Fremantle, £258 (telegraph wire); Melbourne, £1,692; Sydney, £3,495 (including £1,910 telegraph material); Wellington, £198. *Belgium*—Ostend, £1,051. *Brazil*—Rio Janeiro, £30. *Chili*—Valpariso, £44. *China*—Shanghai, £157 (and 30 tons old telegraph wire). *Denmark*—Copenhagen, £175 (telegraph material). *France*—Rouen, £40. *Germany*—Emden, £1,975 (telegraph apparatus); Hamburg, £300 (telegraph material). *Gibraltar*,

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£135. *Holland*—Amsterdam, £240 ; Rotterdam £38 (telegraph wire). *Hong Kong*, £321. *India*—Bombay, £385 ; Calcutta, £663 (including £507 telegraph wire) ; Madras, £370. *Japan*—Tokio, £38. *Mauritius*, £36. *Russia*—Riga, £82 ; Vladivostock, £145. *Spain*—Barcelona, £262 (including £32 telegraph wire). *Straits Settlements*—Singapore, £52. *Sweden*—Gothenburg, £11. Total (for eight days) £13,683 against £6,904 for the week last year (May 31 to June 6).

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Traction Electrique." By Eric Gerard. (Paris : Gauthier-Villars) 3fr. 50c.

"*Proceedings* of the Royal Society of Edinburgh." No. 7, Vol. XXII., and No. 1, Vol. XXIII. (Edinburgh : The Society.)

"Die Elektrischen Bahnen." By Dr. Max Corsepius. (Stuttgart : Ferdinand Enke.)

"Elektrometallurgie und Galvanotechnik." By Dr. Franz Peters. In 4 vols. (Leipzig : A. Hartelben.) 6 marks.

"The Official Gazette of the United States Patent Office." No. 8 Vol. XCI. (Washington : Government Printing Office.)

COMPANIES' MEETINGS AND REPORTS.

Telegraph Manufacturing Co. (Ltd.).

The ordinary general meeting of the shareholders of this Company was held on Thursday last, at Liverpool, Mr. JAMES TAYLOR, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said it was a great pleasure to the directors to meet the shareholders with such a satisfactory increase in their business and profits. Their gross profit for the past year amounted to £41,284, an increase of £13,012 over the previous year. Their property and assets, including goodwill, had also increased from £127,142 to £145,870 in consequence of extended works, and the purchase of 10 acres of land adjoining their works and the railway at Helsby, which they believed would prove a very valuable acquisition. After deducting depreciation, which was off prime cost, the total of their plant and buildings, &c., now stood at £138,842. The stock-in-trade stood at about £84,000, which was rather large, but was necessitated by the frequent demands for immediate supply. They had a large stock at the Cape, of which they hoped to be able to dispose quickly, now that hostilities were ceasing. Out of the balance at their disposal they proposed to add £3,887 to depreciation account, and £17,500 to reserve, increasing that fund to £27,500, which on a capital of £200,000 was not bad for a company with practically less than two years' working. There was also £4,883 for preference dividend, and in addition to an interim dividend of 3s. per share they now proposed the payment of 7s. per share and a bonus of 2s., making in all 12 per cent. for the year on the ordinary shares. This satisfactory result had been brought about by the loyal co-operation of all the staff.

Mr. CROSLAND TAYLOR seconded the resolution, which was unanimously agreed to.

A special meeting followed at which the CHAIRMAN moved: "That the capital of the Company be increased to £300,000 by the creation of 20,000 additional ordinary shares of £5 each, ranking for dividend and in all other respects with the existing ordinary shares of the Company." The immediate issue he said would be 5,000 shares at a premium of £4 per share, the existing shareholders to have the first option of taking them up. The amount of the premium—£20,000—would be added to reserve. The increased capital was required through the large and rapid extension of the business of the Company. The resolution was carried unanimously.

A hearty vote of thanks to the chairman and directors closed the proceedings.

BELLISS AND MORCOM (LTD.)—The directors' report for the year to March 31 last states that after charging interest on the purchase money and debentures, making ample reserves for depreciation, &c., writing off from goodwill the apportioned amount of profit to May 5, 1899 (the date of the agreement for purchase), and providing for the preference dividend paid to March 31, 1900, the accounts show an available balance of £30,203. 6s. 9d., which it is proposed to appropriate as follows : Dividend at the rate of 10 per cent. per annum on the ordinary shares, free of tax, £9,044. 13s. 9d. ; reserve, £10,000 ; preliminary expenses written off balance, £1,046 ; carried forward, £10,112. 13s. The works have been fully occupied during the past year, and new buildings are being equipped with machinery and brought into use as rapidly as possible to deal with orders in hand.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The report of the directors for the year to March 31 states that the balance at credit of profit and loss is £11,361. Deducing proportion of profits due to vendors to completion of purchase and other expenses, depreciation, &c, there remains £7,904, from which £5,400 is deducted for dividends of 6 per cent. per annum on the preference and an interim dividend of 6 per cent. per annum on the ordinary shares, leaving £2,504. The directors propose a dividend on the ordinary shares of 8 per cent. per annum for the half year, making 7 per cent. for the year, leaving £536 to be carried forward.

MICA MANUFACTURING CO. (LTD.)—At the meeting of the shareholders, held last week, the chairman (Mr. Alfred E. Ann) stated that the demand for mica, especially of small size, for the first time in the history of the company rendered a large number of waste heaps of mica at the company's various mines a really valuable asset, and the company was at present working at four or five of these heaps casting the material away as fast as it could be taken, and selling at a good profit. They were employing 75 people, and the company's prospects were in all respects satisfactory. Sir Samuel Canning has resigned his directorship of the company.

NEW COMPANIES, STATUTORY RETURNS, &c.

H. AND H. ACCUMULATOR SYNDICATE (LTD.)—This company was registered on May 31, with a capital of £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in primary batteries, storage batteries, locomotives, rolling stock and electrical apparatus, fittings and appliances of every description, and to enter into an agreement with Charles Bright and Co. (Ltd.).

AUTOMOBILE MANUFACTURING CO. (LTD.)—This company was registered on April 30 with a capital of £100 in £1 shares, to acquire the business carried on by W. C. Bersey, and the business carried on by Messrs. Townsend and Bizzey, and to carry on the business of motor car builders, electrical and general engineers, &c. The subscribers are W. C. Bersey, E. Townsend, H. S. Wyndham, A. E. Bizzey, S. Lambert, H. Webster, and A. A. Brown.

BRITISH AND GENERAL PUBLIC WORKS CONSTRUCTION CO. (LTD.)—This company was registered on May 21, with a capital of £1,000 in £1 shares, to carry on the business of railway and tramway proprietors, and electrical and mechanical engineers, &c.

BRITISH MOTOR TRACTION CO. (LTD.)—This company was registered on May 14, with a capital of £100 in £1 shares, to carry on the business of electrical, steam, oil and other motor manufacturers, tramway proprietors, &c.

CHARING CROSS AND CITY ELECTRIC CO. (LTD.)—This company was registered on May 28, with a capital of £300,000 in £5 shares (20,000 preference), to carry on the business of electricians, electrical and general engineers, suppliers of electricity for light, heat, motive power and other purposes, wire drawers, &c. ; to construct and maintain electrical works, plant, machinery and apparatus, and to promote the use of electricity generally. The subscribers are W. F. Fladgate, 2, Craig's-court, Charing Cross, S.W., chairman Charing Cross and Strand Electric Supply Corporation (Ltd.), 200 shares ; G. H. B. Glasier, 7, St. James's-street, S.W., director ditto, 200 shares ; S. Gatti, Adelaide Gallery, Strand, director ditto, 200 shares ; R. Chadwick, 34, 35, St. Martin's-lane, W.C., director ditto, 200 shares ; J. M. Gatti, Adelaide Gallery, Strand, director ditto, 200 shares ; G. W. Finch, 22, Queen Anne-street, W., solicitor, 1 share ; R. Gatti, 10, Bedford-square, W.C., merchant, 1 share. The first directors are William F. Fladgate, George H. B. Glasier, Stefano Gatti, Richard Chadwick and Joannes M. A. Gatti.

T. COULTHARD AND CO. (LTD.)—This company was registered on May 8, with a capital of £75,000, in £1 shares, to acquire the business of T. Coulthard and Co., Preston, and to carry on the business of electrical and mechanical engineers, motor vehicle manufacturers, &c.

SCOTTISH ELECTRICAL LUMINCRIPTOR CO. (LTD.)—This company has been formed with capital of £10,000 in £1 shares. The first directors are Sir Henry Wardlaw, William Bow, R. Peacock, and Edward Scott.

BROCKIE-PELL ARC LAMP (LTD.)—The annual return to April 23 gives the capital as £80,000 in £1 shares, 79,965 of which have been taken up. £1 has been called up on each of 25,620, and £25,606. 17s. 6d. has been received, leaving £13. 2s. 6d. in arrears. 54,380 shares are considered as fully paid.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The annual return to March 21 has been filed. The capital is £400,500 in 74,000 ordinary and 6,000 preference shares of £5 each and 500 founders' shares of £1 each, of which all the preference and founders' and 34,000 ordinary have been taken up. £5 has been called up on each of £27,334 ordinary and 6,000 preference and £166,670 has been received.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—According to the annual return to April 10, the capital is £95,000, in 13,000 ordinary and 6,000 preference shares of £5 each, of which 12,931 ordinary and 6,000 preference have been taken up.

LONDON ELECTRIC SUPPLY CORPORATION. (LTD.)—The annual return to April 11 has been filed. The capital is £850,000, in 200,000 ordinary shares of £3 each and 50,000 preferred shares of £5 each, of which 111,000 ordinary and 49,840 preference have been taken up. £585,940 has been received, including £3,740 paid on 1,950 forfeited shares.

NATIONAL ELECTRIC WIRING CO. (LTD.)—The annual return to April 16 gives the capital as £250,000 in £1 shares, 118,971 of which have been taken up. 12s. 6d. has been called on each of 100,120 shares. 18,851 shares are considered as fully paid.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—The annual return to March 13, gives the capital as £448,200, in 37,350 shares of £12 each, all of which have been taken up and paid for in full.

WILLANS AND ROBINSON (LTD.)—The annual return to April 25 has been filed. The capital is £500,000 in 50,000 preference and 50,000 ordinary shares of £5 each, of which 40,000 preference and 40,000 ordinary shares have been taken up. £5 per share has been called up on 15,337 and £3 per share on 10,000 preference, and £5 has been called up on each of 15,538 and £3 on each of 10,000 ordinary shares. £215,375 has been received.

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CITY NOTES.

MEMORANDA.—Bank rate 3½ per cent. (since May 24, 1900). Price of silver 27⅝d. per oz. (June 7). Consols (2¾ per cent.) 101 1/16—101 3/16 for money, 101⅛—102 for account; 2½ per cent. 99½—100 (June 7). Stock Exchange Settling Day: Consols, July 4; Stocks and Shares Continuation Days, June 12 and 26; Ticket Days, June 13 and 27; Pay Days, June 14 and 28; Mining Share Carry-over Days, June 11 and 25.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. has been declared payable on 2nd July. The transfer books will be closed from 20th inst. to 2nd July inclusive.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY CO. (LTD. AND REDUCED).—On July 7 a petition for reducing the capital of this company from £100,000 to £74,272. 12s. (by the cancellation of 18s. per share upon each of 28,586 shares of £1 each) is to be heard before Mr. Justice Kekewich.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LTD.)—It is stated that the proceedings of the committee of investigation into the affairs of this company have come to a standstill, owing to a dispute with the directors as to the proper course to be pursued in order to extricate the company from its embarrassments.

MUNICIPAL LOAN.—Plymouth Corporation is inviting subscriptions to an issue of £250,000 3 per cent. redeemable stock at a minimum price of £95 per cent. The money is required for (amongst other improvements in the town) the extension and electrical equipment of the tramways. The first six months' interest is to be paid September 30 next.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—It is intended to pay off the debentures of this company on the 1st September. Debenture holders are to have the option of exchanging their debentures for £4 per cent. cumulative preference shares.

STOCK EXCHANGE NOTICES.—The London Stock Exchange Committee have appointed June 13 a special settling day in a further issue of 10,579 ordinary £10 fully-paid shares (Nos. 100,001 to 110,579) in the *City of London Electric Lighting Co. (Ltd.)*, and have ordered these and a further issue of 20,000 6 per cent. £5 fully-paid preference shares (Nos. 54,001 to 74,000) in the *New General Traction Co. (Ltd.)* to be quoted in the Official List. Application has been made to the committee to appoint a special settling day in and to grant a quotation to the £125,000 4½ per cent. debenture stock of the *Potteries Electric Traction Co. (Ltd.)*, and 40,000 £5 shares of the *Johnson-Lundell Electric Traction Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways	June 2	4,500	+ 269	21	91,224	+ 4,729
Blackpool Corporation...	May 31	455	- 450	9	3,271	- 409
Blackpool and Fleetwood	June 2	370	- 517	22	5,894	- 1,476
Bolton Corporation	...	...	...	..	...	...
Bradford Corporation...	...	...	...	...	...	...
Brisbane Trams	Apl. 18	1,877	+ 574	3	5,368	+ 1,425
*Bristol Trams & Carriag	June 1	3,047	- 9	22	60,750	+ 1,146
*Buenos Ayres & Belgran	May 6	2,404	+ 29	18	41,386	+ 5,257
City & South London Ry.	June 3	1,434	+ 474	22	27,752	+ 4,559
Dover Corporation	,, 2	185	- 1	9	1,718	+ 118
Dublin United	,, 1	3,467	+ 93	22	71,533	+12,748
Dublin Southern Dist...	,, 1	857	- 126	22	17,331	
*Glasgow Corporation ..	,, 2	9,461	- 294	...	...	...
Hull Corporation	,, 2	1,124	...	48	35,799	...
*Liverpool Corporation...	May 26	8,108	+ 862	21	147,458	+18,695
Liverpool Overhead Rly	June 3	1,352	- 126	22	31,009	+ 693
*Sheffield Tramways	,, 3	2,281	- 923	22	43,283	+12,883
*South Staffs. Trams.....	,, 1	695	+ 76	22	14,335	+ 451

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 30.	Price Wednesday, June 6.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 6. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July.....	...	...
25,000	10	...	Amazon Telegraph	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£823,720	Stock	15/0	Anglo-American	62 65	62 65	5 12 8	Feb., May, Aug., Nov	63	62½
£2,038,640	Stock	30/0	Do. Preferred	114½ 115½	114½ 115½	5 4 5	,, ,,	11[illegible]	114½
£3,088,640	Stock	27/0	Do. Deferred	13½ 14½	13½ 14	9 12 10	,, ,,	...	...
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	102 104	3 17 0	,, ,,	...	...
16,000	10	6/0	Cuba Submarine Ordinary	7 8	7 8	8 15 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	16 17	16 17	5 17 8	,, ,,	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11⅛ 12	11⅛ 12	5 16 8	Jan., Apr., July, Oct.	11⅞	11⅞
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100 103	100 103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	150 155	4 10 4	Jan., Apr., July, Oct.	153½	151
£1,826,858	Stock	3½%	Do. 3½ per Cent. Preference Stock	97 100	97 100	3 10 3	,, ,,	93½	...
£1,422,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) ...	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	6/6	Eastern Extension ..... xd & new	15½ 16	15 15⅛	4 10 4	Jan., Apr., July, Oct.	15⅛	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 117	112 117	3 9 2	February and August	114	...
£6,700	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ..	100 103	100 103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	,, ,,	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	103⅞ 103⅞	103⅞ 103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11⅛ 11⅜	11⅛ 11⅜	4 9 4	Jan., Apr., July, Oct.	11⅜	11⅛
180,042	10	3/0	Do. 6 per Cent. Preference	16⅛ 16⅞	15⅞ 17⅛	3 18 2	,, ,,	17⅛	...
150,000	10	15/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July.....	...	...
£296,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	100 104	100 103	4 8 0	June and December ...	...	...
17,000	25	37/6	Indo-European	53 57	53 57	4 7 9	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 109	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's ..... xd	7⅛ 8⅛	7⅛ 8⅛	4 14 1	April and October.....	7⅛	...
2,381	£100 Cert.	6%	Submarine Cables Trust	124 129	124 129	4 13 0	,, ,,	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	⅛ 1	⅛ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 13 7	January and July.....	...	...
88,321	10	1/0	West India and Panama ..... xd	½ 1	⅝ ⅞	...	May and November ...	⅝	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference ..... xd	7 8	6½ 7½	8 0 0	,, ,,	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference..... xd	6½ 7½	6 7	8 11 5	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	106	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	102 105	102 105	3 17 4	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	15⅛	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105 108	105 108	4 13 10	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,350	10/)	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¼ ⅜	¼ ⅜	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	,, ,,	...	...
430,000	5	3/0	National	4⅞ 5⅛	4⅞ 5⅛	5 17 1	February and August	5	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 14	13 15	4 0 0	,, ,,	13	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	11 13	12 14	4 5 9	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5½	5 5½	4 15 3	,, ,,	6⅛	...
3,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	98 101	3 10 3	June and December ...	100½	98½
171,504	1	0/3	Oriental	1 3/16 1 1/16	1 3/16 1 1/16	4 14 1	April and October.....	...	...
58,000	5	2/6	United River Plate	4¾ 5¼	4¾ 5	8 10)	July	4¾	4 11/16
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December ...	5⅛	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	,, ,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, May 30.		Price Wednesday, June 6.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 6.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord. (fully pd.)	⅞	1	⅞	1	...	...	⅞	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7	7⅛	7	7⅛	...	...	7	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	8¾	9¼	8¾	9¼	4 14 9	February and August	9¼	8¾
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾	6	5¾	6	3 15 0	,, ,,	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6¾	7¼	6¾	7¼	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108	111	108	111	4 2 2	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	9½	10⅛	9½	10⅛	3 16 2	February and August	10⅛	10
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12⅝	13⅝	4 8 11	January and July	13⅜	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	124	129	3 18 11	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½	10⅛	9½	10⅛	3 16 2	...	9 1/16	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅛	11⅝	12⅝	4 16 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	110	113	110	113	4 1 1	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13⅛	12½	13⅛	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7⅛	7	7⅛	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1½	2	1½	2	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100	102	100	102	3 19 3	Mar., June, Sept., Dec.	101	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½	14½	13½	14½	3 9 0	April and October	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	2¾/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96	98	97	99	3 11 6	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½	7	6⅝	7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅞	1	⅞	1	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares x 1	170	190	165	185	4 6 6	April and October	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15⅝	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	,, ,,	9⅜	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85	95	85	95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½	15½	13½	14½	4 9 8	March and September	15 7/16	11⅞
			ELECTRIC MANUFACTURING &c. COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞	⅞	⅞	⅞	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅜	1	⅜	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	13/16	15/16	13/16	15/16	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6	6½	6	6½	4 12 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4¾	5¼	4¾	5¼	...	...	5½	...
90,060	2	1/2⅝	Brush Electrical Engineering	1¾	2	1¾	2	4 0 0	September	...	...
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cum.	2	2¼	2	2¼	5 6 8	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103	113	109	114	3 19 10	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103	105	103	105	4 5 9	June and December	...	...
20,000	5	10/0	Callender's Cable Construction Ord. xd bonus & new	14½	15½	13½	14½	5 3 5	,, ,,	13½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference x new	5½	6	5½	6	4 3 4	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112	116	112	116	3 18 5	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,093)	3½	4	3½	4	4 10 9	January and July	3 1/8	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100	103	100	103	4 19 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	2	...
17,139	5	2/9⅜	Do. (£5 paid)	3½	4½	3½	4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜	5	4⅜	5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101	104	101	104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2	2⅛	2	2⅛	5 6 8	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛	3⅛	2⅛	3⅛	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	105	103	103	3 16 2	January and July	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½	14½	13½	14½	3 15 10	February and August	...	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5¼	5¾	5¼	5¾	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	21⅝	21⅝
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	34	38	34	38	4 14 6	March and July	36½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	11½	12½	11½	12½	2 16 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	5⅞	...
30,000	5	7/0	Willans and Robinson Ordinary x new	11½	12½	11	12	5 0 0	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference x new	7	7⅝	6⅞	7⅝	4 2 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	105	104	105	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½	18½	17½	18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102	104	102	104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½	23½	22½	23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£3 paid)	8½	8¾	8½	8¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	118	120	3 6 1	February and August	120	118
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½	10⅞	10½	10⅞	4 13 0	May and November	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15⅜	15⅝	15⅜	15⅝	3 12 9	...	...	...
15,000	10	...	Do. (Nos. 60,001 to 75,000)	15⅜	16⅛	15⅜	16⅛	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12	13	12	13	4 12 4	February and August	12⅝	12⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126½	125½
£150,000	Stock	...	Do. Do. (Issued Feb. 5, 1900)	...		120	123	...	...	...	...
40,000	5	2 8/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5	5¼	5	5¼	5 14 4	...	...	...
27,500	5	...	Do. "B"	4	4⅛	4	4⅛	...	...	4	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	103	103	106	4 16 5	...	105	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk Prov. Certs. (£57½% to be p.l.)	37	41	37	40	...	...	...	...
208,940	10	3/0	Central London Ordinary	10	10½	10	10½	2 17 2	June and December	10⅜	...
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	64	64	65	68	2 15 2	February and August	67	65
370,500	10	1/5 1/16	Do. (Nos. 22,501 to 60,000)	5½	6½	6	7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	,, ,,	...	...
£270,000	Stock	5%	Do. (1898)	132	137	132	137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123	123	123	123	3 2 6	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½	23½	22⅝	23⅝	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	¼	5/8	¼	5/8	32 0 0	March and October	...	...
70,000	1	0/7⅛	Do. 6 per Cent. Pref.	1/16	3/8	¼	1/16	19 4 0	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅛	10⅛	9⅛	10⅛	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 1/16	9 1/16	9⅛	9⅜	4 0 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼	13½	13½	13⅝	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½	5½	4⅜	5½	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜	10⅞	10⅜	10⅞	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½	12½	11½	12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9½	10½	4 15 3	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	100	103	2 18 10	June and December	102	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,152. [No. S. Vol. XLV.] FRIDAY, JUNE 15, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 20fr., or 16gr.

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NOTES.

WE are glad to see that steps are being taken to obtain unanimity among manufacturers of cable for electrical purposes on the question of conventional standards for the weight and resistance of copper. As we pointed out last December, the arbitrary standards arrived at by the "Committee on Copper Conductors" were of no avail unless all the manufacturers of cable had a voice in their selection and undertook to abide by them. At that time the two largest manufacturers of electric light cable stood out from the combination, but, since then, the informal association of rubber cable manufacturers has been developed into a "Cable Makers' Association," and these two firms and, in fact, practically all the cable manufacturers in this country have joined it. The report of the committee above referred to is still under discussion by a sub-committee of the Association, which will meet in about ten days' time to prepare its report, and at a meeting of the Association in three or four weeks from now a definite decision will probably be arrived at. The outcome of the deliberations may be expected to be the adhesion of the Association to the conventional standards for copper resistance and weight specified in the original report of the "Committee on Copper Conductors," but a modification of the rule for the resistance and loss in lay of stranded conductors.

IT is to be regretted that Prof. FORBES and Prof. PERRY should discuss their differences in such an unfriendly spirit, for both have published figures and investigations of two kinds—those of practical value and others of purely academic interest. By concentrating their attacks on one another's contributions of the latter class the two professors have, in the discussion on Prof. FORBES' Paper, and subsequently in our correspondence columns, left it to be inferred that the accuracy or utility of the whole is at fault in each case; whereas there is no doubt that neither Prof. FORBES' tables nor Prof. PERRY's methods are entirely devoid of practical bearing. An illustration of the manner in which the professors are at cross-purposes is given by one of the numerical examples they have chosen. Prof. PERRY says that in a simple transmission system without line boosters, or in a single section of a boosted system, the efficiency *cannot* be less than 50 per cent. Prof. FORBES says it *can*, because if a generator delivers 1,000 volts to a line of 3 ohms resistance, and if 200 amperes be utilised at the other end, the loss in pressure will be 600 volts and the efficiency 40 per cent. No doubt this *can* be done, but Prof. FORBES does not need the unwilling services of Mr. SWINBURNE as "foolometer" (see our Correspondence columns this week) to know that no one but a fool would do it, when to transmit the same 80 kw. at the far end with only 50 per cent. loss, a lighter line of 3⅛ ohms resistance would suffice, with a current of 160 amperes.

THE sensational announcements in the American press with regard to Mr. NIKOLA TESLA's wonderful doings and still more wonderful prophecies, have been attributed in a large measure to the highly developed power of imaginative embroidery possessed by some Western newspaper reporters. An article by Mr. TESLA himself, in the current number of the *Century Magazine*, shows that an injustice has been done to that class of individuals, for this contribution equals in wild speculation anything hitherto attributed to the eminent inventor. The article is headed "The Problem of Increasing Human Energy, with Special Reference to the Harnessing of the Sun's Energy." The writer begins by postulating that human life is a movement. The existence of a body in motion unavoidably implies a force which is moving it. Consequently Mr. TESLA chooses to consider human energy as denotable by the expression $MV^2/2$, and proceeds to consider how it may be increased. M he takes as the "total mass of man in the ordinary interpretation of the term 'mass,'" and V is "a certain hypothetical velocity." He warns his readers against reducing their mass by intemperance, impure drinking water, or laxity of morals—digressing on the subject of food supply, and the production of artificial

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fertilisers by causing the nitrogen of the air to combine chemically with the oxygen in a high-pressure electric discharge.

ORGANISED warfare, Mr. TESLA thinks, is what tends mostly to the reduction of the hypothetical velocity V, and he proceeds to describe a means, he has not yet perfected, of rendering warfare less harmful in this direction. This simple means is the substitution of "telautomatics" for men. So far he has only succeeded in constructing one such apparatus—a boat controlled by electrical oscillations—with a "borrowed mind"; but, he says "I purpose to show that, however impossible it may now seem, an automaton may be contrived which will have its 'own mind' and . . . be capable of distinguishing between what it ought to do and what it ought not to do. . . . . In fact, I have already conceived such a plan." On the other hand, to deal fully with the methods of increasing the force "accelerating the human mass" would lead Mr. TESLA too far. "Suffice it to state that the resultant of all these forces is always in the direction of reason. . ." A "telautomatic" is then presumably not one of the components.

LACK of space precludes us also from dealing more fully with Mr. TESLA'S dreams—or are they nightmares?—with their bright pictures of high-pressure phenomena. We can only mention briefly some of his schemes for the advantage of mankind. He intends to smelt iron by first electrolysing water, burning the hydrogen in air to produce the heat for smelting, and selling the pure oxygen as a by-product. He suggests other methods than windmills of obtaining energy from "the ambient medium," some of which he no longer considers likely to be commercially profitable, and others with regard to which he is more hopeful. He next deals with the transmission of energy through space without wires. The proposal to transmit electricity at high pressure through the upper strata of the atmosphere we have alluded to on a former occasion, but the following bears repetition. Mr. TESLA has discovered causes of error in HERTZ'S researches, with the result that he has "long ago ceased to look upon his [HERTZ'S] results as being an experimental verification of the poetical conceptions of MAXWELL."!

THE electrical department of the Whitechapel Board of Works is sparing no pains to solicit the patronage of the smaller consumers in its district. Not content with issuing a pamphlet setting forth the advantages and comparative cheapness of electric light, it has gone so far as to publish a "Yiddish" edition of it, printed in Hebrew characters, for the benefit of the large Jewish population of Oriental London, "many of whom," Mr. TAPPER humorously points out to us in the letter accompanying the pamphlet, "cannot read English, and to whom it would otherwise be extremely difficult to explain the maximum demand system of charging." The translation must have been done by a Yiddish scholar of no mean ability, whose appreciation of the technicalities of the subject is also complete. We might suggest in the way of friendly criticism, however, that although the definition of a demand indicator is clearly expressed in simple language, those who are not sufficiently educated to read English would experience a difficulty in understanding the word motor even when spelt phonetically in Yiddish, and that to them "Michaelmas" would not fix a season of the year so definitely as the phrase "Rosh-Hoshannah."

American Association for the Advancement of Science.—The forty-ninth annual meeting of this Association will be held in New York on June 23–30.

Electrical Engineers (R.E.) Volunteers.—Corporal A. Holdaway, of the above company, was reported "dangerously ill" at Bloemfontein, on the 9th inst.

Vacant Fellowship.—A research fellowship in pure and applied physics at Owens College, Manchester, of the value of £100 is offered. Further particulars are set out in an advertisement.

Institution of Electrical Engineers. Irish Section.—At a meeting of the Irish Section, held in Dublin last evening, Mr. R. Hammond delivered his postponed address on the "Proposed Dublin Electric Light and Power Scheme."

Boer Conservatism.—At Johannesburg, under a concession granted by President Krüger's Government, one-horse tramcars have been running for some time. A concession for the construction of electric lines has since been refused on the ground that "the farmers would lose the sale of their forage." The same objection has been raised to the cycle, upon which a heavy tax has hitherto been placed.

The English Electric Manufacturing Co.'s Works.—The new works of this company, at Preston (Lancs.), were formally opened yesterday. On the previous day the directors and officials of the company entertained a party of engineers, technical journalists, and others at a private view of these extensive and admirably-planned engineering works. We hope to present our readers with an illustrated description of the works in an early issue.

Improvements in Provincial Telephone Systems.—The new exchange in Bristol worked on the central battery system (described in *The Electrician*, Vol. XLIII., p. 401) is now in successful operation. The National Telephone Co. is laying underground wires both in Hull and Sunderland, and in both these towns the central battery system will probably be in operation within the next three months. In Hull it is replacing the branching system.

The Thames Steamboat Service.—A correspondent in *The Times* of Wednesday suggests that the difficulty in the way of the satisfactory working of the Thames steamboat service is not one of pier dues but arises from the inconveniently-placed points at which passengers take and leave the boats. He proposes, as a remedy, to provide stations in the main thoroughfares near the river, and to construct subways from these to the pier, conveying passengers through the subways to the pier by means of electric cars.

University Intelligence.—On Tuesday the Mathematical Tripos list was published at Cambridge. Mr. J. E. Wright, of Trinity College, is Senior Wrangler. After the reading of the list, honorary degrees were presented. Among the recipients were Sir Benjamin Baker, M. Henri Poincaré, and the Earl of Rosse. —At Oxford the Convocation has passed a statute providing that the occupant of the recently-endowed Wykeham Chair of Physics is chiefly to lecture on electricity and magnetism. The election of a professor has not yet taken place.

The Royal Society.—Among the Papers down for reading yesterday were the following:—"The Electrical Effects of Light upon Green Leaves (Preliminary Communication)," by Dr. A. D. Waller, F.R.S., "The Diffusion of Ions produced in Air by the Action of a Radio-Active Substance, Ultra-violet Light and Point Discharges," by J. S. Townsend, and "On an Artificial Retina and on a Theory of Vision," by Prof. J. C. Bose.—The Annual Soirée will be held at Burlington House, on Wednesday next, the 20th inst.

Aluminium Transmission Lines.—One of the chief features of the power transmission plant of the Snoqualmie Falls Power Co. (described in *The Electrician*, Vol. XLIV., p. 5, and also briefly referred to by Prof. Forbes, in his recent Institution Paper, *The Electrician*, May 10, p. 50), is the exclusive

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employment of aluminium wire on the transmission line; and we read in the American papers that some trouble has recently been experienced in these lines owing to breakages. Heavier wire of a stronger alloy is now being erected between Tacoma and Snoqualmie Falls.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899	—
Cayenne—Pinhieros	Oct. 11, 1899	—
Tangier—Tarifa	Jan. 3, 1900	—
Paramaribo—Cayenne	Feb. 16, 1900	—
Ceara—Maranham	Feb. 20, 1900	—
Pará—Maranham	Mar. 2, 1900	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900	—
San Thomé—Loanda	May 20, 1900	June 11, 1900
Durban—Delagoa Bay	May 31, 1900	June 10, 1900

The International Catalogue of Scientific Literature.—During this week the third biennial conference in connection with the Royal Society's scheme for the publication of an international catalogue of scientific literature has been held at Burlington House. Delegates were present from the United Kingdom, Cape Colony, Natal, India, New South Wales, New Zealand, Queensland, Canada, United States of America, France, Germany, Italy, Japan, Switzerland, Austria, Holland, Belgium, Denmark, Greece, Hungary, Norway, Sweden, and Mexico.

Obituary.—We regret to announce the death of Dr. Julius Althaus, which occurred on Monday last. Dr. Althaus was one of those physicians who devoted considerable attention to electrical treatment, and even if we have been unable at all times to express ourselves at one with him on some of his theories, there is no doubt that he has done much useful work towards advancing the science of electro-therapeutics. Dr. Althaus was a well-known writer on medical subjects, and one of his most recent works was a book on "The Value of Electrical Treatment," which was recently reviewed in our columns. Dr. Althaus, who died at the age of 67, will be regretted not only in medical but also in scientific circles.

Wireless Telegraphy.—It is announced that arrangements are being made at Ilfracombe for experimenting with wireless telegraphy between that town and the Mumbles, across the Bristol Channel, a distance of about 21 miles. The pole to be used is about 120ft. in height. The experiments will extend over a period of about a fortnight.—The *Cape Town Argus* states that wireless telegraphic communication was maintained between the convoy "Doris" and Delagoa Bay while that ship was at Kosi River. This is the only report of wireless telegraphic operations in South Africa that has been received for some time. It would be interesting to know what is at present the occupation of those members of the staff of Marconi's Wireless Telegraph Co. who volunteered to accompany their instruments to the front.

High-Voltage Incandescent Lamps.—An article in a recent issue of the *Electrical World* of New York contains an account of experiments which have been made in the construction of a 500-volt incandescent lamp, of ordinary candle-power. Such a lamp cannot, it is stated, be made with a carbon filament, on account of the comparatively high conductivity of incandescent carbon. The writers tried, with success, mixtures of iridium and nitrates of the rare earths, with solutions of which they impregnated a cotton thread, which was then dried and burned over a Bunsen flame. A current about twice as great as that which it would be required to maintain was next passed through, in order to burn out the last traces of carbon. In another process, one thread was soaked in a solution of some iridium salt, and a second thread in a nitrate of one of the rare earths; these were twisted together, and burned as before. Filaments made by the latter process were not, however, found suitable for voltages above 200. It is finally suggested that the practical refractoriness and the high resistance of these filaments will render them useful as an auxiliary heater in the Nernst lamp.

Thunderstorms.—The reports to hand of the damage done by the thunderstorms during the first half of the present week, show that this visitation was most serious and widespread. The number of fatalities has been larger than usual, and the damage to property has been great. We can but refer to a few of the accidents. Most remarkable of the fatalities is the one by which Major Heywood-Jones lost his life while crossing the camp fields at Harrogate. An umbrella which he was carrying in his hand at the time was destroyed, and his body was marked with severe burns in five or six places. At Sheffield a woman was killed, and in a small village in Co. Kerry two women were killed and a number of others rendered insensible. At Sunderland a man was blinded by the lightning, and has not yet quite recovered. In addition to these accidents to person there have also been some remarkable accidents to buildings, &c. On Tuesday afternoon the chimney-stack of the Peterborough Corporation Electric Light Works was struck, and a heavy derrick was thrown to the ground. This was, fortunately, unaccompanied by any fatality. Church steeples at Little Staughton in Bedfordshire, at Kirkby Stephen, and elsewhere, have not been spared, and in the first case the steeple was entirely destroyed, the masonry breaking through the roof into the basement, and doing considerable damage. Perhaps the most remarkable accident was the total destruction of a group of 14 out of 25 thatched cottages constituting a small hamlet in Northamptonshire.

Society of Engineers.—At a meeting of this society last Monday, a Paper was read on "Electric Traction" by Mr. A. H. Binyon. The author first compared the London traffic with that of New York, and gave figures of its distribution by various channels. He stated that the underground railways in London took only 19 per cent. of the total traffic against 81 per cent. conveyed by omnibuses and tramways. While each of the 5½ millions of people in London travelled 124 times in a year, the New York population of 3½ millions travelled 210 times yearly. He favoured the overhead trolley system as most efficient and economical, and he advocated the side trolley to obviate the unsightliness of very long brackets. The author expressed the opinion that the London United and the London County Council tramways would in time force railway companies to adopt electric traction, even for suburban traffic within a radius of from 10 to 25 miles round London. Beyond this limit he thought that the steam locomotive would beat its electric rival. In combining lighting and tramway plant, Mr. Binyon advocated completely separate dynamos and mains, and favoured slow-speed Corliss engines directly coupled to dynamos of large capacity. He described the double-current generators which would take the load on the alternating or continuous current, according as the demand was far from or near to the station. The power consumption of cars weighing about 12 tons, with speeds of from 6 to 12 miles, and with stops of from 8 to 10 seconds, was given by the author in the following table:—

Power at Trolley Wheel in Board of Trade Units.

Miles per hour.	No. of stops per mile.	B.O.T. units per car.
6	6 to 14	0·7 to 1·08
7	6 „ 13	0·65 „ 1·43
8	5 „ 11	0·75 „ 1·75
9	4 „ 9	0·73 „ 2
10	4 „ 8	0·82 „ 2·2
11	4 „ 7	0·78 „ 2·04
12	3 „ 6	0·73 „ 2·04

The use of meters in cars was recommended for the reason that from 30 to 40 per cent. in power of the waste caused by the careless handling of controllers could be saved.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

WEDNESDAY, June 20th.

ROYAL METEOROLOGICAL SOCIETY.

4.30 p.m. Ordinary Meeting at 70, Victoria-street, Westminster, S.W.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting at 20, Hanover-square, W.

FRIDAY, June 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. The following Papers will be read: (1) "Notes on Gas Thermometry," by Dr. P. Chappius; (2) "A Comparison of Impure Platinum Thermometers," by H. M. Tory; (3) "On the Law of Cailletet and Mathias and the Critical Density," by Prof. J. Young, F.R.S.

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THE CENTRAL LONDON RAILWAY.

(*Continued from page 212.*)

PART I.—POWER GENERATION AND DISTRIBUTION.

The Power Station.—The power station is situated on an extensive 20-acre tract of land at Shepherd's Bush, used partly for the necessary buildings and sheds, and partly as a shunting and train-make-up yard. A plan of this area is shown in Fig. 5. The power station is an ample and substantial structure in red brick, with two lofty chimney stacks in the same material. Figs. 6 and 7 show the general construction of this building. The boiler house (Fig. 8) is 148ft. long by 87ft. wide, and it accommodates at present 16 Babcock-Wilcox boilers arranged in two rows with a central gangway. Each boiler is rated at 12,000lb. of steam per hour at 160lb. pressure, with hot feed from the Green's economisers. Vicars' mechanical stokers are fitted to the furnaces, and the arrangements for the conveyance of fuel from the railway trucks to the furnaces are elaborate and complete. The mechanical conveyer erected by Messrs. C. W. Hunt and Co. consists of 200 buckets, each having a maximum capacity of 140lb., and a normal load of 1 cwt. The normal speed of the conveyer is 40ft. per minute. Of the total 200 buckets only 20 are at any one time being actually lifted, the others moving either along the top of the boilers at a height of 25ft. from the floor, or descending at the far end and returning underneath the boiler gangway. The conveyer is driven by an 8 H.P. continuous-current motor, taking from 10 to 12 amperes at 500 volts. It will be seen that the conveyer arrangements allow of 150 tons of coal being transported to the bunkers every hour. As the total capacity of the bunkers is 1,000 tons, they can be filled in about seven hours. This constitutes a sufficient supply for over a week. The coal descends by gravity from the bunkers through shoots to the mechanical stoker hoppers, which are regulated by a hand valve. These are shown in Fig. 8. The stokers are driven by two Bumsted and Chandler vertical steam engines, either or both of which may be used. In the boiler flues are placed four Green's economisers, for which two separate rooms have been erected. Each economiser consists of 768 tubes, with the usual scraping gear, &c. After passing through the economisers, the furnace gases ascend the two chimneys, being discharged at a height of 250ft. above the ground level. These chimneys are 10ft. internal diameter at the base. The economiser scrapers are driven by continuous-current motors, a 5 H.P. motor being provided for each pair of economisers.

Steam passes from each boiler through an 8in. stand pipe to the main steam range, each engine being also supplied from the main range by a pipe of the same diameter. The main steam pipes are carried over the boiler tops and underneath the machinery-room floor. The exhaust pipes and the injection and discharge pipes are similarly placed below the machinery-room floor, the injection pipe being 20in. in diameter, and the discharge pipe 22in. in diameter. As shown in Fig. 10 each engine is provided with its independent condenser.

The machinery room is 200ft. long by 88ft. wide, and is 60ft. in height. There are at present erected the following steam-

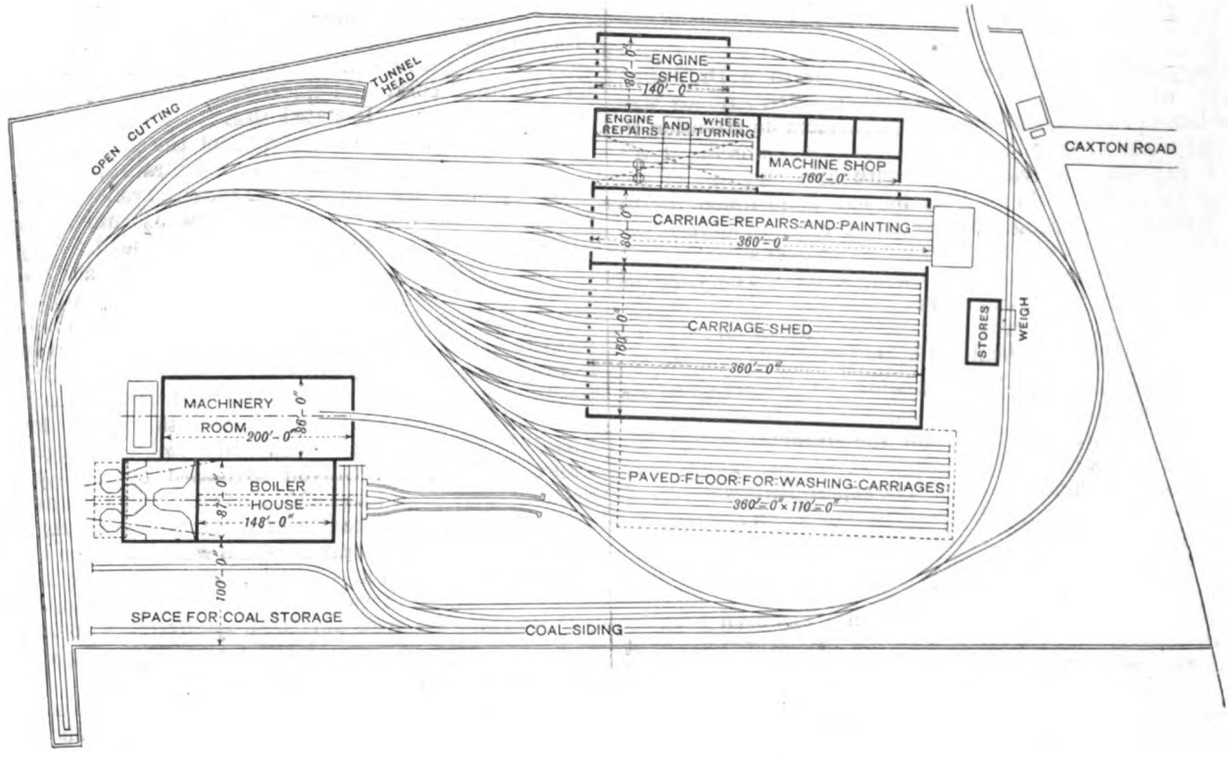

FIG. 5.—PLAN OF DEPÔT AT SHEPHERD'S BUSH.

driven sets: Six main steam generating sets, four continuous-current exciter sets, and two continuous-current lighting sets. All the sets are direct-coupled. The main generating sets consist of 850 kw. three-phase generators, running at 94 revs. per min. and developing 5,000 volts, direct-coupled to horizontal cross-compound Allis steam engines, as shown in Fig. 9. The engines are fitted with Reynolds's Corliss valve gear, and were built by the E. P. Allis Co., of Milwaukee, U.S.A. The high-pressure cylinders are 24in. diameter, and the low-pressure cylinders 46in. in diameter, each piston having a 4ft. stroke. Governing is effected on the cut-off of each cylinder, and there is, in addition, a safety steam device so arranged that on the failure of the ordinary governors, the racing of the engine will cause steam to be shut off. The main shaft is of hammered iron 20in. in diameter at the bearings and 22in. diameter at the centre, running in Babbitt metal bearings 3ft. in length. This shaft carries a 50-ton flywheel, built in eight sections, and the magnet wheel of the three-phase generators. These generators are of the revolving field type and at the normal speed of 94 revs. per min. generate three-phase current at 25 cycles per second. The

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revolving field consists of 32 outwardly projecting laminated poles and magnet cores, bolted to a cast-steel ring. This ring is carried by a heavy cast-iron spider, which in turn is mounted on the extended engine shaft (situated between the high and low pressure cranks) and keyed firmly thereto. The field coils are wound on formers, being afterwards slipped on to the magnet cores and insulated therefrom. They have protecting flanges of wood, and each coil consists of 79½ turns of copper strip, 1·6in. by 0·08in., wound on edge. The object of the half turn per coil is that the terminals of each completed coil shall be on opposite sides of the spool, and when in position, the adjacent terminals being joined together, this connects up the whole winding in series in the best possible manner, both mechanically and electrically. The exciter voltage is 125, and for the normal full load at 5,000 volts terminal pressure with unity power factor, an excitation of 110 amperes is required. The diameter of the field is 143·375in. and the length of each pole arc 9in., while the laminations are piled to a depth of 14½in., making the total area of each pole face 130 sq. in. The collectors, which merely consist of two rings to take the exciting current, are each furnished with two copper gauze brushes, and are supported on the engine shaft alongside the field spider, being insulated therefrom by ebonite. The entire weight of the revolving field, with spider, is approximately 34,000lb. The armature core, which is built up of separately insulated sheet steel punchings 0·014in. thick, is supported by a cast-iron frame into which the laminæ are dovetailed. The actual or active length of the iron (parallel to the shaft) is 10·8in., and there are five ventilating ducts, each ⅜in. wide, spaced at

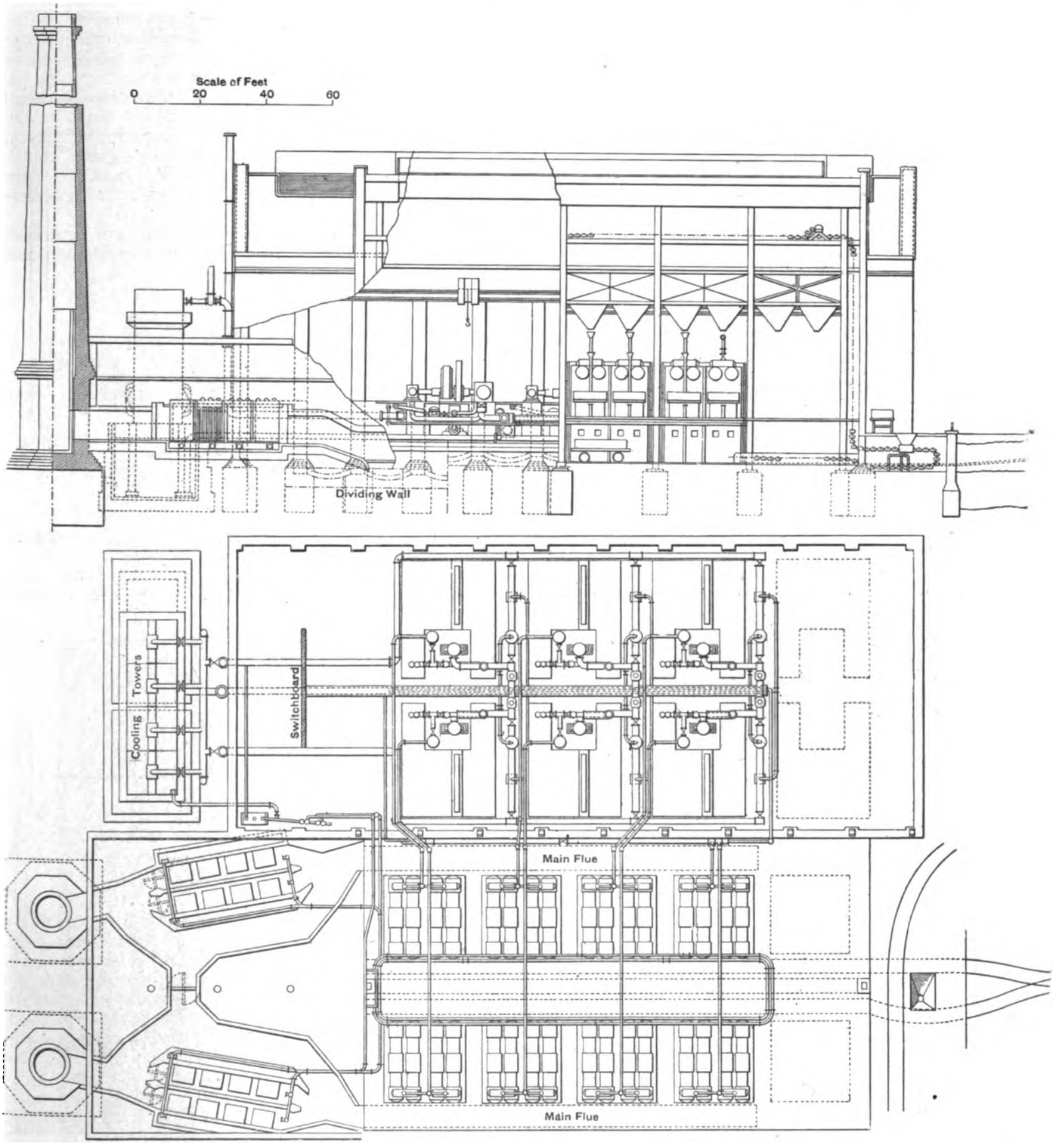

FIG. 6.—LONGITUDINAL SECTION AND PLAN OF POWER STATION.

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equal distances apart, which, with the space taken up by the insulation between the punchings, makes the total length of the armature iron (along the shaft) 14½in. The internal diameter of the armature is 144in., thus leaving an air gap of

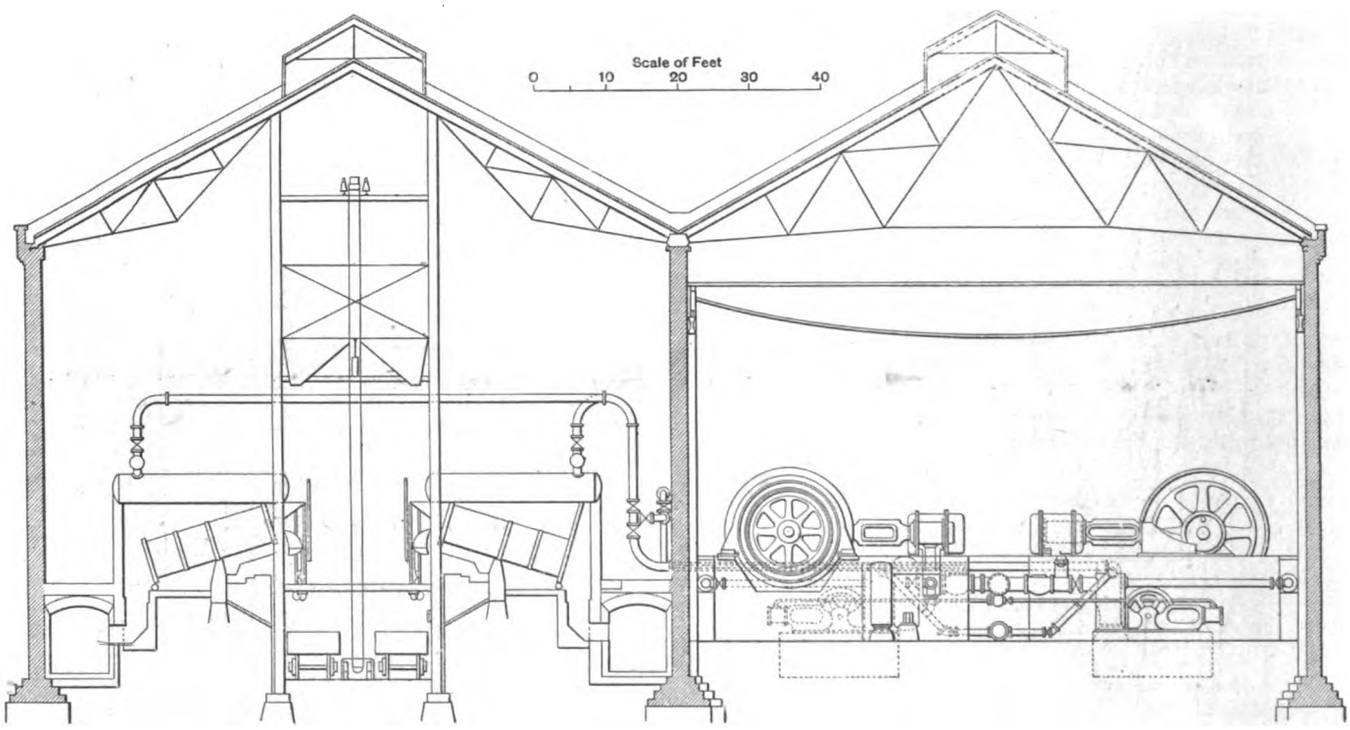

FIG. 7.—TRANSVERSE SECTION OF POWER STATION.

0·3125in. The armature is of the slotted or iron-clad type of construction; the slots, which, of course, are on the inner diameter of the armature, and of which there are 192, are 3·625in. deep by 1·313in. wide. The winding consists

pole. This distribution of winding lessens the inductance, and consequently the reactance of the armature, and improves the thermal properties by distributing one of the chief sources of heating—namely, the C^2R losses—over a larger

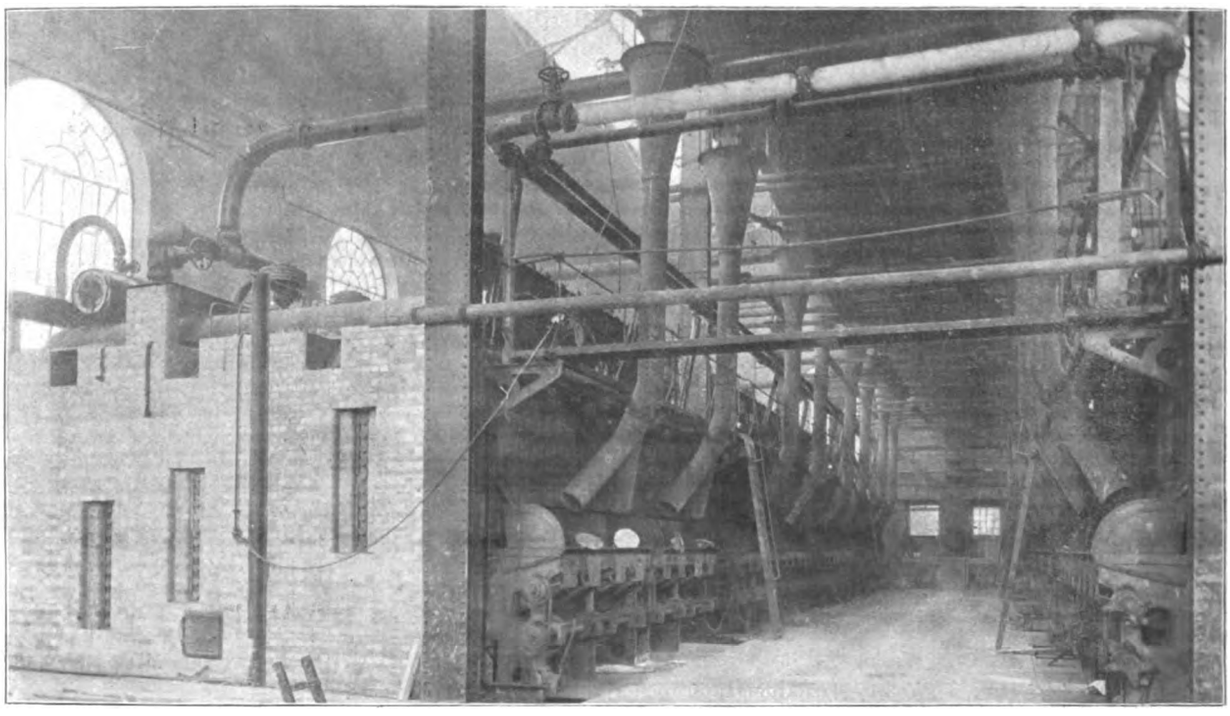

FIG. 8.—VIEW OF BOILER RANGES.

of coils wound on formers, and each separately insulated so as to allow of being readily removed in case of repairs. Each coil has 14 turns of a conductor made up of 36 strands, 17 B.W.G. There are 96 such coils

dissipating area and closer to the radiating surface than is the case if the winding, and consequently the C^2R losses, be concentrated in one deep slot per pole piece. The coils are held in place in the slots by means of wooden wedges driven

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longitudinally into dovetail grooves at the top of the slots, while the projecting ends of the coils are mechanically protected by means of gunmetal shields. The armatures have been tested at a pressure of 10,000 volts alternating. The armature punchings weigh about 4,500lb., while the complete armature, with its supporting frame, weighs approximately 48,600lb.

Beneath each main set the condensing plant is erected as shown in Fig. 10. This condensing plant is of the Allis jet type. Each condenser can deal with 26,000lb of steam per hour normally, or 30,000lb. if required. The pumps are double-acting, 28in. diameter and 24in. stroke, and they can draw water through a 22in. wrought-iron pipe running down the centre of the basement, from the hot-well situated

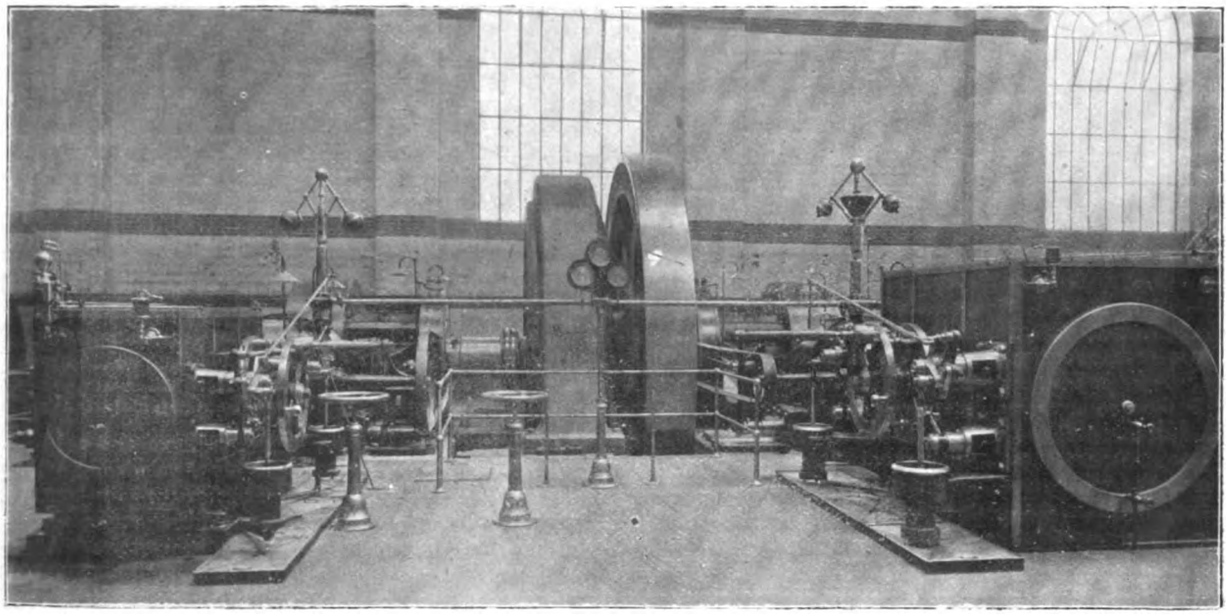

FIG. 9.—MAIN GENERATING SET. VIEW FROM CYLINDER ENDS.

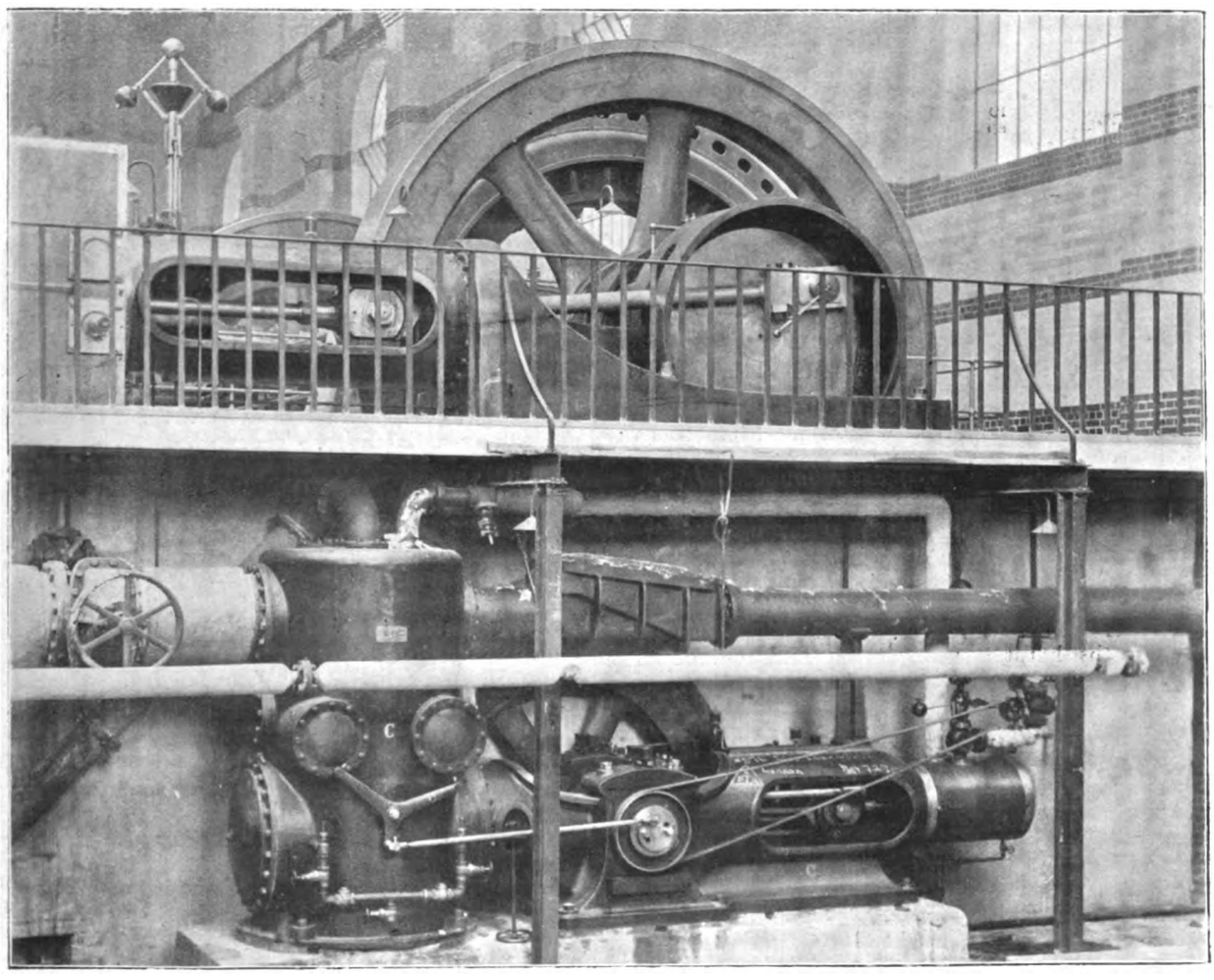

FIG. 10.—MAIN GENERATING SET, SHOWING CONDENSER.

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beneath the cooling towers at the north end of the building, and deliver it back through two 18in. pipes, laid one at each end of the basement, to the top of the Barnard cooling towers. The exhaust steam from the condenser engines passes into the receiver of the main engines so as to secure the economy of compounding. An automatic release valve is provided for each engine, so that should the vacuum fail it exhausts to atmosphere. There is an auxiliary condensing plant, which takes the steam from the exciter and lighting sets, and also from the auxiliary plant. This consists of a Wheeler surface condenser of 1,900 sq. ft. cooling surface. The circulating water is drawn from the hot-well beneath the cooling towers, and delivered back to the top of the cooling towers, while the air pump discharges directly into the hot-well.

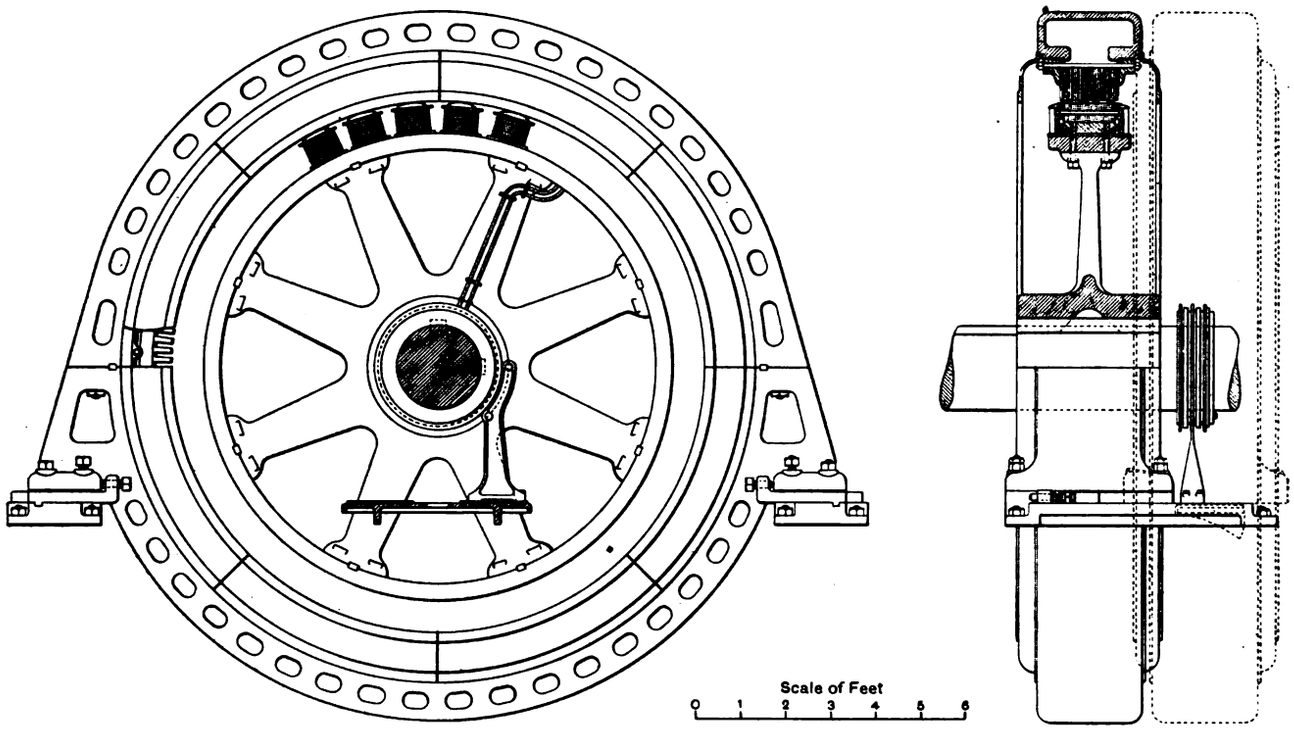

FIG. 11.—THREE-PHASE MAIN RAILWAY GENERATOR.

(To be continued.)

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Active Principle of Uranium.—Sir W. Crookes has succeeded in isolating the radio-active principle of uranium, after a long series of tests and reactions made with all sorts of uranium minerals and all sorts of methods. Ammonium carbonate was eventually found capable of separating out the uranium and leaving the unknown active substance, provisionally denoted by the symbol UrX by its discoverer. By analogy with gallium, scandium, and polonium, the new substance might as well be called anglium or britannium as anything else. The facts known about it are not sufficient so far to warrant its final christening. It is about 300 times more active than uranium. It may be separated from polonium by sulphuretted hydrogen in an acid solution, which precipitates the latter but not the former. But no definite proof has yet been brought that it is not identical with radium. The spectroscopic test fails owing to its lack of sensitiveness in comparison with the photographic test! A further difficulty is introduced by the fact that precipitates have a tendency to drag down with them other substances which should remain in the filtrate. But the required proofs will doubtless soon be forthcoming.

[Sir W. CROOKES, *Royal Society*, Paper read May 10, 1900.]

Röntgen Rays produced by a Continuous Current.—J. Trowbridge has lately completed the installation of a plant of 20,000 storoge cells in the Jefferson Physical Laboratory. This places at his disposal an E.M.F. of over 40,000 volts, and a comparatively steady current through a large resistance. He has succeeded in obtaining X-rays of exceptional brilliancy with the aid of this high E.M.F., which, moreover, yield negatives of great contrast, showing traces of the shadows of ligaments and muscles. The great advantage of this new method of generating the rays is the possibility of exactly regulating the current and difference of potential which is necessary to excite the rays. This is not possible by any of the other methods hitherto used. When the X-ray tube is first connected to the battery terminals no current flows; it is necessary to heat the tube with a bunsen burner. At a certain critical temperature the tube suddenly lights up with a vivid fluorescence, and the rays are then given off with great intensity. The author employed a distilled-water resistance of about 4,000,000 ohms. This places it beyond a doubt that no electrical oscillations had any part in the production of the X-rays.

[J. TROWBRIDGE, *Am. J. Science*, June, 1900.]

Resistance of Metallic Films.—More than 20 years ago Wright pointed out a method of producing thin metallic films upon glass by cathode ray deposition. These films had very brilliant reflecting surfaces, and showed characteristic colours by transmitted light. A. C. Longden has studied the films with special reference to their electrical resistance. He found very soon that the thinnest films have an enormously high electric resistance, very much higher than is warranted by their thickness. A valuable discovery was that the sign of the temperature coefficient of the resistance is variable with the thickness. The thinnest films have, like liquids, a negative temperature coefficient. At a certain thickness the temperature coefficient becomes zero, and the film does not change in resistance with the temperature. A further stability may be imparted by artificial ageing in a bath of hot oil, and subsequent protection from the atmosphere, either by enclosing in a vacuum or embedding in paraffin or in rubber varnish. Contacts are made by thick electro-deposition. The final product is a very accurate standard of from a few ohms to several megohms, which will never vary by more than a few hundredths of 1 per cent.

[A. C. LONGDEN, *Am. J. Science*, June, 1900.]

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Influence of Gravitation upon Resistance.—A somewhat recondite but none the less interesting research has been carried out by G. Gore. He had already shown that the presence of a mass of a heavy substance near one of the electrodes of a voltaic cell alters its E.M.F. Why it should do so could not be determined except by a lengthy series of experiments upon solids and electrolytes. The most obvious explanation was some change in the constitution of the electrode. If there were any such change, it might also show itself in a change of resistance consequent upon embedding a coil in a block of lead. A somewhat tedious series of experiments has been carried out by the author, and it says a good deal for his care and accuracy that he should have obtained a negative result. For positive results, due to secondary causes, are very much more easy to obtain. It appears, therefore, that the gravitational action observed in the case of electrolytic cells probably does not act through the metal. A full explanation of this interesting effect will probably demand more than the patience of a single worker.

[G. Gore, *Phil. Mag.*, June, 1900.]

Interception of Wireless Telegrams.—No system of limiting the receipt of wireless messages has as yet been described, though the solution of the problem has already been several times announced. D. Tommasi suggests a plan which appears feasible enough, though it only reduces the space within which a given message can be received to a spherical shell instead of a line or a point. The idea is to use two transmitters of different ranges of action. The transmitter with the larger range is used for sending the message to the station for which it is intended, while the transmitter with the shorter range is employed in confusing the message within that range by an unmeaning series of dots and dashes. The range of a transmitter can fortunately be adjusted by altering the size of the spark-gap, and thus it should not be difficult to restrict the chances of interception to a zone of, say, half-a-mile. If, in addition, the spherical wave-train could, by reflection or otherwise, be converted into a beam of the form of a searchlight, the problem would be solved in a way. But, of course, a very much more satisfactory solution would be a device of the lock-and-key kind, in which messages could only be received by an instrument of very special construction and dimensions.

[D. Tommasi, *Comptes Rendus*, May 14, 1900.]

Magnetised Coherers.—The coherers with magnetic electrodes devised by C. Tissot (see *The Electrician*, May 4, p. 41) have been applied with great success to the exchange of wireless messages between French battleships and the Portzic lighthouse. The most interesting feature of the contrivance is that it does not contain any of the devices patented by Marconi. The height of the masts did not exceed 100ft., and good signals were obtained at a distance of 33 miles. The coil employed for transmission was a transformer by Wydts and Rochefort. The messages exhanged were complete phrases, telegraphed by the ordinary Morse code and read by the ordinary ship telegraphists on board. The filings in the coherer and the iron terminals are kept very dry, and are best enclosed in a tube hermetically sealed and containing a few fragments of calcium carbide. The E.M.F. of the circuit may be varied within wide limits without interfering with the clearness of the signals. The ordinary resistance of the coherer is from 200,000 to 500,000 ohms. At coherence, it falls to something between 1,500 and 3,000 ohms. The fall of resistance in magnetised coherers is not entirely due to the impact of the waves. The increase of current strength itself brings about a further fall.

[C. Tissot, *Comptes Rendus*, May 21, 1900.]

Electric Pendulum.—An electrically-driven pendulum should, according to Lippmann, fulfil the following conditions: The restitution of kinetic energy should take place when the energy is all kinetic—*i.e.*, when the pendulum passes through the vertical; the "electric sticking" should be abolished—*i.e.*, the adhesion between two points at which the circuit is broken; the isochronism of the pendulum must not be disturbed by the electric contact; and the quantity of energy imparted at every oscillation must be constant, and independent of the state of the battery. Most of these conditions are fulfilled by a pendulum designed by C. Fery. A permanent horseshoe magnet is attached to the bob of the pendulum, and one arm of it passes at every swing into a coil through which a constant quantity of electricity is sent just at the moment at which the pendulum is passing through the vertical. The manner in which the constant quantity of electricity is obtained from a possibly inconstant battery is very ingenious. A balancing arm bears at its ends two coils which fill up the spaces between the poles of two horseshoe magnets. The arm is of soft iron, and when a current traverses either of the coils it is temporarily magnetised. One of the coils is the "motor" coil, and receives the current from the battery. It is attracted by the electromagnet against the force of a spring, and thus brings about a definite displacement of the other coil in its magnetic field. The induced current caused by this displacement traverses the coil which receives the magnet attached to the bob, and thus gives to the latter the impulse required. With an E.M.F. of 10 volts, the current required is only of the order of a milliampere, and the amount of zinc consumed in a whole year would not exceed 20 grammes. Even so, however, the "efficiency" of the apparatus is very small, considering that the power required is only a forty-millionth of a horse-power.

[C. Fery, *Comptes Rendus*, May 7, 1900.]

ON THE SPARK DUE TO THE BREAK OF AN ELECTRIC CIRCUIT.

BY K. B. JOHNSON.

Circuits in general being of very different nature we will imagine an ideal one which can easily be realised approximately, and from this imaginary circuit we will also deduce the true expression of the extra current of the break. We will suppose the circuit to be composed of a single coil and a battery, beside which there is a make-and-break apparatus. The terminals of a condenser are fastened on either side of the interruptor.

Let L be the coefficient of self-induction of the circuit, *i.e.*, that of the coil; R the resistance of the circuit; and C the capacity of the circuit, *i.e.*, that of the condenser increased a little owing to the capacity of the coil and the battery. Further, let E_0 be the electromotive force of the battery, E the potential difference of the condenser at time t, and I the strength of the current at time t from the break of the circuit. Then, for determining the extra current we have the well-known formulæ:

$$L\frac{dI}{dt} + RI = -E, \quad \ldots\ldots \quad (1)$$

and

$$I = C\frac{dE}{dt}, \quad \ldots\ldots \quad (2)$$

as is given by Mr. L. Robb in a Paper "On Oscillations that occur in the Charging of a Condenser" (*Phil. Mag.*, Ser. V., Vol. XXXIV., p. 389, 1892).

Integrating the above equations, we have

$$E = A\epsilon^{-\alpha t}\sin(\beta t + B), \quad \ldots\ldots \quad (3)$$

and

$$T = AC\epsilon^{-\alpha t}[-\alpha\sin(\beta t + B) + \beta\cos(\beta t + B)], \quad (4)$$

the values of α and β being as follows:—

$$\alpha = \frac{R}{2L}, \quad \text{and } \beta = \frac{\sqrt{1 - CR^2/4L}}{\sqrt{LC}}. \quad \ldots\ldots \quad (5)$$

A and B are arbitrary constants to be determined by the initial conditions—viz., that at the time of break, or when $t = 0$, the potential difference of the condenser, is zero, and the strength of current is that of the steady current $\frac{E_0}{R}$. Thus, it becomes $B = 0$ and $A = \frac{E_0}{CR\beta}$. Substituting these values in (4) and (5), we have

$$E = \frac{E_0}{CR\beta}\epsilon^{-\alpha t}\sin\beta t, \quad \ldots\ldots \quad (6)$$

and

$$I = \frac{E_0}{R}\epsilon^{-\alpha t}\left[\cos\beta t - \frac{\alpha}{\beta}\sin\beta t\right]. \quad \ldots \quad (7)$$

It may be observed that we assume that the spark is entirely suppressed. This condition being satisfied, the above

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formulæ (6) and (7) give the analytical expressions of potential difference and strength of current. Hence, it follows that the potential difference at time

$$t=\frac{1}{\beta}\tan^{-1}\left(\frac{\beta}{\alpha}\right)$$

attains a maximum value.

$$E_m=\frac{E_0}{CR\beta}\cdot\epsilon^{-\frac{\alpha}{\beta}\tan^{-1}\left(\frac{\beta}{\alpha}\right)}=\frac{E_0}{R}\cdot\frac{\sqrt{\frac{L}{C}}}{\sqrt{1-\frac{CR^2}{4L}}}\cdot\epsilon^{-\frac{\alpha}{\beta}\tan^{-1}\left(\frac{\beta}{\alpha}\right)} \quad (8)$$

Evidently the spark at the break is generally caused by the increasing potential difference of the terminals, or, what is the same, that of the condenser. Hence, if the potential difference never rises to so large an amount as is required to overcome the "surface resistance" in the interruptor, no spark will take place at the break. Therefore it depends only on the value of E_m in (8) whether a spark will or will not pass, whence the formula (8) may be discussed. There β is always positive, and may be varied from 0 to $+\infty$ by varying C and R. When β increases from 0 to $+\infty$ the multiplier $\epsilon^{-\frac{\alpha}{\beta}\tan^{-1}\left(\frac{\beta}{\alpha}\right)}$ only increases from $1/\epsilon$ to 1, and therefore the multiplier has very little influence on the variation of E_m. Then it follows from (8) that, by making the capacity C or the resistance R large enough, it is always possible to diminish the value of E_m enough for suppressing the spark. However, it may be observed that, the capacity of a microfarad being only 10^{-15} in absolute measure, there would generally be required so large a capacity for suppressing the spark that the use of such a method never occurs in practice. The general practical rules for suppressing the spark are according to the formula (8)—viz., to increase either the resistance alone or both the resistance and the capacity before the break.

The spark not being suppressed, it is obvious that the preceding formula (6) ceases to be an expression for the potential difference when the spark enters, but there is no reason why it should not express the potential difference from the break to the passing spark.

Hitherto we have supposed a circuit of a certain form—viz, such that the capacity is situated at the terminals of the broken circuit; but it can easily be proved that the behaviour of the extra current will be similar to this in other cases also. At first let the condenser be taken away from the imaginary circuit, then C may denote the capacity of the coil and battery, and, according to the opinion of Von Helmholtz, the capacity of a coil may be considered as situated in the terminals. Thus, the formulæ (6) and (7) may be applied also to this case, and from (6) it follows that, β being a very small quantity, E will generally be very large, and thus a spark will pass, unless $\frac{E_0}{R}$ be very small.

That the foregoing case of breaking a circuit in general may probably not essentially disagree with the conditions represented by the above formulæ may be tested by considering another ideal case, which is so different from that considered at first that almost every practical case can be regarded as situated between the two limits—viz., between the first imaginary circuit and the one we are now going to consider. Suppose that the capacity is uniformly extended along the wire forming the circuit, so that the capacity per unit of length is the same at every point of the circuit; and also that the resistance and the self-induction are equal per unit of length, which may be approximately true for a submarine cable. This case has been already considered by Mr. O. Heaviside in a Paper "On the Extra Current" (*Phil. Mag.*, Ser. V., Vol. II., p. 135, 1876), and in formula (20), p. 141, he there gives an expression for the potential v at any point at the distance x from one end of the circuit. Introducing the coefficients L, C, and R for the whole length of the circuit instead of the quantities *sl*, *cl*, and *kl*, used in the above-mentioned formula (20) of Heaviside's, we have

$$v=-\frac{8E_0}{R}\sqrt{\frac{L}{C}}\epsilon^{-\frac{R}{2L}t}\sum_1^\infty i\frac{\cos(2i-1)\frac{\pi x}{L}}{\sqrt{(2i-1)^2\pi^2-\frac{CR^2}{4L}}}\sin t\sqrt{\frac{(2i-1)^2\pi^2}{LC}-\frac{R^2}{4L^2}}$$

v being the potential of the point x at time t from the break.

Putting $\gamma=l$, we have the potential v_1 at one end:

$$v_1=\frac{8E_0}{R}\sqrt{\frac{L}{C}}\epsilon^{-\frac{R}{2L}t}\sum_1^\infty i\frac{\sin t\sqrt{\frac{(2i-1)^2\pi^2}{LC}-\frac{R^2}{4L^2}}}{\sqrt{(2i-1)^2\pi^2-\frac{CR^2}{4L}}} \quad (9)$$

Putting $\gamma=0$, we have the potential of the other end to be $-v_1$, and thus the potential difference of the terminals is $2v_1$, or

$$2v_1=16\frac{E_0}{R}\sqrt{\frac{L}{C}}\epsilon^{-\frac{R}{2L}t}\sum_1^\infty i\frac{\sin t\sqrt{\frac{(2i-1)^2\pi^2}{LC}-\frac{R^2}{4L^2}}}{\sqrt{(2i-1)^2\pi^2-\frac{CR^2}{4L}}} \quad (10)$$

The analogy of the formula (10) with that of (6) is evident; and the reasoning about the formula (6) as to the suppression of the spark may be immediately applied on the formula (10).

Hence, it seems that there is little difference, in considering the spark or its suppression, whether the capacity is situated at the ends of the broken circuit or is uniformly distributed along the whole length of the circuit. As every practical case is an intermediate one between these extremes, it may easily be concluded that the reasoning about a circuit with the capacity at its terminals may be true for a circuit in general to a sufficiently close degree of approximation.

CURRENT-RUSHES INTO TRANSFORMERS.

BY R. C. CLINKER.

It is a well-known fact that at the instant of switching a transformer or a group of transformers on to a live circuit, a momentary rush of current often takes place through the primary winding. This manifests itself usually by a kick of the ammeter, if one happens to be in circuit, or by a loud hum which dies away to the normal sound within the first few seconds. The explanation of the effect is probably this:—The magnetic condition of the iron before the transformer is switched on depends upon that point in the cycle at which the switch was last opened. The magnetic circuit being a closed one, the iron has no poles which tend to demagnetise, hence the induction in the core may have a maximum, zero, or intermediate value, depending upon the instantaneous value of the magnetising current when the voltage was removed from its terminals. If now voltage be suddenly re-applied to the primary in such a direction that to produce the necessary back E.M.F. a change of induction is required in the direction in which the iron is already highly magnetised, the permeability of the iron is so low in this direction that a large rush of current is necessary to produce the required change of flux. During the next few seconds the magnetic cycle in the iron does not take place around the zero point. Indeed, the direction of magnetisation may not even reverse in sign during the first few cycles. The tendency which exists in the iron, however, towards zero magnetisation asserts itself, and the magnetic cycle slowly descends from higher values of induction until it takes place around the zero point. One or two interesting experiments which the author made on this point some months ago make this action more apparent. In one, a direct-current ammeter with well-damped needle (such as a Weston instrument) is included in the circuit when switching on. If this ammeter be of fairly small range, a *direct* current will be seen to pass through the transformer for a considerable time after the circuit is closed. Thus, in the author's test, a 10 kw. transformer was experimented upon, a 5 ampere Weston ammeter being placed in circuit with the 100 volt terminals, which could be switched on to a 100 cycle supply. The normal alternating no-load current was about 1·5 amperes, but a kick of fully 5 amperes could often be obtained upon the Weston ammeter, the direction being of course either positive or negative. After the first kick the needle slowly sank to zero, but in some cases a small direct current flowed

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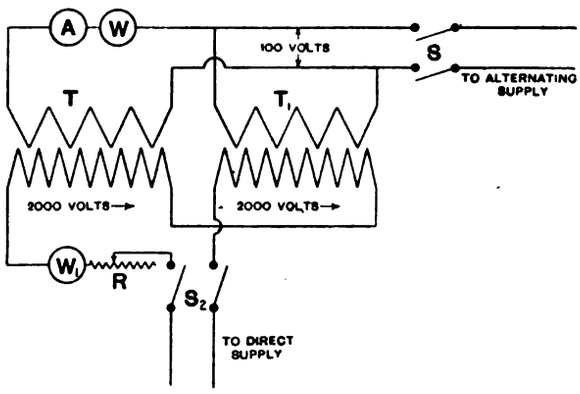
through the transformer for fully one minute after the closing of the switch. It is evident that this direct current means a continuous change of the total induction linked with the circuit, going on quite independently of the cycle or range of induction-value necessary to supply the back E.M.F.

The effect may be produced more artificially by magnetising the core in one direction with a direct current, while the alternating voltage is still applied to the terminals. To neutralise the induced voltage in the magnetising coil, the author used two transformers connected as in the diagram. T and T_1 were two 50 kw. transformers, both of 20:1 ratio. Their low pressure windings were paralleled and connected to a 100 volt source of alternating supply, two ammeters, one an alternating-current instrument (A) and the other a direct-current Weston (W) being included in the circuit. The high pressure windings were connected so that their E.M.F.'s opposed, and a direct-current circuit with resistance and ammeter (W_1) was introduced in series with them. A direct current could thus be made to flow in both primaries quite independently of any induced voltage.

On closing switch S_1 the ammeter A read, of course, the no-load current of T, while no permanent deflection was produced on W, the pointer merely vibrating over the zero. As A was a 60-ampere instrument, this small current produced very little deflection. On closing S_2 and allowing current to flow through the high-pressure coils, a momentary direct current was, of course, indicated by W, while the no-load current read on A was increased, owing to the lower



average permeability of the iron at the higher inductions through which the magnetic cycle was taking place. By reducing R sufficiently, this no-load current could be increased to 60 amperes, the scale limit of ammeter A. The interesting point of the experiment, however, lay in the effect of suddenly opening switch S_2. The magnetic cycle, having no resultant magnetising force left to support it at so high an induction, gradually descended to its normal position, occupying in its descent an interval of at least one minute. For that space of time a direct current could be observed flowing through W. The immediate effect of opening S_2 upon the reading of A was to reduce it about one-third, from which value it slowly crept down to the normal magnetising current. One effect of working at this high induction was to cause the transformers to hum loudly.

The method of connection used in this experiment may also be used to show that the hysteresis loss in the cores is dependent only upon the total range through which the induction passes, and not upon the actual value of that induction, a wattmeter being placed in circuit to measure this in the usual way.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Electric Batteries: How to make and use them." The "Model Engineer" Series No. 5. Edited by P. Marshall. (London: Dawbarn and Ward.) 6d.

"Proceedings of the Royal Society." No. 430, Vol. LXVI. (London: Harrison and Sons.) 1s. 6d.

"The Official Gazette of the United States Patent Office." No. 9, Vol. XCI. (Washington: Government Printing Office.)

A FRICTIONLESS MOTOR METER.*

BY S. EVERSHED.

Preliminary.—Lest their should be any misapprehension of the title of this Paper, let it be said at once that the adjective is used in the comparative sense already sanctioned by such analogous phrases as "smokeless powder," "watertight compartment," and so on. Every one knows that smokeless powder makes some smoke and that a watertight compartment usually leaks, but the smoke is not sufficient to enable the position of a gun to be seen nor to interfere with other military operations, and the leaks are not sufficient to sink the ship. Similarly a frictionless meter is one in which the friction commonly met with has been so greatly reduced as to render correction unnecessary, and reduce wear and tear to an inappreciable amount.

In the course of the last few years the author has tested some of the better known types of motor meter in general use, with the result that the lowest observed value for the moment of frictional resistanceis 57 dyne cm. and the highest nearly 1,400 dyne cm., while values of from 300 to 500 dyne cm. are quite usual. All these tests were carried out upon new meters which had been carefully adjusted by the makers. In the author's meter the frictionmoments so far observed vary from 1·5 dyne cm. in a new meter up to 3·5 dyne cm. in one which has run for many million revolutions. These figures will, it is hoped, serve to excuse if not to justify the title "frictionless."

Among the many links in the long chain connecting the energy locked in the coal store of an electric power station with the work done on the consumers' premises the supply meter is by no means the least important. Yet is has perhaps received less attention from the Institution of Electrical Engineers than any other essential part of an electric supply. It is difficult to assign any cause for this apparent neglect: electric meters began to be invented in the earliest days of electric lighting, and by the time the industry was on a sound basis there were already a large number, working on a variety of wholly different principles, awaiting the test of practical use. There were motor meters, electrolytic meters, differential clock meters, feeler meters—in addition to a host of nondescript meters. There were many kinds of each of the fundamental types; some of them based on more or less simple laws, others practically lawless and destined on that account to succumb in the struggle for existence. But the extraordinary activity of the meter inventor and the very wide field he was working in has left scarcely a trace in the *Proceedings* of the Institution.† While we have over and over again discussed every other link—coal, boilers, engines, dynamos, mains, batteries, transformers, lamps, and so on—and devoted a vast amount of learning and experience to efficiencies (reckoned to fractions of 1 per cent.), to load factors, to costs (calculated to minute fractions of a penny), we have been content to pass the meter over in silence. Is the average meter, then, so good that it needs no attention from us? Far from it; erratic meters are not unknown. One will allow a consumer to run a lamp all day for nothing; another for 30 or 40 per cent. discount. Precious energy after having its cost ascertained to the hundredth of a penny is positively being given away every day by sticky motor meters, unbalanced clock meters, and the like. As a set-off one hears of meters running up a big bill when the consumer is out of town and the main switch off.

Bearing all this in mind, the author feels that a Paper devoted to the description of an attempt to remove some of the more obvious defects of a particular class of meter—the motor type—together with an exhibition of the outcome of that attempt will need no apology.

Motor Meters.—The fundamental principle of all motor meters is very simple. The driving moment (torque) of the motor is made proportional to the power (or to the current, in a coulomb or electricity meter) being metered, and the speed of the motor is controlled by a brake whose resisting moment is proportional to the speed. Consequently the speed will be proportional to the power (or to the current), and the number of revolutions made in a given time will be proportional to the energy (or to the electricity) supplied. This was first clearly stated by Profs. Ayrton and Perry in describing their well known energy meter, the forerunner of nearly all energy meters since invented.‡ Unfortunately, it is easier to lay down the law than it is to make a meter obey it. A motor axle must have bearings; a current has to be led to the rotating armature either by brushes or by means of a mercury bath; and there is a counting train to be driven. All these things involve friction, and a part, often a very considerable fraction, of the available driving torque

* Paper read before the Institution of Electrical Engineers, May 10.

† Here are the only Papers on meters published from 1885 to 1899:—Mr. Hookham, in demonstrating his meter, 1889, *Journal* of the Institution of Electrical Engineers, Vol. XVIII., p. 688 [*see* also *The Electrician*, Vol. XXIII., p. 124—Ed., *E.*]; Mr. Gibbings, "Registration of Small Currents used for Electric Lighting and other Purposes," *Journal* of the Institution of Electrical Engineers, 1898, Vol. XXVII., p. 547 [*see* also *The Electrician*, Vol. XLI., p. 112—Ed., *E.*].

‡ Specification of Patent No. 2,642, 1882.

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will be used up to overcome it. There are other minor difficulties, such as the construction of a motor without iron, variation of electrical resistance due to temperature, and so on, but practically friction is the only serious trouble in a motor meter; it limits the accuracy and involves a good deal of wear and tear.

If one attempts to design a practicable energy meter of the type described by Ayrton and Perry, one is hampered by certain fairly definite limitations, such as cost of manufacture, drop in the current coils at full load (or power wasted in them if that is the more important item), and above all waste of power in pressure circuit. If the full-load drop is fixed at one volt, and the wasted power in the pressure circuit is limited to three or four watts, it will be found that the maximum driving torque obtainable (on the assumption that the meter is to be saleable at present average prices) is something like 20,000 dyne cm., and the friction may be from 300 to 500 dyne cm. A greater driving moment is easily obtained by enlarging the armature, but only at the exponse of increased weight of moving parts and a consequent increase in friction. We shall be fairly stating the result of careful designing if we put the driving torque at 15,000 and the moment of frictional resistance at 300 dyne cm.; in other words, driving torque at full load amounts to about fifty times the frictional resistance. It will be convenient to reduce these figures to percentages by calling the full load 100, maximum driving moment 100, and the friction moment 2, arbitrary units. We may also reckon full speed of the meter as 100 revs. per min. Our hypothetical meter will obviously not start until the load exceeds 2. Also it will make 98 revs. per min. at full load, since of the total driving torque of 100, 2 units are used up for friction, leaving 98 to work on the brake. Hence a table of corrections can be written down at once, on the assumption, of course, that friction is constant throughout the range of speeds contemplated. If there is no fluid friction this assumption is correct. The errors of the meter are given in Table I.

Table I.—*Errors of Uncorrected Motor Meter.*

Maximum driving torque = 100, friction = 2. Full speed = 100; arbitrary units.

Driving moment M.	Friction *f*.	Speed (numerically equal to M − *f*.	Percentage error.
2	2	0	inf.
4	2	2	−50
10	2	8	−20
20	2	18	−10
40	2	38	− 5
60	2	58	−3·3
80	2	78	−2·5
100	2	98	−2·0

Standard range = 1 to 3·3

It will be observed that with such a meter the consumer gets a discount of 16 per cent. when he is taking one-tenth of full load.* The range of a meter within specified limits of error forms the best criterion of comparison as regards accuracy, and the author proposes to call that part of the total range of a meter in which its error is within the limits imposed by the Board of Trade "the Standard Range." Hence the standard range of the hypothetical meter is 1 to 3·3 when the meter is adjusted to register correctly at full load.

Correction for Friction.—Clearly the simple uncorrected motor meter requires some modification before it can be considered as a practical instrument. It is well known that friction can be partially corrected by means of a starting coil in the pressure circuit. At first sight this seems a simple and sufficient solution of the problem. If to the hypothetical meter we add a starting coil whose driving moment on the armature equals 2, the errors in Table I. disappear. A new error will, however, have crept in; the meter will almost invariably run when the load is zero; lessen the strength of the starting coil, and the meter, although not quite so immoral, will still occasionally go on running when the load is off. The author was for a long time completely baffled in his efforts to find an explanation of this effect, but a very simple cause was at last discovered, and as others may have been puzzled besides himself he ventures to give the explanation here.

Every one knows how enormously the friction of light mechanism may be reduced by vibration. The reduction is far too large to be accounted for by the vibration causing cohesion to vanish. Now when a meter is fixed in a town house it is never entirely free from vibration, and the light axle such as is commonly employed in meters is alternating between a position in which it is wholly or partially out of contact with its bearings, and one in which it presses on them with more than normal force. In one sense, of course, the average value of friction remains the same as it would be with no vibration, and, in fact, the constant of a meter is hardly altered appreciably by it; but the fact that friction is higher during one half period of the shaking and the meter therefore at rest (the starting coil is supported just to balance the average friction—it is obviously insufficient to move the armature while the friction is above the average) does not prevent the starting coil from moving the armature during the half periods when friction is less than the average. The author has found that a meter fixed to the brick wall of the office building at Woodfield Works would go on running all night when the driving moment was reduced to a very small fraction of that required to balance the normal average friction; and this can only be accounted for on the assumption that during what may be called the positive half periods of vibration the meter axle and commutator were to all intents and purposes frictionless. If this is the true explanation of a well-known trouble, then it is obvious that there will always be a difficulty with such meters when they are fixed in buildings subject to vibration.

Elimination of Friction.—Instead of regarding friction as unavoidable and attempting to correct for it, the author has approached the problem from another side and endeavoured to remove the causes of friction and so avoid the necessity for correction. These causes are, as has already been stated, (1) friction of axle bearings, (2) friction of brushes on commutator, (3) friction of counting train and gear connecting it with the motor axle. With an ordinary vertical axle the first is nearly all due to the bottom or step bearing, which is usually a rounded steel point resting in a jewel cup. In the author's meter the pressure of the axle on the bottom bearing is reduced to a few grammes by magnetically suspending the axle, armature, and brake. A top bearing is entirely dispensed with, the axle being held in position magnetically—"magnetically pivotted."

The brush friction is enormously reduced by the use of a novel form of commutator having elastic segments against which the edges of two light and freely pivotted wheels roll to act as brushes. The friction of the train is entirely removed as a source of error. The train is driven by a simple electro-magnetic device whose speed of working is controlled by the speed of the motor, although there is absolutely no mechanical connection between them.

These means have already sufficed to reduce the friction from a value between 300 and 400 dyne cm. to less than 3 dyne cm., and there is reason for believing that the limit has not yet been reached.

Early Attempts at Magnetic Suspension.—The possibility of using magnetic force to take the weight of the rotary parts of a motor meter off its bearings has no doubt presented itself to many minds, and probably a good many inventors have made experiments with that object in view. In 1887 Mr. Hookham refers to the subject in one of his meter patents, but he confines himself to the statement that "the magnets may be so disposed as to counteract or partially counteract gravity, and thereby lessen friction."* A little later Mr. Ferranti turned his attention to magnetic suspension in connection with alterate-current meters, while quite recently in America Mr. Stanley has brought out a motor meter in which the vertical axle is entirely suspended by means of the attraction of iron discs fixed on the axle and ring poles surrounding them. Pivots at the top and at the bottom of the axle are required to keep it and the discs exactly concentric with the ring poles, the relative position of the discs and ring poles being one of unstable equilibrium laterally, although perfectly stable axially.

The author began experimenting with magnetic suspensions a few weeks after the publication of Prof. George Forbes' Paper on his "windmill" meter. It occurred to him that the Forbes meter might be made less wasteful of power if it were compounded much in the same way as a steam turbine, and he proposed to make the compound windmill as nearly frictionless as possible by magnetically suspending the axle and its series of rings of vanes. A meter was made on this plan with a bar magnet placed in line with and immediately above the end of the axle, which was pivotted top and bottom (see Fig. 1); the arrangement proved quite unworkable and was abandoned. In 1891 the author, in connection with Mr. Vignoles, was working at a motor meter of the Ayrton-Perry type, in which friction was eliminated by floating the armature in water or oil. The armature was held in the centre of the vessel containing the liquid by means of a little iron rod projecting axially below the armature, with its end close to the bottom of the vessel (Fig. 2). A bar magnet was fixed underneath the vessel, in line with the iron rod, and with its upper pole as close as possible to the bottom of the vessel. The iron rod was consequently held in the magnetic axis of the bar magnet, and the axis of rotation of the rotary system coincided with the magnetic axis. This "magnetic pivot," as it was called, worked admirably, but the meter itself was a failure.† Another application of magnetic suspension was attempted in 1891-2 in connection with an early form of the Richards-Evershed Ships' Telegraph. In this apparatus a very powerful magnet is

* Through the kindness of Prof. Ayrton the author has been able to test an actual meter made in the manner described. Its maximum driving torque was 19,000 dyne cm., and its friction 350 dyne cm., the accuracy being therefore rather better than that shown in Table I. But this was dearly purchased at the expenditure of no less than 10 watts in the pressure circuit.

* Specification of Patent No. 4,225**, 1887.

† It is worth mentioning that the train of this meter was to be driven by a coil with a vertical axis fixed on top of the armature and alternately attracting and repelling a magnet, an idea which has, after the lapse of nearly ten years, been tested and proved to be entirely practicable.

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required to be freely pivotted and to have as little inertia as possible. An induced magnet was tried, magnetised by induction from an electromagnet. The induction was led from the fixed to the movable magnet through the ends of the axle as shown in Fig. 3. The arrangement gave much trouble owing to the magnetic attraction forcing one or other of the pivots against the end of its bearing. In a modified form (see Fig. 4) the induction was led into the axle radially, and at the same time a little axial displacement was given to the enlarged part of the axle with respect to the fixed ring pole in order to relieve the bottom bearing of the weight of the magnet N N and its heavy axle. This was accomplished to some extent, but two new difficulties arose: if the axle was not absolutely concentric with the hollow poles of the fixed magnet, there

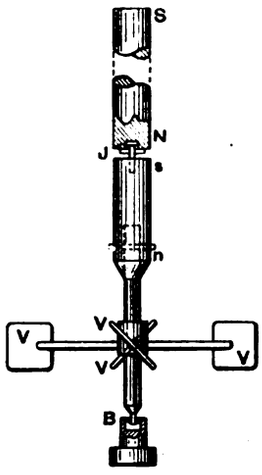

Fig. 1.—Magnetic Suspension applied to Professor Forbes' "Windmill" Meter.

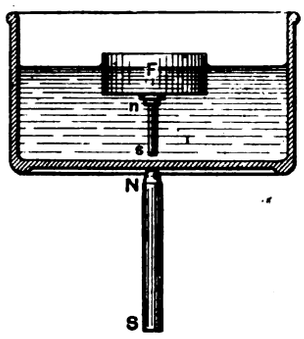

Fig. 2.—Magnetic Pivot applied to the Floating Armature of a Motor Meter.

was a lateral magnetic pull upon it, causing the pivots to bear with corresponding pressure on their bearings, so that the elimination of one friction had only served to introduce another; the other difficulty arose from want of perfect mechanical truth in either the axle or the ring poles, or both. This led to the ring poles having a directing moment on the axle, and gave rise to errors in the indications of the telegraph. In a sense, these troubles were due to imperfect workmanship and were consequently avoidable. But anything requiring great nicety of adjustment was quite out of place in the particular apparatus of which the movable magnet formed a part, and after much fruitless work all idea of magnetic suspension was given up and the whole magnetic circuit was made to move as one piece.

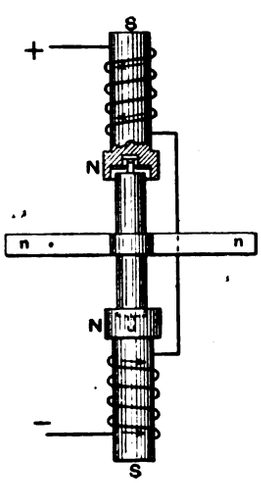

Fig. 3.—Magnetic Suspension, applied to the Needle Axle of a Ship's Telegraph.

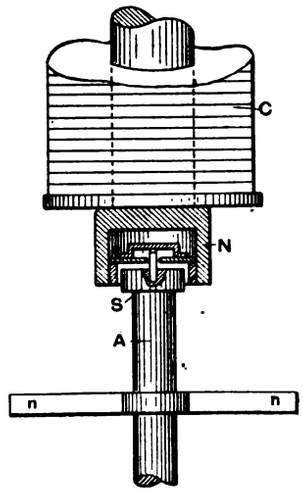

Fig. 4.—Modified Form of Magnetic Suspension for a Ship's Telegraph.

In a renewed attempt to make a frictionless meter of the Ayrton-Perry type, the weight of the rotary part was suspended by the attraction of a fixed solenoid surrounding the upper end of the iron axle (Fig. 5). The magnetic circuit was made as perfect as possible by fixing an iron disc on the axle just below the coil and carrying an iron tube up from the disc so as to partially enclose the coil. It was, however, not found practicable to reduce the waste of power in the solenoid below about 5 watts, and this was quite sufficient to put this form of suspension out of court so far as motor meters are concerned.

Present Form of Magnetic Suspension.—Finally, the author returned to the first idea (Fig. 1) of a simple magnetic pole fixed above an iron axle. Experience had proved that one of the worst troubles with all forms of supension was caused by the magnetic axis not being absolutely coincident with the rotational axis, the latter being determined by the pivots. If the top pivot is removed, the axle is free to centre itself in a magnetically symmetrical fashion, and it will then rotate about the magnetic axis (Fig. 6.) Any directional moment due to the axle and suspending pole not being perfect figures of revolution will be enormously reduced by diminishing the diameters of axle and pole; and with diameters not much exceeding 5mm. the supporting pole has no measurable directing influence upon the axle. Thus the combination of the suspension shown in Fig. 1 (minus its top pivot) with the magnetic pivot of Fig. 2 has resulted in a perfectly practicable and very simple arrangement for relieving a step bearing of the greater part of the weight of the rotating system.

To prevent the axle from accidentally coming into contact with the supporting pole, a thin plate of non-magnetic metal (seen at *e* in Fig. 6) is interposed between them. It is fixed immediately above the end of the axle, leaving a very small clearance. The supporting pole is adjusted until nearly the whole of the pressure on the step bearing is relieved. If the pressure is reduced to zero, a slight shake will jerk the axle up until it rests against the plate, where it will remain, since the upward attracting force increases as the space between axle and supporting pole diminishes. It is therefore necessary to leave a few grammes weight unbalanced so that there is sufficient gravitational force downwards to pull the axle off the end-plate, should it happen to rise into contact with it.

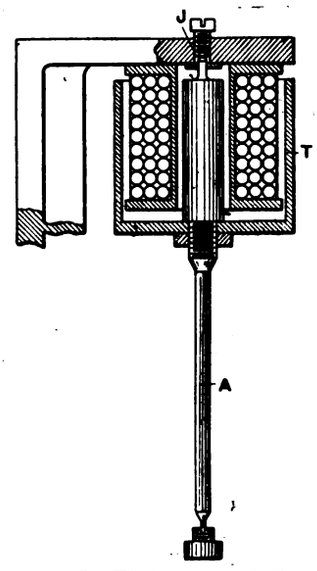

Fig. 5.—Electro-magnetic Suspension applied to a Motor Meter.

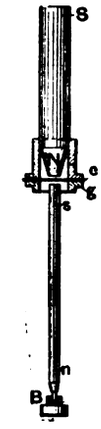

Fig. 6.—Present Form of Magnetic Suspension applied to a Motor Meter.

Essential Points in Magnetic Suspension of Meter Axles.—Magnetic attraction has been used to partially support the weight of dynamo armatures by the simple expedient of boring the pole pieces excentrically. Again, if a dynamo has a vertical axle, the whole of the pressure upon the step bearing may be removed by allowing the armature core to fall a little below the level of the pole pieces; but these and similar applications of magnetism to the relief of bearing pressure must not be confounded with its use as a means of reducing the resistance to rotation of a meter axle.

Our object in magnetically suspending the axle of a motor meter is twofold. It is certainly an advantage to reduce wear and tear of bearing, but primarily we desire to improve the meter as regards accuracy and waste of energy, and to that end it is essential that there should be a reduction of all the resistances to rotation other than that offered by the brake. Now, while it is easy to suspend a meter axle by some such means as those just referred to as applicable to dynamos, a moment's consideration shows that in reducing the friction of the step bearing to zero, we have at the same time introduced a new source of friction, namely, hysteresis in the iron core on which the two pole pieces act. This, as is well known, offers a resistance to rotation. Its amount in any practical example will be found to be enormously greater than the frictional torque of the step bearing. In a dynamo or motor the hysteresis torque is there in any case, whether we suspend the armature or not, so that the relief of bearing friction by displacing the armature in the pole pieces is a clear gain, but in the meter there is no iron core within the armature, and in order to suspend the axle in the same way a core must be put upon the axle for that purpose, thus introducing a resisting torque which did not exist before.

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We thus arrive at an essential principle for magnetic suspension of meter axles: *The induction density in the magnetic devices used for support must remain absolutely constant during rotation of the axle.* This at once disposes of unsymmetrical bipolar arrangements; nothing of the nature of two poles attracting a piece of iron will serve. To secure uniform induction density in the rotating part of the magnetic circuit, the attracting pole must be a figure of revolution with its axis coincident with the axis of rotation. As an example, the attracting pole might be a ring concentric with the axle; an iron disc fixed upon the axle a little below the plane of the ring pole would be attracted upwards, and if the ring and disc could be made mechanically true and magnetically homogeneous, the induction density would be uniform in the disc and there would be no resistance to rotation due to hysteresis. In practice it is exceedingly difficult to ensure these conditions. The disc is in unstable equilibrium transversely, and as there is necessarily a little clearance between the axle pivots and their bearings, the disc will always run a little out of centre; this at once raises the density at one part of the annular air-gap and lowers it on the opposite side, and during rotation the iron of the disc goes through a minute magnetic cycle, absorbing a corresponding amount of energy. The disc is also pulled sideways and causes the pivots to press against the bearings. These effects were very marked in the experimental devices already referred to (Figs. 3 and 4) and led the author to abandon that type of suspension for the simple form finally adopted, namely, a cylindrical magnetised rod fixed with its lower end immediately above and in line with the cylindrical iron axle.

It must not be supposed that this is a complete solution of the problem; but it has proved itself to be a thoroughly practicable one, and if the diameter of the supporting pole and axle is small enough, there appears to be no trace of hysteresis, nor is any difficulty experienced in obtaining the requisite mechanical truth. Of course the position of the axle is one of unstable equilibrium in a vertical direction, the magnetic attraction increasing rapidly if the axle rises towards the supporting pole. But if means are adopted to confine the possible travel of the axle within narrow limits, it will run with very little pressure on the step bearing.

(To be continued.)

ELECTRICITY WORKS ACCOUNTS.

The City of London Electric Lighting Co. (Ltd.).

The retrogression in the financial results of this undertaking, as shown by the accounts for 1899, is hardly surprising in view of the altered conditions brought about by competition.

As may be noticed from our table, the increase in the ratio of costs to revenue and the falling off in the profits are almost wholly due to the reduction in the revenue. The costs have slightly increased, however, the chief source of increase being in the fuel item as a result of the coal trade dispute last year. We are sorry to find that the repairs and maintenance item has risen from what was a very satisfactory figure in 1898. The wages item also shows an increase, but at 0·86d. per unit is not unsatisfactory. The result of these increases in the several items becomes marked in the total generating and works costs, which stand at figures quite 0·5d. too high. The management and property charges have dropped to a most reasonable figure at not quite 0·7d. per unit.

So far as the progress of the concern in the accession of new business goes, the figures of the output and lamp connections have a brighter aspect. The output at 8,549,353 units sold shows an increase of 23·2 per cent., while the equivalent 8 c.p. lamp connections show an advance of 19·4 per cent. The load factor has also slightly increased, having been 10·7 per cent., as compared with 10·2 per cent. in 1898. As showing to some extent the history of the development of the company's business the following table is reproduced:—

Dec. 31.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
No. of consumers	242	1,080	2,740	4,230	4,303	6,32[illegible]	7,414	8,737
Equiv. 8 c.p. lamps con.	20,241	65,341	135,460	195,317	247,785	296,012	355,825	437,612

As in the 1898 accounts, we have departed from the rendering of the official accounts in respect to the repairs and renewals items. In the company's printed accounts these charges are debited to the depreciation fund, and are not included in the costs of generation and distribution. The following are the details:—

Year.	Total.	Repairs and renewals at station. Total at station.	Buildings.	Boilers, heaters, &c.	Engines and condensers.	Dynamos and exciters.	Other machinery, instruments, and tools.	Repairs, maintenance, and renewals of mains, lamp-posts and transformers.
1898	£12,426	£8,820	£1,153	£2,986	£1,428	£874	£2,379	£3,606
1899	19,120	14,729	1,995	5,200	2,037	981	4,516	4,391

Following our course last year the above £19,120 has been included in the costs in our analysis, although there is no data to show what part, if any, is legitimately chargeable to "depreciation" or "renewals." The result is, of course, to show a smaller working profit and allocation to depreciation than is shown in the official accounts.

The Bromley (Kent) Electric Light and Power Co. (Ltd.)

To have produced the satisfactory financial return and the costs figures shown in our second table in the first year of working and under the adverse conditions of situation, small output and low load factor is a result upon which the engineer of this little undertaking is to be congratulated.

During 1899 the total output sold was 110,958 units, of which 79,500 were sold for consumption in Bromley, and 31,458 units were transmitted to the sub-station at Chislehurst. At this output, and with a maximum supply demand of 200 kw. the load factor was 6·33 per cent. At such a low figure the fuel charge of 1·19d, per unit is really most satisfactory. The other elements of generating costs are remarkably low, and were the works and total cost figures higher by 0·5d. per unit than they actually are we could not have adversely criticised them.

At 5·84d. per unit, the revenue figure practically represents the average, irrespective of output and load factor, and it must be highly gratifying to be able to show with such a tariff and upon so small an output a working profit of 2·74 per cent. of the expended capital in the first year. We only hope that it will be found possible to maintain the position of 1899 in the current and succeeding years.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, 1900
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	April 14, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, 1900	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	July 14, 1899	Northampton (Company)	Oct. 20, ,,
Brompton & Kensington (Co.)	Mar. 23, 1900	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, 1899	Notting Hill (Company)	Mar. 16, 1900
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, 1899
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	April 13, 1900	Oxford (Company)	April 13, 1900
Cardiff (Municipal)	Dec. 15, 1899	Pontypool (Company)	May 5, 1899
Charing Cross (Municipal)	Mar. 9, 1900	Portsmouth (Municipal)	July 14, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	May 18, 1900	Salford (Municipal)	Feb. 23, 1900
Coventry (Municipal)	Feb. 23, ,,	Scarborough (Company)	Nov. 8, 1899
Croydon (Municipal)	Feb. 9, ,,	St. Helens (Municipal)	Dec. 8, ,,
Derby (Municipal)	Jan. 26, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	June 8, ,,
Dover (Company)	April 27, 1900	Sheffield (Municipal)	Dec. 29, 1899
Dundee (Municipal)	Jan. 12, ,,	Shoreditch (Vestry)	Oct. 27, ,,
Eastbourne (Company)	May 4, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Folkestone (Company)	April 27, 1900	Stafford (Municipal)	Dec. 29, ,,
Glasgow (Municipal)	Sept. 1, 1899	Sunderland (Municipal)	July 28, ,,
Guildford (Company)	May 5, ,,	Taunton (Municipal)	June 16, ,,
Halifax (Municipal)	July 21, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Walsall (Municipal)	June 23, ,,
Hanley (Municipal)	April 28, ,,	Wandsworth (Company)	May 18, 1900
Harrogate (Municipal)	Oct. 20, ,,	Westminster (Municipal)	Mar. 9, ,,
Harrow (Company)	June 16, ,,	Whitehaven (Municipal)	July 28, 1899
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 20, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 13, ,,
Kensington & Knightsbr'(Co.)	Mar. 16, 1900	Worcester (Municipal)	April 20, 1900
Kingston-upon-Hull (Mun.)	June 9, 1899	Yarmouth (Municipal)	Nov. 8, 1899

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	CITY OF LONDON.		BROMLEY (KENT).	
Undertaking Worked by	The City of London Electric Lighting Co. (Ltd.)		The Bromley (Kent) Electric Light and Power [Co. (Ltd.)	
Date of Commencement of Supply	December, 1891.		January, 1899.	
System of Supply	[con.-cur. 3-w. system.		3-wire low-pressure and 2-wire high-pressure [con.-current.	
Chief Engineer	Alt.-cur. trans. sub-sta. feeding 3-w. net. ; also Frank Bailey.		R. L. Gamlen.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	—	—	—	—
,, SOLD (TOTAL)	6,939,763	8,549 353	—	110,958*
,, sold to consumers	5,837,317	7,446,703	—	110,958
,, sold for public lighting, &c.	1,102,446	1,103,650	—	—
,, used on works	167,109	—	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	191	197	—	10·5
Maximum supply demanded	7,809 kilowatts	9,138 kilowatts	—	200 kilowatts
Number of public lamps	502 arc	543 arc	—	—
Number of consumers	7,414	8,737	—	136
Connections to mains in 8-c.p. lamps	355,825	437,612	—	10,337
CAPACITY OF PLANT IN 8-C.P. LAMPS	364,000	434,500	—	10,600
CAPACITY OF PLANT IN KILOWATTS	11,660	13,900	—	340
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£1,600,000 / £137·2	£1,600,000 / £115	— / —	£30,000 / £88·2
Share	1,200,000 / 102·9	1,200,000 / 86·3	— / —	20,000 / 58·8
Loan (including Debenture charges)	400,000 / 34·3	400,000 / 28·8	— / —	10,000 / 29·4
RECEIVED (TOTAL)	1,400,000 / 120·0	1,400,000 / 101	— / —	15,112 / 44·4
Share	1,000,000 / 85·75	1,000,000 / 72·0	— / —	5,112 / 15·0
Loan (including Debenture charges)	400,000 / 34·30	400,000 / 28·3	— / —	10,000 / 29·4
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	200,000 / 17·15	200,000 / 14·4	— / —	14,838 / 43·8
Share (unissued)	200,000 / 17·15	200,000 / 14·4	— / —	11,365 / 33·4
Share (uncalled)	nil / —	nil / —	— / —	3,523 / 10·4
Loan (including Debentures)	nil / —	nil / —	— / —	nil / —
REPAID (TOTAL)	nil / —	nil / —	— / —	nil / —
RESERVE OR SINKING FUND	14,000 / 1·200	16,349 / 1·18	— / —	— / —
DEPRECIATION FUND	105,047[a] / 9·01	108,934[h] / 7·84	— / —	— / —
EXPENDED (TOTAL)	1,374,689 / 118	1,513,456 / 110	— / —	43,156 / 127
Lands and buildings	280,224 / 24·0	336,174 / 24·2	— / —	7,058 / 20·8
Plant	571,026[b] / 49·0	615,696[i] / 44·3	— / —	18,186 / 53·5
Mains	405,038[c] / 34·7	443,174[j] / 31·9	— / —	17,441 / 51·3
Miscellaneous	118,401 / 10·2	118,413 / 8·49	— / —	470 / 1·38
BALANCE OF CAPITAL ACCOUNT	+25,311 / +2·17	−113,456[k] / −8·16	— / —	−28,044[a] / −82·4
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£168,840 / 5·841d.	£179,843 / 5·050d.	— / —	£2,699 / 5·840d.
Revenue from supply	150,761 / 5·218d.	159,739 / 4·448d.	— / —	2,358 / 5·102d.
,, meters, &c.	5,151 / 0·718d.	6,169 / 0·173d.	— / —	63 / 0·147d.
,, public lighting	12,928 / 0·447d.	13,088 / 0·368d.	— / —	— / —
,, sale of lamps, &c.	— / —	684 / 0·019d.	— / —	272 / 0·588d.
,, miscellaneous sources	— / —	162 / —	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£85,492 / 2·957d.	£113,351 / 3·183d.	— / —	£1,517 / 3·280d.
WORKS COSTS	60,875 / 2·104d.	88,599 / 2·487d.	— / —	1,005 / 2·174d.
Generation of electricity	*50,361 / 1·741d.*	*77,319 / 2·170d.*	— / —	*1,005 / 2·174d.*
Fuel (including cartage, &c.)	27,145 / 0·939d.	44,027 / 1·236d.	— / —	549 / 1·188d.
Oil, waste, water, stores	3,743 / 0·129d.	4,531 / 0·127d.	— / —	69 / 0·149d.
Wages at station	10,055 / 0·348d.	12,900 / 0·362d.	— / —	378 / 0·818d.
Repairs and maintenance at station	8,820 / 0·305d.	14,729 / 0·414d.	— / —	9[b] / 0·019d.
Distribution of electricity	*8,463 / 0·293d.*	*9,127 / 0·256d.*	— / —	—[b] / —
Wages, &c.	4,857 / 0·168d.	4,470 / 0·126d.	— / —	—[b] / —
Repairs, renewals of mains, &c.	3,606[d] / 0·125d.	4,391[d] / 0·123d.	— / —	—[b] / —
Public lighting	*2,051 / 0·071d.*	*2,153 / 0·060d.*	— / —	— / —
Attendance	1,356 / 0·047d.	1,351 / 0·038d.	— / —	— / —
Renewals	695 / 0·024d.	802 / 0·023d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	24,617 / 0·852d.	24,752 / 0·695d.	— / —	512 / 1·108d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*11,912[e] / 0·412d.*	*10,596[e] / 0·298d.*	— / —	*119 / 0·257d.*
Management	*12,705 / 0·440d.*	*14,156 / 0·398d.*	— / —	*393 / 0·850d.*
Salaries	7,584 / 0·262d.	7,864 / 0·221d.	— / —	299 / 0·647d.
Stationery, &c.	870 / 0·030d.	907 / 0·025d.	— / —	51 / 0·110d.
Establishment charges	737 / 0·025d.	1,044 / 0·029d.	— / —	23 / 0·050d.
Law charges, &c.	3,514 / 0·122d.	4,341[l] / 0·122d.	— / —	20[c] / 0·043d.
FINANCIAL RESULTS—	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded
WORKING PROFIT FOR YEAR	£83,348 / 6·27%	£66,492 / 4·60%	— / —	£1,182 / 2·74%[f]
Sum carried to Depreciation Fund	4,574 / 0·344%	1,879 / 0·130%	— / —	— / —
Sum carried to Reserve or Sinking Fund	3,075 / 0·231%	2,349 / 0·163%	— / —	— / —
Net interest on loans (incl. Debenture charges)	15,927 / 1·198%	17,621 / 1·22%	— / —	83 / 0·192%[f]
BALANCE FROM LAST ACCOUNT	1,055 / 0·079%	3,382 / 0·234%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	59,489[g] / 4·475%	48,023 / 3·32%	— / —	938[d] / 2·17%[f]
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	4% / —	— / —	2½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	50·6%	63%	—	56·2%
Expenditure per kilowatt capacity	£7. 6s. 7d.	£8. 3s. 0d.	—	£4. 9s. 2d.
REVENUE PER KILOWATT CAPACITY	£14. 9s. 7d.	£12. 18s. 7d.	—	£7. 18s. 10d.
Expenditure per 8-c. lamp capacity	4s. 8½d.	5s. 2½d.	—	2s. 10½d.
REVENUE PER 8-C.P. LAMP CAPACITY	9s. 3½d.	8s. 3½d.	—	5s. 1d.
REVENUE PER 8-C.P. LAMP CONNECTED	9s. 5⅝d.	8s. 2½d.	—	5s. 2½d.
Price charged for lighting, per unit	7d. to 4d.	5d. to 4d. or 4½d.[m]	—	7d. to 4d.[e]
Price charged for power, per unit	4d. to 3d.	3d. to 2d. or 2½d.[n]	—	4d. to 1d.[e]
Price charged for public lighting	£26 per arc per ann.	£26 per lamp per ann.	—	—

CITY OF LONDON.—REMARKS—*a* Being £61,422 in respect of generating machinery, and £43,625 in respect of buildings, lamps, lamp-posts, mains, meters and transformers. *b* Of which £65,977 was in respect of public lighting, £443,357 in respect of private lighting, and £61,592 not allocated to either. *c* Includes £19,939 cost of provisional order and expenditure on mains, &c., Southwark lighting. *d* Includes repairs and renewals of lamp-posts. *e* "Rents, rates, taxes and lighting." *f* Includes £139 to auditing, £202 meter reading, £105 trustees' fees, £1,398 to insurance, and £868 collection charges and various fines. *g* After writing £1,338 off suspense account. *h* Being £71,826 in respect of generating machinery, and £108,934 in respect of buildings, mains, lamp-posts, transformers, &c. *i* Includes £28,232 to lamp-posts, lanterns, lamps and accessories. *j* Includes £21,078 cost of provisional order and expenditure on mains, meters, &c., Southwark lighting. *k* Over-expended. *l* Includes £216 meter reading, £139 auditing, £913 collection charges, £1 707 insurance, and £230 professional charges. *m* At option of consumer, either on maximum demand system at 5d. per unit for first 100 hours of maximum demand per quarter and 4d. after, or at uniform charge of 4½ per unit. *n* Either on maximum demand at 3d. per unit for first 250 hours of maximum demand per quarter and 2d. after, or at uniform charge of 2½d. per unit.

BROMLEY (KENT).—REMARKS—* Of this total the units used at Bromley were 79,500, and the supply to the Chislehurst motor-generator station was 31,458 units. *a* Over-expended. *b* The distribution, repairs and maintenance are included under "Repairs and maintenance at station." *c* Being insurance charges. *d* After deducting £162 preliminary expenses written off. *e* On maximum demand system, 1-hour scale. *f* Per cent. to capital at Dec. 31, 1899.

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The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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INVENTION.

The establishment of a college for inventors is apparently the aim of a writer in the June number of *Cassier's Magazine*. Mr. W. H. Smyth, the author of the article we refer to, desires to "systematise inventive effort," and his arguments, even if they do not convince us of the necessity for an organised effort in this direction, are interesting reading, in spite of an occasional lapse into the involved style of diction peculiar to some American writers. However, to quote Mr. Smyth:—"Verbal statement, particularly in the inflexible form of written language, is but a clumsy tool for analytical processes which are difficult, even when expressed in terms of mental material with all its infinite plasticity. It, however, must serve, if lamely, to indicate the suggested method." On this plea, therefore, we may excuse the wording of the appeal itself, and also the logical subtleties in the opening paragraph:

> The inventive faculty is recognisable solely by its product. The Courts and Patent Office say that an invention is recognised solely by being the product of the inventive faculty. Assuming these propositions to be true which is to be the criterion, the faculty of the product, or the product of the faculty? Then, what shall constitute a test of the criterion itself—a test by which to settle that ever-recurring question of the presence or absence of invention in the production of patented devices and those on which patents are refused by the patent office?

We will, however, leave on one side the question as to the definition of an invention from the legal aspect, and turn to the main subject of the article—viz., to what extent the work of practical inventing may be fostered. The first part of the article is devoted to proving that an invention is not a spontaneous creation of the inventor, but is merely the outcome of a number of almost invisible steps, the Patent Office probably rendering the individual steps more visible than they otherwise might be. To illustrate this, an example is chosen of an invention which at first sight might appear to lack every suggestion of evolution, viz., that of the hydraulic dredge, and it is shown that it has in reality taken ten years for this invention to have been created, and that it is actually the outcome of a series of inventions approaching gradually nearer to the final realisation of the machine in question. That such an invention should take so long to evolve shows, says the author, "an amazing lack and need of system, order, and method in the direction of effort, and a

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most prodigious waste of time and vital energy as a result of this unscientific, haphazard empiricism." But at this point, we think, Mr. SMYTH'S reasoning is at fault. Delay in the evolution of an invention is not due to the absence of logical system in the minds of inventors, but rather to the impossibility of the would-be inventor being able to acquaint himself with all that has been done in a direction likely to assist him to the required end. This is the reason that "inventors, as a class, have been almost invariably recruited from makers," for the maker has the best opportunity, in the pursuance of his own business, to observe the trend of invention in manufactures kindred to their own. But Mr. SMYTH'S argument is just the opposite of this. He unfairly considers that makers are devoid of the mental training necessary to an inventor. "They still depend," he says, "on their hardly-acquired manual skill, and have not yet learned to use the higher form of dexterity which employs the infinitely plastic images and concepts instead of refractory physical things themselves. The art is yet in embryo whose craftsmen consciously, skilfully, and intelligently employ that wonderful mental handicraft which has been unconsciously attained with, and by reason of, the acquirement of physical manual skill."

In the example chosen by Mr. SMYTH to illustrate his argument, he unconsciously proves that his view is erroneous. He takes the case of the heat engine and works out by his system of logical deduction what are the requisites for the invention of a more economical engine than we have at present, and what are probably the directions in which the inventor must work to attain this object. The conclusions he arrives at have, for long past, been well known to makers and designers of heat engines; many have been already engaged in research on more or less the same broad lines as he indicates, and it is extremely doubtful whether the wished-for revolution in gas engine design would be precipitated by the formation of a chair for "invention" at one of our colleges any more than by the nomination of an additional professorship in Sanskrit.

THE ELECTROLYTIC PRODUCTION OF SOLUTIONS OF HYPOCHLORITE FOR BLEACHING AND DISINFECTING PURPOSES.

BY JOHN B. C. KERSHAW, F.I.C.

I.—Introduction.

The production of bleaching compounds by the electrolysis of solutions of the alkali metal chlorides or of magnesium chloride, has for many years attracted the attention of practical electro-chemists; and the names of Hermite, Stefanow, Kellner, Woolf, Corbin, and Vogelsang are only a few of those connected with work in this particular branch of electro-chemistry. Ahrens, indeed, states* that so long ago as 1820 Brand bleached cotton goods between platinum electrodes by aid of the electric current; and this method of preparing bleaching solutions is clearly indicated in Charles Watt's Patent, No. 13,755, of 1851, which may be regarded as the master patent of the electro-chemical industry.

The principle of electrolytic bleaching depends upon the production of hypochlorite of sodium or magnesium, by combination of the chlorine liberated at the anode, and the hydrate formed at the cathode, when sodium or magnesium chloride solutions are decomposed by the electric current. The changes involved when a solution of sodium chloride is the electrolyte are chemically represented as follows:—

1.	$2NaCl$	=	$2Na$ (cathode)	+	$2Cl$ (anode)
2.	$2Na + 2H_2O$	=	$2NaOH$	+	H_2
3.	$2NaOH + 2Cl$	=	$NaClO$	+	$NaCl + H_2O$

* *Elektrochemie*, Stuttgart, 1896.

Equation (1) represents the primary results of the electrolysis of the salt solution; (2) and (3) represent the secondary reactions which end in the production of hydrogen gas, sodium chloride, sodium hypochlorite, and water. Two molecules of salt thus yield one molecule of sodium hypochlorite. The above reaction between the chlorine and sodium hydrate only takes place at low temperatures; if the solution becomes heated, chlorate is produced. The conditions requisite for the production of bleaching solutions by electrolysis are, therefore: (1) Insoluble electrodes, (2) no diaphragms, (3) low temperature of the electrolyte, (4) rapid circulation of the electrolyte from the cathode towards the anode.

The forms of cell which have been devised to attain these conditions have naturally many features in common, and it is only in minor details of construction that they differ one from the other. The tendency now to be observed in the textile industries in many countries to adopt electric transmission of power, is one which will hasten the development of the electrolytic bleaching industry, for it is evident that when a large factory already possesses an electrical generating plant for lighting and power purposes, the use of a fraction of this power for the preparation of bleaching solutions will be a comparatively simple matter. In such cases the addition of an electrolyser and two storage vats will be all the additional plant required. The subject of electrolytic bleaching is therefore of considerable interest at the present moment, and in the succeeding portions of this article the writer intends to describe the various forms of cell now in actual use, and to examine some of the published figures bearing on the relative costs of the older and newer methods of bleaching.

II.—Electrolysers for Production of Hypochlorite now in use.

The Hermite Electrolyser.—One of the earliest forms of Hermite electrolyser was patented in 1884, and the patent is therefore now extinct. The form eventually adopted in the various trials with this process consisted of a long, shallow open tank, containing two sets of revolving zinc discs, which acted as cathodes. These discs were entirely immersed in the electrolyte, and between each was fixed a platinum gauze anode, carried in a glass or ebonite frame. A solution of common salt and of magnesion chloride was used as the electrolyte, but owing to the difficulties caused by the adhesion of magnesium hydrate to the face of the zinc cathode the use of the latter was discarded. A solution of salt alone is, therefore, now used, or sea water where it is obtainable. The form of electrolyser described above has been used at Stjernfors, in Sweden, since 1890 for bleaching cellulose, and it has also been used experimentally at Havre, Worthing, Ipswich, Lytham, Bombay, Netley Hospital, and Marseilles for disinfecting purposes. These trials have not resulted in any permanent success; and, as regards sewage purification, the Hermite process is unlikely to be heard of again. At Stjernfors, however, and one or two other places, the cell and process are understood to be still in use for bleaching purposes, and at the former place 75 H.P. is said to be utilised. According to the figures supplied for the work of the Hermite electrolyser by Roscoe and Lunt* 10·2 E.H.P. hours yield 1 kilogramme chlorine in the form of hypochlorite.

The Stefanow Electrolyser.—This form of electrolyser is reported to be extensively used in the textile industry of South Russia, but the writer has not been able to obtain much detailed information concerning it. The cell is believed to closely resemble the Hermite cell in its chief features, and a strength equal to 6 grammes free chlorine per litre is said to be attained. This result is facilitated by the use of lime with the solution of common salt. The lime probably prevents reduction of the hypochlorite already present in the solution, by the hydrogen liberated at the cathode, in the manner suggested by Oettel when discussing the electrolytic production of chlorates. No figures for the work of the Stefanow electrolyser are available.

The Kellner Electrolyser.—This electrolyser in its most recent form consists of an earthenware cell containing the electrodes, communicating with a centrifugal pump and an

* *Journ. Soc. Chem. Industry*, 1895, p. 224.

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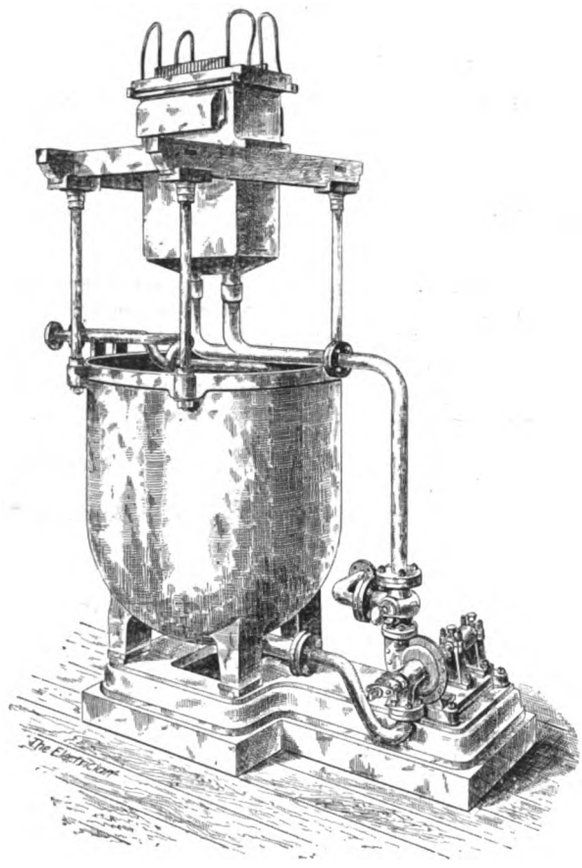
enamelled receiver, in which is placed a cooling spiral connected with the water supply. The salt solution is kept in continuous circulation by means of the pump through the electrolysing cell and the cooler, until the desired strength is attained. The electrodes are formed by winding platinum-iridium wire upon glass plates, and are stated to be highly efficient. The Kellner electrolyser is said to be used for the production of hypochlorites at Golling in Austria, at Sarpsfos in Norway, at Yorda in Hungary, at Lucerne, and at many places in southern Russia. Actual trial has shown that 114 amperes at 112 volts for 3 hours yielded 5·5 kilogrammes active chlorine. This is equivalent to 9·4 E.H.P. hours per kilogramme active chlorine.



The Dr. Kellner's Patent Electrolyser.

The Woolf Electrolyser.—This form of electrolyser as erected at Havana in Cuba, consists of a large wooden circular vat about 8ft. in depth, containing 417 positive and 425 negative electrodes placed ½in. apart. The positive electrodes are of platinum-iridium; the negative electrodes are of zinc. The electrodes are connected in parallel, and at Havana two electrolysing vats are run in series. Sea water is used as the electrolyte. At this plant 216 kw. electrical energy yield 935 kilogrammes active chlorine per 24 hours. This is equivalent to 7·5 E.H.P. hours per kilogramme active chlorine. The Woolf electrolyser has also been used with some degree of success at Brewsters and Rickers Island (New York) and at Danbury (Conn.) for disinfecting purposes; but the writer does not believe that these installations are now working.

The Corbin Electrolyser.—The Corbin form of hypochlorite cell is used at the cellulose factory of Messrs. Berges and Corbin at Lancey in France. The cell itself is built up of cement, and contains a large number of secondary electrodes of platinum-iridium foil. In order to prevent lateral dispersion of the current, these secondary electrodes are held in wide ebonite frames, and are placed only ½in. apart. A solution of common salt is used as the electrolyte and rapid circulation is provided for, by allowing the brine to flow in below, and to pass away over the top, by channels running round each of the four sides of the cell. The electrodes are therefore entirely submerged. The cells at Lancey contain 18 secondary electrodes and take 150 amperes at 120 volts = 18 kw. Each of these cells can produce liquor sufficient to bleach 750 kilogrammes cellulose per 24 hours. No details of the strength of this bleaching liquor are available; but it is stated that 150 kilogrammes bleaching powder would be required to effect the same work. Taking this as a basis of calculation, we find that 18 kw. in the Corbin hypochlorite cell yields 52·5 kilogrammes active chlorine. The consumption of electrical energy per kilogramme active chlorine is therefore 11·1 E.H.P. hours.

The Vogelsang Electrolyser.—This electrolyser is stated to be an improved form of the Stefanow apparatus. Each cell contains a large number of secondary platinised electrodes, and the number of these is arranged to absorb 65 or 110 volts. Further details of the construction of this electrolyser are lacking. A solution of common salt is used as the electrolyte. An electrolyser taking 85 amperes at 115 volts is said to produce bleaching liquor sufficient to bleach 4,000lb. cotton yarn in a 10-hour working day. This weight requires 20 kilogrammes active chlorine, and the yield of the Vogelsang form of electrolyser is, if these figures are trustworthy, 1 kilogramme active chlorine per 6·6 E.H.P. hours. The Vogelsang electrolyser is in use at a considerable number of textile factories and bleaching establishments in Germany.

III.—Comparative Costs.

The electro-chemical equivalent of chlorine is 0·0003672 grammes. Therefore 1 ampere hour will liberate 0·0003672 × 3,600 = 1·322 grammes chlorine, from a solution of common salt. Taking the minimum E.M.F. required to carry a current through the latter as 2·8 volts, the yield of chlorine per kilowatt hour is found to be 574 grammes. The equations given in the earlier portion of this article show, however, that for every two atoms of chlorine liberated at the anode, only one atom makes its appearance as active chlorine in the hypochlorite; and, therefore, *the theoretical yield of available chlorine* per ampere hour is 0·661 gramme, and per kilowatt hour is 287 grammes. Converting these yields into the form used for expressing the yields of the different electrolysers, we find that to obtain 1 kilogramme chlorine in the form of hypochlorite, theory demands an expenditure of current equal to 1,512 ampere hours, and of electrical energy equal to 4·73 E.H.P. hours.

In order that the yields of the various forms of electrolyser described above may be compared with that theoretically possible, the figures have been collected in Table I.; and the energy efficiencies have been worked out, using the theoretical figures as basis of the calculations. The results show considerable variation, ranging from an efficiency of 41 per cent. to one of 71 per cent. It may be observed that in such an electrolytic decomposition as that, by which hypochlorite is produced, the energy efficiency depends greatly upon the current density used, and also upon the arrangements made for circulating and cooling the electrolyte. The removal of the hydrogen gas liberated at the cathode has also great influence upon the results, since hypochlorite is readily reduced to chloride by nascent hydrogen.

In the absence of details concerning the current density used, the energy efficiencies given in Table I. are not of great practical importance; for it is evident that a high energy efficiency may be obtained under conditions which would not be economical in actual work. In electrolytic bleaching as in other electro-chemical operations, the problem is to find the point at which increased output per unit of plant ceases to be remunerative, owing to the increased E.M.F. required to operate each decomposing cell. Further, the question of losses in the external parts of the circuit must be taken into consideration. It is certain that these will be greater in the case of the Woolf form of electrolyser, with its 842 electrodes connected in parallel and its dynamos generating current at 12 volts pressure, than in those forms constructed to utilise a much higher E.M.F.

In the writer's opinion the most satisfactory form of electrolyser for hypochlorite production, is one provided with a large number of secondary electrodes, and thus capable of

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Table I.—*Yields and Energy Efficiencies of various forms of Hypochlorite Cell.*

Name.	E.H.P. hrs. per kg. active chlorine.	Energy efficiency per cent.	Remarks.
Corbin	11·1*	42	No direct test of electrolysed solution.
Hermite	10·2	46	Roscoe and Lunt's figures, based on actual trials.
Kellner	9·4	50	3 hours' trial with 114 amperes at 112 volts.
Vogelsang	6·6*	71	No direct test of electrolysed solution.
Woolf	7·5	63	Estimated yield of plant per day.
Theoretical figures	4·73	100	...

utilising a fairly high E.M.F. between the two terminal electrodes. The Kellner, Corbin, and Vogelsang electrolysers are examples of this type.

In the remainder of this article, the figures for the Kellner electrolyser are taken, since they are apparently based on reliable trials, and they are a mean between those representing the work of the Corbin and Vogelsang electrolysers. A circular relating to the Kellner electrolyser † contains the following details of cost for the preparation of 650 litres of hypochlorite solution, containing 0·85 per cent. of active chlorine :—

	s.	d.
Common salt, 71·5 kilogrammes, at 16s. per ton	1	$1\frac{3}{4}$
Electrical energy, 19 H.P., for three hours, at 0·282d. per E.H.P. hour	1	$4\frac{1}{4}$
Depreciation, 10 per cent. for three hours		$9\frac{1}{2}$
Total	3	$3\frac{1}{2}$

The 650 litres of solution contained 5·5 kilogrammes active chlorine, and the cost per kilogramme was, therefore, $\frac{39{\cdot}5}{5{\cdot}5} = 7\frac{2}{10}$d.

It is somewhat difficult to obtain figures which shall represent the cost of an equivalent amount of chlorine in the form of bleaching powder, for losses occur in making the solution from the solid compound, and it is doubtful if on the average more than 90 per cent. of the 86 per cent. chlorine available in the bleaching powder is obtained in the bleaching liquor. The labour necessary for preparing the solutions is also greater in the case of bleaching powder, and may be reckoned at 20s. per ton. Allowing for these two increases, we find that the cost of 1 kilogramme available chlorine with bleach at £5 per ton at the point of consumption, is 4·8d., and with bleach at £7. 10s. per ton, is 6·8d. It is, of course, evident that the relative cost of the two bleaching agents depends chiefly upon the relative costs of electrical energy and of bleaching powder at the point of consumption. But the question of relative cost is not settled by the figures given above. Hypochlorite of soda is a more efficient bleaching agent than hypochlorite of lime (bleaching powder) and for many years it has been used for bleaching the higher classes of goods, in spite of its higher cost per kilogramme of active chlorine ‡ Not only is there no danger from particles of lime remaining in the fabric bleached, but less acid is required for scouring; and the bleached goods gain not only in colour, but also in strength. These advantages more than balance the slightly higher cost per kilogramme of available chlorine. In support of this statement, the following figures, representing the costs of actual trials with solutions prepared from bleaching powder, and from common salt by electrolysis, are given. They are taken from the circular already named, and the hypochlorite of soda solution was prepared in the Kellner electrolyser. The cost of the kilogramme of active chlorine in the electrolysed salt solution is taken at $7\frac{2}{10}$d.

First Trial.—2,800 kilogrammes of Light Calico Goods for Dyeing and Printing.

Electrolytic Method.	s.	d.
1,075 litres of solution containing 0·281 per cent. chlorine = 3 kilogrammes chlorine at $7\frac{2}{10}$d.	1	$9\frac{6}{10}$
60 kilogrammes hydrochloric acid at 4s. per 100 kilogrammes ..	2	$4\frac{8}{10}$
Total cost of chemicals.....	4	$2\frac{4}{10}$
Older Method, with Bleaching Powder.		
40·7 kilogrammes bleaching powder, at £7. 5s. per ton*	5	$10\frac{8}{10}$
200 kilogrammes hydrochloric acid, at 4s. per 100 kilogrammes	8	0
Total cost of chemicals.....	13	$10\frac{8}{10}$

Second Trial.—3,450 kilogrammes of Heavy Calico for White Goods.

Electrolytic Method.	s.	d.
1,250 litres of solution, containing 0·512 per cent. chlorine = 6·4 kilogrammes chlorine at $7\frac{2}{10}$d.	3	$10\frac{8}{10}$
115 kilogrammes hydrochloric acid at 4s. per 100 kilogrammes...	4	$7\frac{2}{10}$
Total cost of chemicals.....	8	$5\frac{4}{10}$
Older Method, with Bleaching Powder.		
50 kilogrammes bleaching powder at £7. 5s. per ton*	7	3
345 kilogrammes hydrochloric acid at 4s. per 100 kilogrammes...	13	$9\frac{6}{10}$
Total cost of chemicals.....	21	$0\frac{6}{10}$

In conclusion, the fact may once again be emphasised, that the use of electricity for lighting and power purposes is leading to a reorganisation of the internal arrangements of many of our mills and factories. In the textile industry the change is likely to be accompanied by a change in the method of bleaching, since hypochlorite of soda can now be produced as required, by a comparatively small addition to the electrical generating plant; and produced under favourable conditions in this way, it has been found by *actual trial* to be, not only an efficient, but also an economical bleaching agent.

PHYSICAL SOCIETY.

At an ordinary meeting held May 25, 1900, Prof. Everett, F.R.S., vice-president, in the chair, Prof. S. P. Thompson showed some

"Experiments Illustrating the Aberration Called Coma."

If a converging lens is placed obliquely in a parallel beam of light, instead of forming a point image, it produces unilateral distortion, and the bright central spot is accompanied by a pear-shaped tail which is known as a "coma." The direction in which this tail points depends upon the side of the lens which is presented to the light. With a concavo-convex lens the convex surface gives an inward pointing coma, and the concave surface an outward pointing coma. The existence of this phenomenon is due to unequal magnification from different zones of the lens, a fact which was shown by covering the lens with a zone plate of three or four rings and viewing on a screen the distorted images of the several zones. The form of a coma varies greatly with the distance of the screen from the lens. A parallel beam of light which has passed obliquely through a convex lens is capable of producing some curious shadows. The shadow of a rod can be obtained as a circular spot, and that of a grating made by stretching threads between rods, as concentric circular rings. Prof. Thompson also showed a stringed model illustrating the paths of the light rays in the formation of a coma.

Mr. R. T. Glazebrook then read some

"Notes on the Measurement of Some Standard Resistances."

Three methods have been employed by the author for building up multiples of a standard resistance, such as a 1 ohm coil. The first method consists in making as accurately as possible 3 ohm coils. These in parallel can be compared directly with the standard by Carey Foster's method. Their resistance in series is very approximately nine times that in parallel, and hence an accurate determination of a resistance about 9 ohms can be obtained. If then this resistance is put in series with the standard an accurately known 10 ohm resistance is obtained. By a similar process a 100 or a 1,000 ohm coil can be built up. The second method consists in calibrating a resistance box. The 1 ohm coils of the box are compared directly

* These figures are based upon the weight of bleaching powder required to perform the same work, and they are, therefore, less trustworthy than figures based upon actual tests of the electrolysed solutions. It is probable that the first is too high and the second too low.

† *See* also *Zeits. f. Elektrochemie*, Vol. V., p. 375.

‡ The higher bleaching efficiency of solutions of hypochlorite of soda, electrolytically prepared, is now explained as due to the presence of free hypochlorous acid. See *Zeits f. Elektrochemie*, Jan. 4 and 11, 1900.

* The bleaching efficiency of the hypochlorite solutions prepared by electrolysis, is in these two instances, three to five times greater than the efficiency of the solutions prepared from bleaching powder. This higher efficiency of the hypochlorite solutions prepared by electrolysis, first noted by Cross and Bevan, is now fully explained by the research work of Sieverts.—*Zeits. für Elektrochemie*, Vol. VI., p. 364, *et seq.*

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with the standard, and the other resistances determined accurately by a building-up process, using a subsidiary resistance box. In comparing the high resistances the difference between the two boxes may be so great as to send the balance off the bridge wire. In these cases the third method is employed. The equal arms of the bridge are accurately known, and one of them is shunted with a resistance, which need not be accurately known, until the reading is brought back on to the wire. The coils chiefly used throughout the experiments are made of platinum-silver.

Mr. CAMPBELL asked if the same degree of accuracy could be obtained with manganin coils. If so, then the small temperature change of manganin would be an advantage.

Mr. TROTTER asked if proper allowance could be made for the large number of mercury cups used in method I.

Mr. RENNIE advocated the use of the build-up box in preference to the first method. With two mercury cups there is less chance of errors escaping notice than with eight. Every 10 or 100 ohm coil tested at the Board of Trade is subjected to a comparison with a box calibrated by a build-up process.

Dr. HARKER asked if the resistance of the eight mercury cups in series had ever been measured, and if so, what was the magnitude of the result and what the uncertainty.

Mr. GLAZEBROOK said he had investigated the resistance of the mercury contacts, and it was negligible. In answer to Mr. Campbell, the author said he had no experience of manganin coils himself, but he had seen some figures for German coils which agreed very closely.

Mr. J. J. GUEST then read a Paper

"On the Strength of Ductile Materials under Combined Stresses."

The author throughout his experiments has used the "yield point" of a material as the true criterion of its strength, and has rejected the elastic limit as being modified by local yielding. At present two theories are used in the calculation of strengths of materials. The first is that the material yields when one of the principal stresses reaches a certain amount. This theory, which was adopted by Rankine, and is used by engineers in England and America, is not in accord with recent experiments. The second theory is that the material yields when the greatest strain reaches a certain amount. This was advocated by St. Venant, and is used by engineers on the Continent. Besides these, there is a third theory of elastic strength, in which the condition of yielding is the existence of a shearing stress of a specific amount. In the case of a solid bar subjected to torsion there is a variation in the strain from the axis outwards, and consequently the materials have been used in the form of thin tubes. This allows the application of an internal fluid pressure. The specimens were of steel, copper, and brass, the state of set caused by drawing having been removed by annealing. The tubes were subjected to (1) torque, (2) torque and tension, (3) tension only, (4) tension and internal pressure, (5) torsion and internal pressure, and (6) internal pressure only. The axial elongation, the twist, and occasionally the circumferential strain were measured. Towards the end of the experiments observations were made on bending. The results disprove the maximum stress theory, and are at variance with the maximum strain theory. The maximum shearing stress developed and the corresponding shearing strain were comparatively constant throughout the experiments, and no other simple relation between the stresses or strains was even approximately constant. The results of the experiments have been plotted synoptically on a curve, and the several lines have been drawn upon which these points should be according to the various theories. It is readily seen that the points cluster round the line which represents the existence of a specific shearing stress. The author therefore favours the existence of this stress for any material.

The Chairman read a communication upon the subject from Dr. CHREE. Mr. Guest in his Paper has regarded the shearing stress theory as a little known one. As the shearing stress is half the difference between the greatest and least principal stresses this theory is the same as Prof. G. H. Darwin's maximum stress-difference theory. All the theories suppose that the stress-strain law is linear, and that strains are so small that their squares and products can be neglected. Mr. Guest concludes that in ordinary materials the law is linear to the elastic limit, which answers to a stress lower than that which answers to the yield point, and that yield point phenomena arise between these. Nevertheless he focusses attention on the yield point as the criterion of strength, and assumes that Hooke's law holds up to it.

Prof. PERRY congratulated the author upon his Paper, and said there was no time left to discuss it at length. The results obtained gave information upon a subject of which very little is known experimentally.

The Society then adjourned until June 8.

At an ordinary meeting held June 8, 1900, Dr. J. H. Gladstone, F.R.S., Vice-President, in the chair, a Paper on

"The Magnetic Properties of Alloys of Iron and Aluminium. Part II.,"

by S. W. RICHARDSON and L. LOWNDS, was read by Dr. Richardson. Experiments have been made to ascertain in what way the hysteresis loss, between given limits of the field strength, is connected with the temperature, for an alloy containing 3·64 per cent. of aluminium. The experiments show that the hysteresis loss attains a maximum value at a temperature considerably higher than the temperature of maximum induction. The changes produced in the magnetic properties of the alloy by heating and subsequent cooling have also been investigated. The properties depend largely on the previous history of the specimen, but there does not appear to be any essential difference between the behaviour of the alloy during heating and cooling (except near the temperature of minimum permeability). Experiments have also been conducted on the abrupt change in the permeability that takes place at a temperature of about 650°C. The conclusions arrived at are as follows:—(1) The hysteresis loss at first diminishes as the temperature rises. It then increases, and reaches a maximum at about 550°C. On further heating it falls off rapidly, and is negligible at 700°C. (2) The magnetic properties of the specimen depend largely on its previous history. (3) There is no essential difference between the behaviour during heating and cooling, except near the temperature of minimum permeability. (4) An abrupt increase in the permeability takes place at about 650°C. during heating followed by an equally abrupt diminution on further heating. (5) This abrupt change is more marked with falling than with rising temperatures. (6) Continued heating and cooling diminish the permeability. (7) The curve connecting temperature of minimum permeability and percentage of aluminium is a straight line. (8) The microscopic examination of the specimens shows the presence of crystals.

Prof. S. P. THOMPSON asked if the specimens had been kept for any length of time at a high temperature, because crystals changed and grew in metals at temperatures even far below their melting points.

Prof. REINOLD asked if any specimens had been examined where the crystalline structure had not been observed.

Mr. BLAKESLEY asked if any explanation of the orientation of the crystals could be given.

The CHAIRMAN said it was difficult to know exactly what substances were being dealt with. They might be pure alloys or mixtures of two or three alloys with iron or aluminium.

Dr. RICHARDSON, in reply, said the crystals might be dissolved in nitric acid and analysed, but at present he did not know their composition.

Mr. W. CAMPBELL then read a

"Note on Crystallisation Produced in Solid Metal by Pressure."

In the preparation of sections of tin, particles cling to the file and, if allowed to remain, tend to tear the surface of the metal. The effect is not immediately noticeable, but on etching the polished surface there appear, besides the usual structure of the tin, lines of much smaller crystals with irregular boundaries, but possessing different orientation. The effect is only superficial, because it can be removed by polishing. The same behaviour is noticed in some alloys, and it would thus appear that the pressure of a file is sufficient to cause a metal or an alloy to rearrange itself.

Prof. S. P. THOMPSON suggested that the effect might be due to local heating caused by tearing rather than to pressure.

Mr. CAMPBELL said the effect was not due to the heating of the file, because if the file were kept perfectly clean no crystals formed.

Prof. S. P. THOMPSON asked if scratching the surface with a diamond produced crystallisation.

The AUTHOR said he had tried with a sharp knife without success, but cutting with a blunt chisel produced crystallisation along the chisel mark.

A Paper on

"The Viscosities of Mixtures of Liquids and Solutions"

was read by Dr. C. H. LEES. Three formulæ have been suggested for expressing the viscosity of a mixture in terms of the percentages and viscosities of its constituent parts. The first of these represents the viscosity, as being the sum of a number of terms, each one of which is the product of the percentage of any constituent and its viscosity. The second formula represents the logarithm of the viscosity in a similar manner, and the third one the reciprocal. None of these formulæ represents the viscosity of a mixture with closeness. The author suggests a formula in which the mth. power of the reciprocal of the viscosity of a mixture is equal to the sum of a number of terms each one of which is the product of the percentage of any constituent and the mth power of the reciprocal of the viscosity of that constituent. This formula gives satisfactory agreement, and, moreover, leads to Slotte's formula for the variation of viscosity with temperature.

The Secretary read a note from Prof. WOOD, on

"An Application of the Method of Striæ to the Illumination of Objects under the Microscope."

The object chosen was powdered glass immersed in cedar oil of the same refractive index. The glass particles were almost invisible under ordinary conditions of illumination. The illuminating system was then arranged as follows:—A screen bounded by a straight edge was placed in front of an incandescent gas lamp so as to cut off half of the mantle and give a source of light bounded by one perfectly straight edge. A small lens of very short focus was placed below the stage as close as possible to the object. The lamp was at a distance of 6ft., and the light reflected from the mirror was brought to a focus by this lens, passing

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through the object on its way. An image of the lamp was formed in space and viewed by the microscope. A little strip of thin brass with a carefully cut straight edge was fastened to the stand carrying the bull's eye condenser, and moved into position between the objective and object, so as to cut off the flame image with the exception of a narrow thread of light along the straight edge. The brass screen must be in the plane of the flame image with its edge parallel to the straight edge of the flame. The brass was then advanced over the flame until nearly all the light was cut off. Upon lowering the microscope until the object was in focus, and carefully advancing the brass strip until practically all the flame image was cut off, it was found that the glass particles suddenly appeared with great sharpness, showing as distinctly as if in air. Two photographs of glass in oil were shown, one taken with ordinary illumination and the other by the Schlieren-Methode.

The meeting then adjourned until June 22nd.

SOME CONSIDERATIONS CONCERNING ELECTRIC DRIVING.*

BY H. A. MAVOR.

The institution of public supply stations for the distribution of power is now well begun in this country, and is likely to show very important developments in the immediate future. It is not necessary to prejudge the case now being considered by a committee of the House of Commons to determine whether or not the public supply of power ought to be in the hands of the local or municipal authorities or in the hands of private companies. In either case the results as regards the practical requirements for the supply of motors are likely to be qualitatively, if not quantitatively, similar. The chief determining factor in the quantity of motors to be required will be the price for the supply of electrical energy. It seems probable that the price to be aimed at in the immediate future will be about 1d. per unit for a 500-volt supply on three-wire system. It is not probable that this price will be seriously reduced in such a time as need be considered for our present purpose. It is well known that large users of power can produce electric energy for their own purposes at or about this figure, and it is very unlikely that they would in any case draw upon the public supply, and therefore the demand is likely to come rather from users of small powers or of large powers in such an intermittent manner as to preclude economical production.

The fixing of a standard voltage of 500 and continuous current for public supply must necessarily tend to standardise private supply on the same lines, not only because of the convenience of interchange of sources of supply by the user, but because of the preference by the manufacture to supply a standard article. It may be assumed that the probable range of size of motors required for connection to public supply will be normally from about ½ H.P. to about 20 H.P. each. The lower limit is certainly far above the power required for many industrial operations, but the manufacture of motors below ½ H.P. for use, even on 250-volt circuit, is not likely to be satisfactory for two reasons: first, because of the high initial cost in proportion to the effective power, and secondly, because of the very inefficient working of the smaller sizes. In cases therefore where the individual units are smaller than ½ H.P., as for example, sewing machines, they will probably be grouped so as to utilise the larger sizes of motors.

From the user's point of view efficiency is usually a matter of secondary consideration until the experience of comparative bills of cost induce a more intelligent inquiry into the relative values of the motors. In the first instance the capital cost of the motor is too often allowed to be the sole determining factor in choosing it. The cost of the ½ H.P. motor may be taken at about £15, and the cost of running it nine hours per day for a year at 1d. per unit would be about £5, so that the calculation of the value of improved efficiency is a simple one, *i.e.*, a saving of 10 per cent. on efficiency on the motor would amount to 10s. per annum. The charge for interest and depreciation of £15 being taken at 30s., an increase of one-third in the price of the motor would be justified if it gave 10 per cent. better efficiency. This would approximately increase the size of the motor by about twice, and the argument is therefore a strong one in favour of spending money on material for the purpose of gaining increased efficiency on motors of this size. The smaller the machine is the greater the handicap under which it works. The use of smaller machines is attended with further disadvantage in the direction of frequent necessity for and difficulty in carrying out repairs.

Looking at the matter now from the manufacturer's point of view, let us consider how the probable demand for motors can best be met.

Motors of 5 H.P. to 10 H.P. present no difficulty. They can be economically designed and made at a reasonable cost. The smaller motors, on the other hand, if they are to be efficient working machines present many difficulties. The cost of material for the smaller machines of normal design as regards their magnetic and electric features bears a very high proportion to the total value of the machine, and the amount of labour to be expended upon these materials is made up of so many small items that it is extremely difficult to effect any material saving in cost. These facts apply more especially to the manufacture of small shunt-wound machines for high voltage. The manufacturer would therefore probably prefer to supply for the small sizes series-wound motors, and they may fairly plead the several advantages from the users' point of view to weigh in the consideration:—

A series-wound motor is more easily started with the load.

The maximum current required to give the starting torque is usually less in the series motor than in the shunt motor and therefore the starting resistance need not necessarily be so large, the resistance of the series-winding of the motor supplements the starting resistance.

As there is a much smaller number of turns of wire on the series motor the inductive effects on making and breaking the current are much less likely to cause damage to the motor and to the starting switch.

Series motors can be designed to give a comparatively small variation of speed within ordinary working limits if they are properly applied to the work, and if the care be taken that the machine is not working at an improper speed either above or below its most efficient range then the efficiency need not be worse and may be better than that of a shunt-wound machine.

The use of a series-wound motor for a very large proportion of industrial operations does not appear to present any serious difficulty. It is, perhaps, not very generally recognised that the working efficiency of nearly all manufacturing machines is extremely low, so that the variation of load produced by change in the amount of work done by the machine is much less important than would at first sight be anticipated; for example, a bank of sewing machines running light, *i.e.*, without stitching, absorbs very nearly as much power as when the machines are stitching. Printing machines, if they are in motion at all, absorb about the same power whether they are printing or not. Tools used in engineering manufacture are not more efficient than those used in other industries. The insertion of the tool into the work in a turning lathe produces a surprisingly small variation in the current required to drive the lathe. The same is true to an even greater extent in the case of planing machines, and to a less extent in the case of milling machines.

It is easy to design a series motor so as to give a variation of power which is amply sufficient to cover the fluctuations arising from variations in work done by the machine, and to maintain the speed within a range of variation similar to that which occurs in all belt-driven machinery; and this can be done with a very slight variation in the efficiency of the motor. The necessarily high resistance of motors of the size under consideration, and their relatively low efficiency even under the best conditions, put practically out of account any risk of damage from the motor running away when lightly loaded. Many starting switches are now in use with magnetic devices for cutting off the supply when the current falls below a desired minimum or rises above a desired maximum, and there need be no fear of damage on this score.

The insurance companies are beginning to take an interest in the subject of electric driving, and care must be taken by engineers and all concerned that they are not allowed to impose absurd restrictions such as have so much hindered the proper development of electric wiring arrangements. In Glasgow, so far, there is not much of which to complain, but already proposals have been made by insurance companies which tend to injuriously affect the convenience and efficiency of electric motor arrangements. The best way to deal with the companies in such matters is, while treating them confidentially in the way of explaining what are the real dangers, and how they ought to be avoided, and giving them every encouragement to insist upon good workmanship, to be perfectly firm in refusing to adopt any absurd measures, such, for example, as placing motors on insulated non-combustible bases. The indications are that the enclosed motor is likely to be largely adopted in preference to the open-type machine, and, on the whole, this is quite a defensible preference, but it must not be forgotten that the enclosed motor is a less efficient machine than the open motor.

The starting switch is a much more probable source of danger, and, in fact, much yet remains to be done from the designers' and manufacturers' standpoint to make the starting switch even for small motors a thoroughly satisfactory article. The liquid switches largely employed in connection with some of the electric lighting stations seem, on the whole, to give satisfactory results; but the arrangement is more cumbrous and expensive than it ought to be, and is too liable to get out of repair from corrosion or to become ineffective from evaporation of the liquid. The American types of wire-starting switches, which have been largely imported into this country, are not satisfactory, and, in fact, the problem is still an open and unsolved one.

The enlightened policy now being followed by the Glasgow Corporation electrical engineer is likely to result in a very large demand for motors, and it would appear that there is here a more interesting

* Paper read before the Glasgow Section of the Institution of Electrical Engineers, April 27th.

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and productive field of enterprise for the electrical engineer, as distinguished from the wireman, whose reputation is as good and his character no better than it ought to be.

There are a thousand interesting problems awaiting solution at the hands of electrical engineers for the application of electric power to all departments of industry, and there is now no lack of interest on the part of the public, so that an intelligent and skilful application to the problem will certainly result in profit to those engineers who have the ability to solve it.

DISCUSSION.

Mr. HIRD entered into an explanation of some curves shown by Mr. Mavor during the reading of his Paper. These had been plotted from results obtained, partly experimental and partly by calculation, from a smaller motor, wound successively as a shunt and as a series machine.

Mr. WM. A. CHAMEN could not quite follow the results shown by Mr. Mavor, as in some cases they seemed to point to the fact that series-wound motors were superior to shunt-wound motors; he always thought that series motors were the thing for sudden bursts of load, but from the diagrams shown it seemed that shunt motors would be far better for this than the series. A more interesting item to him personally was the question of switching a motor on and off a circuit, and it was a point that did not seem to get proper attention, or else very elaborate, and to his thinking, unnecessary devices were used. A very simple arrangement had been used by him for a long time with very satisfactory results. The first movement of the switch handle immediately put the full pressure on to the exciting circuit, the armature circuit being closed only through a resistance which was cut out step by step by further movement of the handle till the armature got the full pressure. In the same way in breaking the motor current, the full pressure was kept across the field circuit till the current in the armature circuit had been reduced to a minimum, and the importance of this latter point he insisted upon, viz., that the shunt circuit should be kept fully excited till the armature circuit was open. He further pointed out that with a shunt-wound motor an automatic cut-out switch was essential, as the motor might often be so situated that the supply might be stopped for a time and then resumed, in which case, if the motor was left in circuit, serious damage would probably result.

After a few remarks by Prof. GRAY,

Mr. McWHIRTER endorsed Mr. Mavor's opinion that the question of the advantages of the use of a shunt or a series motor was all a question of experience. Mr. Mavor's remarks with reference to the inefficiency of engineering tools must, he said, have appealed to all who have had to do with such work. The use to which the motor was to be put seemed to him to limit the use of series motors, as, for instance, in the case of sewing machines; the speed might with a series motor be doubled or even trebled with very serious consequences. His son had designed a switch on the same lines as that mentioned by Mr. Chamen for use with hydraulic work.

Mr. COATES said that the fact should not be lost sight of that with some machines which motors were called upon to drive there was a very great difference between light and full load, and he instanced such tools as hay cutters and oat crushers.

Prof. WATKINSON said that series motors were only suitable when the load was constant, as the speed was not so easily regulated. With regard to the question of variable speed and constant power, there were lots of people who claimed to have solved this problem, but, he believed, only with indifferent results; he understood, however, that Mr. Ferranti had recently designed a motor to effect this purpose.

Mr. STUART thought that the question of varying-speed and constant-load motors was purely one of design.

Mr. MAVOR, in reply, said that he would like to make one addition to Mr. Chamen's switch—viz., a few lamps across the shunt. As regarded Mr. Coates' reference to hay-cutters and similar tools, there were, of course, some which were very efficient indeed, notably, for instance, the circular saw. Mr. Tidd, without getting up, had mentioned to him the punching machine, and he would like to point out a very interesting point in connection with this tool, a point probably that few even of those present realised—viz., that a very small motor, even a ½ H.P., would be sufficient to drive a large punching machine, provided only that a sufficiently heavy flywheel was fitted.

CORRESPONDENCE.

LONG DISTANCE TRANSMISSION OF POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: What have I done that I should be pilloried by being dragged into a holiday discussion between two professors? I never said you could transmit below 50 per cent., and I never read Prof. Perry's 1886 Paper, and have no notion of the truths of which it reeks. I have known for a long time, however, that the efficiency of a system with a constant pressure at the generating end goes up with the receiving pressure until it equals the generator pressure, and that the intake of the motor goes up until its pressure is half that of the generator. From this it is clear that you can always get at least 50 per cent., even if you have to put down gold conductors, but Prof. Perry stated that you cannot get less than 50 per cent. No doubt he meant that no one would be such a fool as to take less, which is not quite the same thing. It may be true—I do not know—I am not a foolometer. If Prof. Perry cannot convince me of the truth of his statements by elementary algebra, it is probably not the fault of his algebra, but of the looseness of his statements.

In the discussion on Prof. Forbes' Paper I said nothing contradicting Prof. Perry's efficiency statement; as far as I remember, I found fault with calculations as to conductors based on false assumptions. Insulation and other matters complicate the cost of high pressure cables so that the ordinary calculations based only on the cost of copper per ton often lead to untrue results. I have frequently attacked mathematiculists for falsifying data in order to air their mathematics. In electrical engineering this vice is very prevalent. Fully two-thirds of the mathematical writing in the electrical press is waste paper, not because the mathematics are faulty, but because the data or assumptions are wrong. Of course it is an easy but an unfair reply to insinuate that I know no mathematics, or that I dislike mathematics, and that I cannot understand a simple thing because it involves elementary algebra. Prof. Perry knows as well as I do that that is no answer, and that when I object to the doings of the electrical mathematiculists it is because their data are twisted to make their mathematics possible, and because a display of mathematical symbols impresses the ignorant, and such work gets credit which it in no way deserves.

First-rate scientific work often demands mathematics of a high order, but it is a vulgar error to credit the value to the mathematics, and to suppose a Paper is valuable because it is mathematical. As a matter of fact, most of the electrical mathematical writing is done not by good mathematicians like Prof. Perry, but by mathematiculists with an elementary equipment. Most of the alternating-current hypothetics that fill the electrotechnical press involve nothing more than analytical trigonometry, and it is easier to work out such problems oneself than to follow the mathematiculist through mazes of, often, roundabout calculations. But as long as people like Prof. Perry prostitute their mathematical knowledge by working out false economy formulæ for conductors, and adding ignorance to the industry under the guise of science, the smaller fry may be deceived into thinking a Paper is good because it looks mathematical. The mathematiculist, and, indeed, the professor, is also under another misapprehension. He thinks that he alone can make calculations, and that the practical man is full of data from which he is unable, owing to his mathematical and scientific ignorance, to deduce anything. He therefore, data being cheap, and one lot being as good as another, assumes data that admit of mathematicules, and patronisingly presents the practical man with reams of matter which nobody reads, and which is very expensive to print. It enhances the mathematiculists' reputation, no doubt, but that is an evil. It ought to be generally realised that there is no bar to a practical man being scientific or mathematical, or both, if he likes, and that it is quite possible he knows what problems he wants to solve, and how to solve them, and also that he does so, and does not write Papers with full length calculations every time.

"Any ass can make mathematical calculations, but it takes a wise man to state a problem correctly."—*Ancient Eastern Proverb.*—Yours, &c.,

JAMES SWINBURNE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think that if Prof. Perry's case were stated rather differently Prof. Forbes might be found ready to admit his argument. Assuming the instance quoted by Prof. Perry, of a motor working at one end of a line having 3 ohms resistance, with 1,000 volts at the generator end, taking 200 amperes and running at 400 terminal volts, with efficiency 40 per cent. The same motor, if geared to its work with gear ratio 2 to 3, would take 133 amperes and run at 600 terminal volts, efficiency 60 per cent., same mechanical output as before. The same result could be obtained without gearing if the motor were wound with 50 per cent. more turns on the armature, or if any equivalent alteration were made.

In general, if a motor is found running at the end of a transmission line with less than 50 per cent. efficiency, it

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shows that the plant is not properly designed, since the same output can always be obtained with a higher efficiency than 50 per cent., the sum of the two efficiencies being 100.—Yours, &c., CHAS. A. CARUS-WILSON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Forbes seems anxious for the dignity of the Institution of Electrical Engineers. He did not show much anxiety in this direction when he prepared his Paper; when in reading it he informed us that he disclaimed all idea of teaching the members anything about their profession; when he declared the uselessness of describing systems of which he had no personal knowledge, and then described six such systems,—with one other, of which he had had no personal knowledge for more than five years; when he repeatedly and loudly informed the meeting that the President-Elect had no knowledge of what he was talking about. And when I, using the very mildest words at my command, have ventured to say that my remarks were really correct and not wrong, Prof. Forbes pretends that the President of the Institution has no right to defend himself. Prof. Forbes is justified by past experience in assuming that men of position prefer not to answer him, but I have duty to consider, and not mere preference. Sir, I affirm that on all occasions everywhere I have refrained from exercising the full force of my arguments when, by doing so, I could avoid a quarrel. I cannot think it possible that there is a single instance of my having provoked a quarrel when it was possible to avoid one without failing in duty.

There has been too much bad mathematics published about electrical engineering. There are many tables which purport to be correct and useful, and they are quite wrong. Surely if I know that all the numbers examined by me in the tables recently published by Prof. Forbes are quite wrong, it is my duty to say so, and that my duty is made clearer when he asserts after two warnings that they are quite right, because they have been computed by four computers. His remark (1) proves my surmise to be quite true. With a given conductor and generator we can transmit 1 H.P. with a minimum or with a maximum economy; he deliberately chooses the most wasteful method, and of course gets a very low efficiency. When I said that less than 50 per cent. efficiency was impossible, I made it clear that I meant that it was impossible for a competent electrical engineer. Anybody can waste energy unnecessarily, but to a competent electrical engineer it would be impossible in a scheme of power transmission.

In his remark (2), Prof. Forbes is quite right: I really did not dream that he was using his copper so very uneconomically. I did not dream that he would use nearly three-quarters of all his copper in his first section of 50 miles. But in spite of this, taking his copper exactly as he arranges it, if he started wasting 7·27 H.P. and transforming 2·53 H.P. in his boosters to give up 1 H.P. at the distance of 100 miles, then I say that, unless he employed an artificial method of preventing economy, he would presently find that he was giving up 1 H.P. at the distance of 100 miles wasting only 0·784 H.P. and transforming only 0·517 H.P. in his boosters. Instead of an electrical efficiency of 12 per cent., he would have one of 56 per cent. The examination of column 2 of the foregoing table will make this clear to anybody.

If, however, he would allow me to re-arrange his copper without altering the amount—if he would even allow me to use the same size of conductor throughout, and equal lengths in the two sections—I would give him very much greater economy, or 72·6 per cent., instead of his 12 per cent., although these conditions are not the best.

Why, Sir, even if he takes only one section of 100 miles, and boosts at the end he will get 62·8 per cent. efficiency.

There is not one case that I have examined in which I cannot get as good electrical economy as is specified by Prof. Forbes with only a fraction of the amount of copper which he specifies.—Yours, &c., JOHN PERRY.

June 13.

Per Horse-Power Delivered.

—	According to Prof. Forbes.	Correct figures	Conductor everywhere of same cr'ss-section: Two equal lengths.	One section only. One booster only.
Voltage of generator	10,000	10,000	10,000	10,000
Length of 1st section	50 mls.	50 mls.	50 miles	100 mls.
Tons of copper in 1st section	0·374	0·374	0·252	0·504
Tons of copper in 2nd section	0·130	0·130	0·252	
Resistance of 1st section	10,540	10,540	15,660	31,320
Resistance of 2nd section	30,430	30,430	15,660	
Horse-power delivered	1	1	1	1
Horse-power from generator	8·27	1·784	1·378	1·593
Current in 1st section	0·6201	0·1331	0·1023	0·1188
Voltage drop in 1st section	6,536	1,403	1,610	3,721
Efficiency of 1st section	0·3464	0·8597	0·8391	0·6279
Horse-power delivered at end of 1st section	2·88	1·534	1·156	1
Horse-power transformed by booster at end of 1st section	1·88	0·2138	0·1861	0·372
Current in 2nd section	0·2148	0·1144	0·08624	...
Voltage drop in 2nd section	6,536	3,481	1,351	...
Efficiency of 2nd section	0·3464	0·6519	0·8650	...
Horse-power transformed by booster at end of 2nd section	0·6536	0·3481	0·135	...
Total horse-power transformed by boosters	2·5336	0·5169	0 321	...
Total horse-power wasted in heating conductor	7·27	0·7844	0·378	...
Total electrical efficiency of the system	0·12	0·5604	0·7257	...

ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have to accord you my thanks for having made my recent Paper a text for a leader in *The Electrician*. At the same time, however, I must point out that what you call my "most vital position" is neither stated in nor to be inferred from the Paper.

The subject which I discussed is the "Calculation of Distributing Systems," and the questions of the best system of generation was not touched upon. Therefore you will not find in the Paper any deductions as to the relative merits of the various systems of generation. What I tried to show is: that it is possible to calculate conductor systems, and the cost of distribution upon general principles, and I applied those principles to a given case as an example. The cost of generation was taken as a constant and identical in each of the three arrangements suggested. I pointed out that the results show what saving has to be made by generating the energy at a single station (whether on the line or at a distance) to overbalance the increased cost of distribution. I claim that this method of treating the matter is the best and most practical way of approaching the consideration of the best means of supplying power to a particular system of tramways or light railways.

Estimates of the cost of generation are much more complicated, and must be made with regard to local conditions of such a various character and so numerous that every case needs the careful study of an experienced man.

The simpler calculation will often narrow the scope and abridge the length of the more complex estimate.

I am certainly not a "polyphase engineer," nor a "continuous," "high" or "low" tension engineer, but with an open mind, I hope, am anxious to use any method at hand which will give the best results in each case.

The supply of electrical energy to a whole county, and the question whether such supply in bulk is likely to prove more advantageous to all concerned than supply to smaller districts from many stations, are questions of a quite different character, and involving data of far greater complexity than the subject I discussed. They are, as you point out, under the consideration of more august bodies than those to whom my modest remarks appeal.

It is incontestable, however, that so long as we are confined to the direct-current motor for electric traction upon streets and highways, polyphase supply systems are very

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heavily handicapped, and can only be properly adopted where there is clear evidence that the generating costs will be greatly lessened by the centralised power production. The system of calculation I have discussed will show "how much" such saving in generating costs must be in each case.—Yours, &c.,

HENRY M. SAYERS.

London, S.E., June 11.

THE ARTIFICIAL PRODUCTION OF DIAMONDS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the *Anglo-American Magazine* for January last, and in a now defunct English illustrated paper issued in the same month, there appeared Papers on the above and other subjects from the pen of a Mr. "Hudson" Maxim, claiming for himself, amongst other things, the merit of being the inventor of an electrical process of manufacturing diamonds. May I ask you to give me space in your journal to say (1) that this Mr. "Hudson" Maxim must not be confounded with Mr. Hiram Stevens Maxim, whose inventions and discoveries have done very much to benefit the whole world. As a matter of fact, this Mr. "Hudson" Maxim's real christian name is Isaac, and he is a brother of the man whose inventions he is so anxious to father.

In particular, Isaac claims to have applied for a patent in 1895 for an electrical process for making artificial diamonds, and makes the "startling" announcement that if a carbon rod is electrically heated in an atmosphere of hydro-carbon vapours, the carbon will be deposited upon the hottest part of the rod. Now, as is well known, Mr. Hiram S. Maxim's historical electric lamp patent, registered in the United States Patent Office on Oct. 4, 1878, was the first patent filed in any country for the deposition of carbon on electrically-heated rods,* and consequently Isaac Maxim's claim to be the inventor falls to the ground; and the same may be said for the remainder of his claims, which include high explosives and special forms of guns, with both of which subjects Mr. H. S. Maxim's name has been associated for the past quarter of a century. It ought to be added that the patent applied for in 1895 in the name of "Hudson" Maxim was rejected.

I may say that Mr. Hiram S. Maxim's patent, lodged in 1878, underwent many alterations before it was finally issued as Patent No. 230,958 on Aug. 10, 1880. So far back as 1881 Mr. H. S. Maxim showed specimens of deposited carbon to Profs. J. and H. Draper, Barker, Vanderwyde and others.

In the course of a communication I have recently received from Mr. Hiram S. Maxim he writes:—

In 1888, Isaac Maxim came to my house at Crayford and spent six months, and went home at the beginning of 1889. While he was with me I told him of my carbon experiment, and I told him that Prof. John Draper had said that I had come nearer to the production of artificial diamonds than any man living. In 1895 or 1896, or somewhere about those dates, Isaac was again in England, and I was told by him that he had thought a good deal of what I had said to him on the deposition of diamonds, and that he had applied for a patent in the States for making them on the process I had described, and that the patent had been rejected on the ground of my earlier application. It was in September, 1897, that I again took up the question, and, as all my experiments formerly had been done with low pressures, I determined to experiment with high pressure; but, of course, a high pressure of hydro-carbon gases would not do at all, on account of the rapid and smutty deposit. It occurred to me that I might get new results which might be advantageously used in making my new compound filaments if I heated carbon extremely hot under a very high pressure, and in order to get this pressure I filled the apparatus with carbonic acid gas and gasoline. Now, when the electrical current—that is, the voltaic arc—is brought into action in the presence of these materials the carbon dioxide is converted into carbon mon-oxide, and the result is an extremely high pressure, which need not be so rich in hydro-carbon vapours as to produce a rapid and smutty deposit. This was the first patent ever taken out for producing high pressures without a superabundance of hydro-carbon vapours, the first time that a slow deposit was obtained under a high pressure. My recent patent was for the means of obtaining high pressures and the apparatus employed therefor.

I purchased the breech end of an old gun, and when the apparatus was thoroughly under way I called on Isaac Maxim, who had been experimenting with a view of making calcic carbide. The process had been a dead failure, and I knew that the same current could be obtained. I told him that I had got the breech end of a gun which I was making into an apparatus, but I did not tell him how I was going to obtain high pressure. A few hours later* I saw a flaming account of my apparatus of the breech end of an old gun; and a lot of nonsense about high pressures, electrical deposits, and so forth. However, as I had said nothing about how the high pressures were obtained, he was unable to give any part of the show away. To speak of a pressure without saying what it is, discloses nothing and means less. I knew Isaac could not apply for a patent, but he did the next thing to it. He tried to make the process public.

If you can find space for this letter I shall be glad.—Yours, &c.,

W. G. C.

London, June 11, 1900.

* The following is a quotation from the specification: "Upon heating of the carbon by the passage of the current, its great heat decomposes the gasoline vapours immediately contiguous to it, and precipitates a slight coating of carbon taken from it upon the hottest part of the incandescent conductor, which is thus slightly increased in size at its weakest points."

As far back as 1885, in "'The Electrician' Electrical Trades' Directory and Handbook" (published in January, 1885), in the biographical sketch of Mr. H. S. Maxim there appears the following sentence: "At this time Maxim expressed to Mr. Shuyler—with whom he had made an arrangement for electrical experiments—his opinion that the carbon of lamps does not become fused or volatilised, but simply oxidised, by the atmosphere or by some combination of the oxygen in the lamp. To prove that oxygen is the sole destructive agent he made a lamp from which he expelled the air, introducing gasoline vapour in its place, when he found that the carbon, instead of wearing away, gained in weight and volume, while assuming a grey metallic colour."

A MOTOR-TESTING CRADLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a passage in Prof. Fleming's excellent "Electrical Laboratory Notes," in which (No. 17 Elementary) a motor test is made by balancing the motor on what is there called a "Brackett" cradle, that is a cradle devised and used by Prof. Brackett, of the College of New Jersey, America. May I be allowed to correct the date of the cradle method, which has turned out to be both accurate and easy to use. In a correspondence with the Professor, he states "There have been no Papers published by myself concerning the cradle other than the simple descriptions which have appeared in *The Electrician* and other publications of a similar character." I find that the earliest account of the Brackett method is given in *The Electrician*, Vol. XIII., p. 80, June 7, 1884. In 1882 I devised exactly the same method, and an account of it was given at the University College, Bristol, in 1883, and the apparatus and the method are described with one diagram in the *Proceedings* of the Bristol Naturalists Society, November, 1883.—Yours, &c.,

Oxford, June 6. F. J. JERVIS-SMITH.

[Mr. Jervis-Smith encloses a photograph of the machine which was in constant use in 1882 in his laboratory at Taunton.—ED. *E.*]

PARLIAMENTARY INTELLIGENCE.

ROCHDALE TRAMWAYS.

The Rochdale Corporation Bill was considered by the Police and Sanitary Regulations committee of the House of Commons yesterday, Lord E. Fitzmaurice presiding. The bill proposes, among other matters, to authorise the Corporation to reconstruct the tramway system and to work it by electric traction, and to make extensions in the adjoining districts of Heywood, Castleton, Whitworth and Morden.

Mr. HARPER, for the Corporation, stated that the statutory term of the existing companies, which was incorporated in 1881, was about to expire, and the Corporation had decided to acquire the lines, and to work them. With the proposed extensions there would be over 12 miles of single line, and about 5½ miles of double line. The tramways were at present on the 3ft. 6in. gauge, and it was proposed to re-construct them to the standard gauge The amount proposed to be borrowed was £400,000, of which £145,000 was for tramway construction and £71,400 for street works. When the lines were re-laid on the wider gauge they would be able to work the system homogeneously with the tramways of the surrounding districts and provide a through service to Bury and Manchester.

Mr. J. Kincaid (Messrs. Kincaid, Waller and Manville), electrical adviser to the Corporation, spoke as to the desirability of the proposed scheme, and the Mayor of Rochdale (Mr. Cunliffe), and the chairmen of the Councils whose jurisdiction would be entered by the Rochdale tramways supported the bill.

The Committee passed the tramways and streets improvements portion of the bill.

* The *Pall Mall Gazette* for Sept. 8, 1897.

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LEGAL INTELLIGENCE.

Electric Construction Co. (Ltd.) v. Imperial Tramways Co. (Ltd.) and British Thomson-Houston Co. (Ltd.) (third parties).

In the Court of Appeal (the Master of the Rolls and Lord Justices Rigby and Collins), yesterday (Thursday), the appeal was heard of plaintiffs from the judgment for the defendants of Mr. Justice Cozens-Hardy on Nov. 14 last. The action was for an injunction to restrain defendants from infringing letters patent (No. 9,527, 1885) granted to T. J. Handford, of which plaintiffs were the holders. The infringement complained of was the use of electric motors supplied by defendants on the Middlesbrough, Stockton, and Thornaby tramways. The British Thomson-Houston Co. were added as third parties, but were treated as defendants. The patent sued upon having expired, plaintiffs asked for damages in lieu of injunction. The pleaded defences were a denial of infringement and an allegation that plaintiffs' patent was invalid. Defendants also said there was no subject-matter in the invention. The case was fully reported in *The Electrician* of Nov. 10 and 17, 1899.

Mr. FLETCHER MOULTON, Q.C., for appellants, said in this case infringement was admitted. The allegation of invalidity was based on the usual objections—anticipation and no subject-matter being the chief ones. But the point on which the judge decided against the validity of the patent was one of construction—construction of one of the claims of the specification itself. That being so, he proposed to take their lordships at once to the specification, because he should submit that the interpretation put upon it by the learned judge could not be sustained.

The MASTER OF THE ROLLS: Do you admit if the learned judge's construction of the impeached claim is right, there was no anticipation?

Mr. MOULTON: There is a later question, which arises in this way: We say the claim is so limited that even upon the learned judge's construction there would not be anticipation. In order to assist their lordships to understand the specification, he would shortly explain what the nature of the invention was. It applied to the question of how to mount an electric motor on the car which it drove. Of course, the first peculiarity of an electric motor was that it was purely rotatory, and the next was that many parts of it must be exceedingly massive. It was a machine which ought not to be subjected to violent jolts, because the work was very delicate, in order to sustain perfect insulation of the wire both on the fixed and the moving parts. The only part of a motor which moved was the armature, which rotated inside the field-magnets. In order to have effectiveness it must revolve quite close to the field-magnets, because the intensity of magnetism diminished very rapidly as the surface of the magnets was left. It was absolutely essential that the motor should be fixed in its place. The bearings could not be allowed to move at all relatively to the motor, and the motor must not be subjected to shocks. The idea for using motors for cars was first started in 1880, or even earlier. He thought the Master of the Rolls would remember seeing in the Exhibition of 1881, at Paris, a car by Siemens, driven by a motor. Several methods of mounting the motor on the car were tried, and in 1885 the present inventor, Mr. Frank Julian Sprague, invented this method, which now in the vast stride of electric traction had become the universal one. What the inventor did was this: He sleeved the field-magnets of the motor on one of the axles and supported the other end by means of springs. The consequence was that by sleeving one end if there was a jolt on the wheel it was not a dead jolt of the whole of the weight of the motor, as it would have been if the centre of gravity of the motor had been above the wheel. This had the effect of causing a kind of rotation which would take off a great deal of the severe jolt, and the movement of the truck only communicated itself to the motor through the supporting springs. The two features of the invention were the sleeving of one end on to an axle and having spring supports at the other end. This enabled the inventor not only to avoid jolts, but also enabled him to reduce the speed of rotation from the motor to the wheel. Effective motors, unless they were very big, moved rapidly, having a large number of revolutions per minute. It was not practicable to make the wheel of the car go as fast as that. It was necessary to gear down so that several revolutions of the motor corresponded to one revolution of the wheel. The sleeving at one end made the gearing accurate in spite of the jolts. One thing was that no jolting would throw your gear out of gear, and the other was, that the jolts were very much diminished. That was the nature of the invention. Having referred to the specification, Mr. Moulton said he should confidently submit that one thing was clear, that this was a spring-supported motor, characterised by being sleeved upon a driving axle and having one or two sets of springs to connect it either with the truck, or with the carriage body if there was no truck. That was the invention which they were prepared to defend, and which they insisted was the invention described. Now the learned judge in the court below had taken what he should contend was quite a wrong view of the case. Taking that part of the specification, he said, "D is the field magnet of an electro-dynamic motor, and E the armature thereof. The yoke or back piece of the field-magnet is hung from a cross piece of the truck by heavy springs or from the car body itself in case of a street car or other vehicle having no truck," the learned judge had found that that meant was hung not by springs in the case of a car which had no truck. He (Mr. Moulton) failed to see absolutely any justification in the language of the specification for such a view as that.

The MASTER OF THE ROLLS: You say springs are essential in both cases?

Mr. MOULTON: Certainly that was the whole spirit of the invention. He must say there was a disputed interpretation of claim 1 as to whether it included springs or not. The claim was for the "motor of an electric railway car or carriage having its field-magnet centred or sleeved upon a driving axle, its armature supported directly upon the said field magnet, and having a shaft separate from the driving axle and gearing communicating motion from the armature shaft to the driving axle, substantially as hereinbefore described," but reading the specification from beginning to end it was plain that the inventor relied upon springs.

The MASTER OF THE ROLLS: Your point is that springs are essential, and that the only things optional are relieving or supporting springs.

Mr. MOULTON said it was so, but the learned judge had said that was not so. That where there was a car body and no truck there was suspension without springs. But really the truck and the car body without the truck were mechanically the same. The car body might not be called a truck, but it was the same thing.

Mr. Justice RIGBY: It is rather peculiar that the inventor never used the word springs in connection with the car body.

Mr. MOULTON: Oh, yes, he does. He says: "These springs extend to cross bars on the truck frame, or to the car body in case no truck is used." The "or" is "or" to, and not "or" by. There is no possible conceivable reason why he should not have spring suspension in both cases, and it is only a too abundant caution that makes him refer as a practical man to the case of a car body without a truck.

Lord Justice RIGBY: I think the meaning might have been made more clear by a little alteration of the language of the specification.

Mr. MOULTON: The claims I shall submit describe nothing but a spring attachment. The second claim brings in the relieving or optional springs, and I do not think I need trouble much about that.

The MASTER OF THE ROLLS: The serious question seems to be claims 1 and 3.

Mr. MOULTON said that with regard to claim 1, although no express mention was made of it, it implied spring supports. Supposing for an instant they intended suing a man who bolted his dynamo to the truck, and said to him, "You have got everything mentioned in claim 1," did anyone suppose for a minute that the Court would not say, "What! Is that substantially as hereinbefore described?"

Lord Justice RIGBY: What is the difference between claims 1 and 3.

Mr. MOULTON: The difference is two-fold. In the first place, claim 1 is limited by the phrase, "having the armature directly supported on the field-magnets." Then there was a difference in the point of view. Claim 3 is drafted in a totally different way to 1 and 2. 1 and 2 go through the specification, but claim 3 seizes the spirit of the thing. I did not want to get off the safe ground of what my invention is: I say my invention never contemplated anything but spring suspension, and that is reiterated all through the specification. The whole connection is through springs. I dare say that the claims might cover a good deal of latitude as to the way in which the springs are to be applied, but I would not include cases where the motor was bolted to the truck or the car body. That was never contemplated, and, indeed, it was the whole aim of the invention to obviate that. I quite agree with the learned judge that claim No. 2 is claim No. 1 plus the optional springs, but both imply the spring supports or the equivalent to spring supports.

Lord Justice RIGBY: What would be the equivalent to spring supports?

Mr. MOULTON: I do not know of any equivalent. A case has been suggested of a motor suspended by links to something having springs on either side, and that *de facto* would, of course, be spring supported. The only question really is, however, whether the inventor meant to tell the public that he claimed fixing the motor by any other method than that of springs.

The MASTER OF THE ROLLS: We shall have to consider whether he has warned the public off a wider field in his own interests.

Mr. MOULTON: If spring suspension had been found in claims 1 and 2, the inventor would still have added claim 3, because it is a wider claim.

The MASTER OF THE ROLLS: I must say I do not think, on looking into it, that claim 2 refers only to relieving springs, and if that is so it is seriously against you.

Mr. MOULTON: I shall submit it refers to relieving springs only Else of what value would be "substantially as hereinbefore described?"

The MASTER OF THE ROLLS: Those words cover a multitude of sins.

Mr. MOULTON: It is not necessary to read in the words "spring supports" if it is understood, as any one would understand it, that the spring connections with the truck is essential.

The hearing was then adjourned.

River Plate Electric Light and Traction Co. (Ltd.).

On Wednesday Messrs. Glyn, Mills, Currie & Co., petitioned Mr. Justice Wright for the compulsory winding up of this company. Counsel for the company stated there was a scheme of reconstruction in hand under which the creditors would be paid in full. The hearing was therefore postponed until 20th inst.

Appleford v. Charing Cross and Strand Electricity Supply Corporation (Ltd.).

This case was down for hearing before Mr. Justice Kekewich on Wednesday, but was ordered to stand over as the parties were likely to come to terms.

"Workshop" v. "Workplace."

At the Guildhall (London) Police Court, on Tuesday, Mr. W. Brass, the owner of a building in Threadneedle-street, E.C., in which persons of both sexes are employed, was summoned for failing to comply with an official notice to make certain alterations in accordance with the Public Health (London) Act, 1891. It appeared that the lessees of the third and fourth floors of the building employed a number of female typists, and the questions to be decided by the magistrate were whether this

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was a "workplace." It was stated that although a "workshop" had been defined there had been no definition of "workplace." The complaint was that the sanitary arrangements on the premises were not only inadequate, but were provided for the use of all persons without distinction of sex. It was contended, for the defence, that the room used by the female typists was not, under the Act, a "workplace," and that if the Act were so construed, it would affect every office where females were employed. Particularly, it was contended, that premises where lady telegraph clerks were employed had been held not to constitute a "workplace" under the Act, and, by implication, it may be assumed that where lady telephone operators are employed the law would similarly hold.

Mr. VICKERY, who prosecuted on behalf of the City of London Corporation, said the question before the Court had never been fought out before. He contended that these young ladies, being mere "mechanical machines" the place where they were employed was a "workplace" under the Act.

Mr. Ald. ALLISTON, who tried the case, said the question was a most important one, but he must hold that the premises in Threadneedle-street, used as described, did not come within the meaning of sec. 38 of the Public Health (London) Act, and the summons must be dismissed.

FORTHCOMING LEGAL CAUSES.

List of cases with an electrical interest entered for trial at the Royal Courts of Justice, London, during the Trinity Sittings :—

COURT OF APPEAL (CHANCERY DIVISION). *General Appeals.*

Electric Construction Co. (Ltd.) *v.* Imperial Tramways Co. (Ltd.). (British Thomson-Houston Co. (Ltd.) third parties). Appeal of plaintiffs from order of Mr. Justice Cozens-Hardy, dated Nov. 14, 1899.

Rucker *v.* The London Electric Corporation (Ltd.). Appeal of plaintiff from order of Mr. Justice Farwell, dated February 12, 1900.

Hawkes *v.* Leyton Urban District Council. Appeal of defendants from order of Mr. Justice Buckley, dated February 28, 1900.

City of London Electric Lighting Co. *v.* Mayor and Corporation of London. Appeal of defendants from order of Mr. Justice Farwell, dated May 3, 1900.

Attorney-General *v.* London County Council. Appeal of defendants from order of Mr. Justice Cozens-Hardy, dated March 19, 1900.

QUEEN'S BENCH APPEALS. (*Final list.*)

Borough of Hyde *v.* Oldham, Ashton and Hyde Electric Tramway, (Ltd.). Appeal of defendants from judgment of Mr. Justice Grantham, dated July 3, 1899.

HIGH COURT OF JUSTICE.—CHANCERY DIVISION.

Before Mr. Justice Byrne.

Isle of Thanet Electric Trams, &c., Co. *v.* Abbott. Cause for trial without witnesses.

QUEEN'S BENCH DIVISION.—*Special Juries.*

Hampstead Electric Supply Co. (Ltd.) *v.* Bromwich and another (bill).

Fell *v.* British Electric Traction Co. (Ltd.). (Money paid.)

Common Juries.

Evered *v.* Electrical Undertakings (Ltd.). (Wrongful dismissal.)

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aldershot.—The Board of Trade has intimated that the consideration of the question of revoking the Aldershot electric lighting order for a further period of twelve months from Aug. 12 has been deferred. The Council has already decided to establish municipal electricity works, and are seeking a suitable site.

Argentina.—Mr. F. Scharrer, who holds an electric lighting concession from the Rosario municipality, has acquired land for the erection of electricity works.

Bahia Blanca municipality has declared as lapsed the electric lighting and tramway concession granted to Mr. C. Thursby.

Asylum Lighting.—The question of electric lighting will come before the Poplar and Stepney (London) Sick Asylum Board at an early date.

Ayr.—A report was submitted to the Council on Monday by the burgh electrical engineer, recommending the changing of the system of electricity supply in the centre of the town from low-tension alternating current to low-tension three-wire continuous current distribution. The estimated cost of the alteration was £8,730. Consideration of the matter has been postponed.

Barnes.—The District Council are about to invite tenders for condensing plant and an overhead travelling crane for the electricity works.

Blackpool.—At the meeting of the Town Council, on Tuesday, the chairman of the Tramways committee (Ald. Brodie) announced that during the Whitsuntide ten days they had taken £2,159, an increase of £706 compared with last year, and had carried 327,594 passengers, an increase of 148,496 on the previous year, whilst the mileage run was 16,459, being 6,509 over last year. The new Claremont Park line meant an increase of 50 per cent. on the profits.

Bohmisch-Kamnitz (Austria).—The Austrian Schuckert Co. has secured a contract for erecting central electricity works in this town.

Bradford.—The salary of the manager of the electric tramways (Mr. C. J. Spencer) has been increased from £200 to £300 per annum from June 1, with an annual increase of £100 until a maximum of £500 per annum is reached, on condition that Mr. Spencer enters into an agreement to remain in the service of the Corporation during the next five years.

Burton-on-Trent.—The accounts of the Electricity department for the year ended March, 1900, have been issued, and show very satisfactory progress. The total number of units sold was 154,290, compared with 118,145 in 1899 ; and the average price per unit was 5·45d., against 5·57d. in 1899. Expenditure (including interest and sinking fund) exceeded income by £5. 9s. 6d. In the previous year the adverse balance was £769. 16s. 2d.

Central London Railway.—The opening of this line has been fixed for 27th inst. by His Royal Highness the Prince of Wales.

Cheltenham.—Application has been made for sanction to borrow £790 further for electric lighting.

Chester.—The accounts of the electricity department for the year ended March 25 have been issued. Generation, distribution, and management expenses, &c., amount to £4,607. 18s. 7d., and gross receipts from public and private lighting, meter rentals, &c., to £9,628. 3s. 10d., leaving a balance of £4,932. 13s. 11d., out of which interest (£1,889. 8s. 4d.) and sinking fund (£1,903. 5s. 7d.) have been paid, leaving net profit £1,140 to be carried to reserve. The total capital expenditure was £65,765. 13s. 3d., and sanction to borrow £65,000 of this sum has been received. 763,154 units of current were generated, of which 217,823 units were supplied to public lamps, and 399,969 to private consumers. There are 165 arcs and 206 incandescents used in the public lighting. The total maximum supply demanded was 529 kw.

Cycle Lights.—An interesting point was raised at the North London Police Court last week. A Mr. Thornton was summoned for riding on his bicycle on the night of May 28, and that he, instead of having the regulation lamp on his machine, wore a small electric button-hole lamp attached to his coat. A policeman pulled him up for not obeying the regulations to have a light attached to his bicycle. His reply was that he considered he had sufficient light to signal his approach, and, as he was a member of the National Cyclists' Union, the police might summon him. For the Union it was maintained that a great many cyclists who had been consulted were of opinion that there had been no evasion of the law. The police-constable admitted he saw the light at a distance, but thought it was a cigar. The magistrate (Mr. Bros) held that the light was not on the machine as required by law, and imposed a nominal penalty.

Dalkeith.—By arrangement with the Burgh Commissioners, Messrs. Crompton & Co. will apply for electric lighting powers for this district. The Commissioners' consulting engineer (Mr. A. A. Campbell Swinton) advised that Messrs. Crompton & Co.'s proposals were fair and reasonable. Current will be supplied at 3d. per unit for public lighting.

Death from Electric Shock.—An inquest was held this week at Wolverhampton into the deaths of Samuel Clulow and Daniel Trawford, who died on May 31 from the effects of an electric shock received at the Mars Ironworks, Ettingshall. Mr. C. F. Wright represented Messrs. George Adams and Sons (Ltd.), and Mr. J. S Sharpe and Mr. J. E. Ashworth the relatives of deceased.

Witness MEREDITH stated that on the night of May 31 he noticed Clulow lying on his back in the weighing cabin. His left hand was in contact with a wire used for raising and lowering an arc lamp. When witness went to his assistance his hand touched the wire, and he received a shock. It was necessary to pass the wire to enter the cabin, and witness had often touched it.

Witness JONES stated that he saw the two men lying in the cabin. He caught hold of Clulow, and received a shock which drew his arms up. In answer to Mr. Wright witness said he was in a perspiration. He took hold of Clulow by the trousers.

Witness FELTON deposed that Trawford was lying across Clulow. Dr. Bulger was sent for, but was not at home, and the men were taken to the Wolverhampton Hospital, where attempts were made to restore animation. He had received no complaint of anything wrong with the plant.

Mr. W. J. BAKER, electrical engineer, in the employ of Messrs. Adams and Sons, deposed to installing the electric light at the works in November last. The lamps were second-hand, and all the repairs he did himself. He could not explain how the current got down the wire touched by deceased. He had had no special electrical training, and what he knew he had learned from books and by serving with an electrical engineer. He had put in another installation, but he had no experience of so high a voltage as that at these works. It would have been better to have had porcelain insulators on the top of the lamps to which the pulley wire for raising them was attached instead of the wood blocks.

Mr. HY. LEA (Messrs. H. Lea and Son) consulting electrical engineer, Birmingham, who had made an inspection of the electrical plant at the works, was unable to state how the accident happened.

Mr. W. H. THORNBURY, consulting electrical engineer, Birmingham, said the wire was no part of the electrical system, and ought to have been completely isolated. He thought that at the time of the accident there was electrical connection between the lamp and the pulley-wire, which

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thus became a "live" wire; and if there was a leakage of electricity to earth at a distant part of the system a man standing on the ground, and touching the pulley-wire, would receive a shock. When the tests were made no such leakage could be discovered, but he thought that at the time of the accident there was a leakage from another lamp through a suspension wire to the earth some distance away. It was customary to use wire for raising and lowering lamps, and some lamps were still made without a porcelain insulator. Some of the wires passed through brick walls, and were liable to have their insulating coating worn off by friction, though in this case there was no evidence of leakage from this cause. With regard to a statement that had been made that the installation was capable of carrying 25 arc lamps at 1,250 volts, and that at the time of the accident there was a current of 700 volts, witness said such a high voltage was not necessary in these works. There were safe systems by which arc lamps could be worked at low voltage, and he recommended that the plant be reconstructed. With the exception of the electrical connection between the lamp and the suspending wire there was nothing wrong with the plant.

Dr. T. W. LACHFORD, assistant house surgeon at the hospital, said the appearance of the bodies was consistent with death from electric shock.

The CORONER said he did not think anyone was to blame.

The jury found that deceased met their deaths from an electric shock, accidentally received, and recommended that a low-voltage system be introduced into the works, or that suspension wires should be out of reach.

Mr. WRIGHT said the suggestion made by the jury would have careful attention. He might add that the company would satisfy all claims for compensation.

Dessau (Germany)—The line of tramway in this town, which has until now been driven by gas motors, is to be converted to the overhead electric trolley system during the present summer, notwithstanding that the present line has attained a fair measure of success financially.

Doncaster.—The accounts for the first year's working of the electricity undertaking just issued show a deficit of nearly £1,000.

Dorking.—An offer by Edmundson's Electricity Corporation to take a transfer of the Council's provisional electric lighting order has been referred to the General Purposes Committee.

Dublin.—At the Corporation meeting on Monday, Mr. Jones said that since the change-over in the electric system their electrical business had been brought to perfection. The change had given every satisfaction, it was working in the best possible manner, and it had resulted in a very large and immediate increase of the business of the Corporation. The great improvement in the lighting was spoken to by Mr. Ald. Meade, the High Sheriff, and the Lord Mayor.

Eastbourne.—Several thoroughfares are to be lighted by arc lamps, and the question of the electric lighting of the whole of the streets is under the consideration of the Electric Lighting committee.

East Grinstead—Application is to be made for a provisional electric lighting order.

Eccles.—The Council have entered into an agreement with the promoters of the South Lancashire Tramway scheme, whereby the Council undertake to obtain powers to construct the portion of the tramways from the boundary of the township to the junction of the existing tramways at Peel Green.

The accounts of the Electric Lighting department for the past year show a deficit of £789, but of this £346 is for repayment of loans. The estimated loss on next year's working is £800. At the last Council meeting Ald. Kendall said he regarded the figures as satisfactory, considering the difficulties the Council had had to contend against. Ald. Spary suggested that the Electric Lighting committee should ascertain whether they could be supplied in bulk with electric current cheaper than the committee could generate it.

Edinburgh.—A sub-committee (Bailie Mackenze, Councillors Auldjo Jamieson, Sir Jas. Russell, Carmichael, Gibson, and Macpherson) has been appointed to consider the question of the provision for maintenance and renewal of the electric lighting plant.

Electrical Enterprise in Russia—In a recent report on the trade of the Kertch district, reference is made to a concession offered by the municipality for the electric lighting of the town and the construction and working of electric tramways. This scheme has so far not been carried out, as municipal contracts in Russia are seldom drawn up in such a manner as to induce British firms to tender. It is pointed out, however, that firms in a position to investigate the particulars and ascertain requirements on the spot often find that the apparent difficulties are easily overcome. The report concludes by appealing to commercial firms to send their representatives to Kertch to investigate the possibilities of the market, "for this is really a growing country."

The municipality of Mariupol have invited tenders for the construction of an electric tramway and the installation of the electric light. The tramway is to run through the principal thoroughfares, and to connect the town with the new port and extensive metallurgical works established in this district.

At Rostov-on-Don the conversion of the present horse tramways to electric traction is about to be commenced.

Electrically-Driven Dust-Cart Tenders.—The Public Health Department of the City of London Corporation recently advertised for tenders for the hire of an electrically-driven dust-cart. We learn that, although advertisements were inserted in all the journals likely to secure offers for these vehicles, not even an inquiry regarding these requirements was received. Mr. A. A. Voysey, the electrical engineer to the Corporation, in a communication to hand, writes:—

Possibly none of the people likely to take up such a matter have considered what excellent conditions a dust-cart service offers for the use of electricity.

Electric Tramways in Spain.—Up to March 31st last concessions for the following suburban electric tramways (as distinguished from those granted for inter-town traffic) have been awarded, and the majority of these are either working or in process of construction and equipment:—San Sebastian to Tolosa, Cadiz to San Fernando, Corunna to Burgos de Santiago, and Arriondas to Coradonga. The chief towns in Spain for which concessions for electric tramways have been granted are as follows:—Barcelona, Valencia, Seville, Saragosa, Corunna, San Sebastian, Cadiz, Oviedo, Almeria, and Carthagena.

"**Engineering Magazine.**"—The June issue contains articles on "The Paris Exposition as a Mechanical Achievement," "The Commercial Organisation of the Machine-shop," "The Power Equipment of the Tall Office Building," and "Russian Opening for Anglo-Saxon Enterprise in Asia."

Fareham (Hants).—The Lighting committee has been authorised to enter into an agreement with the Southern Electric Free Wiring Co. for wiring premises in the district on the easy wiring system.

Flash and Search Light Regulations.—The London County Council has just issued bye-laws for the regulation of flash and search lights as follows:—

Flash and Search Lights.

No person shall exhibit any flash light or search light so as to be visible from any street or other other place (whether a thoroughfare or not) and to cause danger to the traffic therein, nor shall any owner or occupier of premises permit or suffer any flash light to be so exhibited on such premises. Any offender shall be liable for every such offence to a fine not exceeding £5.

The expression "flash light" means and includes any light used for the purpose of illuminating, lighting, or exhibiting any word, letter, model, sign, device or representation in the nature of an advertisement, announcement or direction which alters suddenly either in intensity, colour or direction. The expression "search light" means and includes any light exceeding 500 c.p., whether in one lamp or lantern or in a series of lamps or lanterns used together and projected as one concentrated light, and which alters either in intensity, colour or direction.

Fulham (London).—A proposal to expend £23,212 in providing additional electric lighting plant and extending the mains has been adjourned for two months. Up to date 1,176 applications have been received for electric current.

Glasgow.—The Corporation electricity rental to date amounts to £49,884, an increase of £11,986 compared with 1899. The Glasgow and South Western Railway Co. having applied for terms for supplying 660,000 units of electric current annually for lighting St. Enoch station, a sub-committee recommends the supply be given at the same rate as to ordinary subscribers (1½d. per unit), the price to rise or fall as found necessary. In reply to the application by the Police Commissioners of Partick for a temporary supply of electric current to consumers within the burgh until the new works which the Commissioners propose to erect have been completed, it is recommended that supply be granted for 12 months from Oct. 1, at 3½d. per unit, but at no time is the supply to exceed 250 amperes at 500 volts on the three-wire system, the Corporation reserving the right to terminate supply at a month's notice. The latter condition is unacceptable to the Partick Commissioners.

The Corporation are recommended to increase the salary of Mr. W. W. Lackie, chief assistant engineer of the electricity department, from £300 to £375 for the first year and £425 for the second year; that of Mr. J. A. Ward from £225 to £300 for the first year and £350 for the second. The salary of the chief engineer of the tramways department (Mr. W. Clark) is recommended to be increased from £450 to £500 per annum.

Hamilton, N.B.—Messrs. M. Buchan and Hogarth have been instructed to prepare a preliminary report as to the probable cost of an electric lighting scheme. The Council have withdrawn their opposition to the Hamilton, Motherwell and Wishaw Electric Tramway Bill, which, with the exception of the Larkhall section, had already passed the Commons. By arrangement with the promoters, the Council were to receive £10,000 for street improvements. They, however, considered this inadequate, and the promoters' offer of a further £1,500 has been accepted.

Hammersmith (London).—The question of the reduction of the charge for electric current to a uniform 3d. per unit has been referred to the Electricity committee.

Inverness.—Mr. E. G. Craven, who has reported to the Council upon the tenders sent in for the supply and erection of electric

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generating plant, &c., seems to have fallen foul of many of the tenderers. Messrs. Crompton and Co. complain of the manner in which Mr. Craven has treated their tender in making up his report to the Council. Their figures, it appears, have been reduced from £21,446 to £21,338, and from this must be deducted a credit of £497 for multipolar dynamos, making this firm's total figure £20,841 against the Brush Company's tender of £21,060 Mr. J. Stuart, manager of the Haythorne Tubular Boiler Syndicate, complains of the statement that his firm intended to experiment with their boiler at Inverness, and states that the Haythorne boilers offered were those having all the latest improvements, all of which, except in two small details, have been tested and approved by experts. Messrs. Lowdon Bros. and Co. state that they have quoted for a 1,500 ampere hour E.P.S. battery at nearly £4,000, but now find that an 800 ampere-hour battery was the one on which their prices were based. This would, they urge, reduce their contract price of £21,862 by nearly £2,000, making it lower than any other tender. Other complaints are made with regard to Mr. Craven's handling of the tenders. Mr. Craven, in his turn, appears to have a grievance, his complaint being that he was compelled to expend a larger sum for travelling and hotel expenses than was allowed for by the Council. The correspondence in connection with this matter is to be printed and distributed amongst members.

Japan's Imports.—There was imported into Yokohama in 1899 electric light apparatus to the value of £24,899, electric wires and cables £12,035, submarine telegraph cables £16,394, and telephones, telephone parts, and accessories £26,058. The latter item shows an increase over 1898 of about £11,000.

Jedburgh.—The Police Commissioners have accepted Messrs. Crompton and Co.'s proposals for establishing electricity works in this town. A provisional order is to be applied for.

Kendal.—The consulting engineers (Messrs. Handcock and Dykes) have been instructed to prepare plans and specifications of an electric lighting scheme.

Kilmarnock.—The Council have decided to apply for powers to borrow £50,000 for establishing electricity works.

Kirkcaldy.—Prof. Kennedy has been instructed to prepare plans and specifications of a joint electric lighting and tramway scheme.

Leamington.—Mr. Robert Hammond has been retained as consulting electrical engineer by the Council. A deputation has been appointed to confer with the local tramway company on the proposed acquisition of the tramways by the Council.

Leeds.—On the recommendation of the Lighting committee it has been decided to apply for further borrowing powers for £27,573 for electricity supply. It has also been decided to form a reserve fund, to be called the "Electric Lighting Equalisation Fund," and £8,287 from profits on the electric lighting undertaking has been transferred to this fund. The Council on Wednesday authorised the committee to let contracts for two additional sets of generating plant and for condensing plant at a cost not exceeding £15,000.

Leyton.—In the last report presented by the Electric Lighting committee it was stated that 60 arc lamps are now employed for public lighting. Extensions of the mains have been authorised.

Light Railways.—The following is a list of the applications lodged during May with the Light Railway Commissioners for powers to construct light railways :—

Barnsley & District (Extensions, No. 2)	Mid-Anglian (Amending).
Bath and District.	Nidd Valley.
Blackburn, Whalley and Burnley.	Norwich and Dereham.
Cleobury, Mortimer & Ditton Priors.	Pwllheli and Nevin.
Deanhead.	Rhyl and Prestatyn.
Durham and District.	Sheerness and District.
Hayling Island.	Southwold (Extension).
Hyde and Dukinfield.	Staines and Egham.
Jarrow and South Shields.	Swansea and District.
Kidderminster and Bewdley.	Wales and Laughton.
Kingston, Surbiton & District (Extns.)	Warrington & Northwich (Extension).
Mansfield and District (Extensions).	Warrington and Runcorn.

An inquiry was held last week into the application of Mr. J. Fell and others to construct light (electric) railways in Wakefield and the adjoining districts of Horbury, Outwood, Sandalagna and Alverthorpe. The local authorities interested supported the scheme, and Mr. Robert Green (Pritchard and Co., consulting engineers) gave technical details. The estimated cost of the lines, which will be constructed to the standard gauge, was put at about £82,000, and the overhead electric system will be adopted. The Commissioners announced that they were prepared to recommend the granting of the order.

The Cheltenham-Cleeve Light Railway order has been approved by the Board of Trade.

Manchester.—The foundation stone of the extensive car shed to be erected at Queen's-road, Cheetham, was laid on Tuesday by the chairman of the Tramways committee (Mr. D. Boyle), who said that the works were the first step towards the realisation of the Corporation electric tramway system. The shed would provide accommodation for 252 cars. The area to be covered was about 4 acres. The shed, when completed, would have a front 85 yards long by 11 yards wide. There would be an entrance gateway 16ft. wide to a covered approach road 48ft. wide, with track lines leading to 14 bays of sheds arranged at right angles thereto. These sheds would be 37ft. wide, and would each contain 18 cars. A pit would be formed in 11 of the sheds for examination of the motors beneath 198 cars, while the remaining three sheds would be for 54 trailing cars, to stand on the solid ground. The principals of the shed roofs would contain over 400 tons of steel, carried by steel girders on about 100 cast-iron columns, and the roofs would be covered by boards and slating and about 60,000 square yards of patent glazing. Three gateways 14ft. wide would be provided as emergency exits only, to provide for any temporary block in the entrance roadway. The tracks and connections within the shed were equivalent to a length of 2 miles of single line of tramway, and consisted of 14 bays, three tracks in each bay, branching off from a double line running parallel with the wall of the shed abutting on the intended street. Each track would take six cars, thus accommodating a total of 252 cars. A pit with an area of 6,500 square yards, 4ft. 6in. deep, would be provided under 11 of the bays for the inspection of the car trucks and motors. The tracks would be supported on steel stanchions, with girders formed of the old rails from the existing lines in the city, which are to be reconstructed. Free access would be obtained over the whole area of the pit, to allow of 200 cars being under inspection at one time. The total weight of the steelwork in the tracks and connections would be about 500 tons, and in the stanchions and girders for supporting the tracks about 250 tons. The total estimated cost of this work was £11,000. The shed and pit would be lighted by electricity. It would be, when completed, the largest car shed in Europe certainly, and perhaps the largest of the kind in the world. It would be necessary to have three additional sheds of almost equal size, and probably one or two smaller ones, for other roads. The substitution of electric for horse traction made a great difference in stabling, and the cost would be small.

Mr. W. H. Vaudrey, who was recently elected chairman of the Telephone committee, in succession to Mr. Southern resigned, declines to accept the honour.

Municipal Insurance.—A conference of delegates appointed by Metropolitan local authorities was held last week at the Shoreditch Town Hall for considering the question of Municipal Mutual Insurance. Mr. Joseph Cox, J.P., chairman of the Shoreditch Vestry, presided. A statement, prepared by Dr. H. Mansfield Robinson, clerk to the Shoreditch Vestry, showing approximately the value of the fire and other insurances effected by 55 out of 76 of the central and local authorities in London, was circulated, and showed that the total amount of insurances, including those for fire, employers' liability and fidelity was £8,979,468 ; the annual premiums amounting to £13,967 ; the annual losses by fire during the last five years amounted to only £8,650. 15s. 1d. ; the claims paid by the insuring companies under the Employers' Liability Act were £613. 10s. 1d., and there were no losses under the fidelity policies. A resolution urging the desirability of establishing a municipal insurance fund was carried in a form pledging the conference to the adoption of a system of mutual insurance against fire and other risks. A further resolution authorising the appointment of a representative committee from the delegates present for drawing up a scheme is to be submitted to a future conference.

Oldham.—The question of placing the contract for boilers for the new electricity works was considered by the Council on Wednesday. Owing to the necessity to economise space water-tube boilers will be adopted instead of Lancashire boilers, as originally proposed.

Para.—There is stated to be an exceptional demand just now for electrical goods and appliances for Para and district, which is one of the best parts of Brazil from a business standpoint. Para is to have an elevated railway if Dr. F. Bolonha, an enterprising citizen, is able to secure a franchise from the municipality to form a company to build the road, which is very much needed. It is considered probable that the franchise will be granted. There is at present a poorly-equipped horse-car line, which is in the market. The present company owns a concession which has 50 years to run.

Presentations.—Mr. E. J. Taylor, who was recently appointed chief assistant at the Birkenhead tramway power station, was last week presented with a dressing case by the employés at the Kelham Island (Sheffield) power station.

On Wednesday Mr. A. H. Gibbings, who recently resigned the position of city electrical engineer at Bradford in order to engage in consulting work, was presented with a testimonial subscribed to by about 100 members of the staff of the Bradford electricity department. The presentation consisted of a keyless gold hunter watch for Mr. Gibbings, and an electro-plated fruit stand and a set of flower vases for Mrs. Gibbings, and took place at the Valley-road electricity works. Mr. T. H. Shaw, chairman of the Electricity committee, who made the presentation, spoke in high terms of the ability displayed by Mr. Gibbings, and alluded to the good feeling which had marked the relations between Mr. Gibbings and the staff. Mr. R. A. Chattock, recently appointed City electrical engineer, and

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other members of the staff also spoke, and Mr. Gibbings suitably acknowledged the presentation.

Prevention of Diseases.—The Hammersmith (London) Vestry has received a report from the medical officer of health, Dr. A. C. Collier, L.R.C.P., L.S.A., setting out the means to be adopted to prevent the spread of consumption and other pulmonary complaints. The rules include the following:—

Where practicable the electric light should be used for lighting purposes in dwelling-houses and other occupied buildings, as nothing tends more to the production of consumption than the breathing of an atmosphere charged with the products of combustion, whether such products are the result of overcrowding or otherwise.

Rhondda.—A provisional electric lighting order is to be applied for by the Council. The question of seeking light railway powers has been adjourned for a month.

Rhyl.—Sanction to a loan of £19,000 for electricity supply has been received by the Council.

Royal Patronage of the Motor Car.—The Prince of Wales has patronised the auto-motor vehicle, and makers and others interested in this branch of enterprise anticipate that this will give a much-needed impetus to the industry in this country, where so far not much has been effected. At the Ascot Royal Hunt Meeting this week His Royal Highness in his motor carriage was conspicuous. A Daimler vehicle built in this country, but with a French-made under frame and wheels, has been selected for the Prince of Wales' use.

Salford.—Wholesale resignations from membership of the Electric Light committee are the order of the day. On Wednesday the Council were invited to appoint successors on the committee to Ald. Snape and Messrs. Haworth and Wilkinson. The Mayor announced the receipt of a joint letter of resignation from Messrs. Ward and Williams. Mr. Bates gave verbal notice of his resignation, and the Mayor said he had been authorised to convey to the Council a similar intimation from Mr. M'Mechan. Mr. Jackson, after stating that the committee were divided upon a certain line of policy, proceeded to describe at considerable length the causes of disagreement, and the reason for some of the resignations. A resolution by Mr. Broxap, in favour of referring the matter of reconstituting the committee to the Selection committee, was, after a rather lively discussion, adopted.

Sheffield.—The accounts of the Tramway department for the year ended March 25 were submitted to the Corporation on Wednesday by Ald. Clegg, chairman of the Tramways committee. He reminded members that, with regard to the electrical part of the undertaking, they only started from Sept. 5, 1899, and went up to March 25. The approximate street mileage at present was 13½ miles, compared with 10¾ in the corresponding period of 1899. The number of miles run was: Horse traction, 815,728; electric traction, 527,292—total, 1,343,020 miles, compared with 841,871 for 1899. The number of passengers carried was: Horse 11,494,400, electric 7,715,314, total 19,209,714, against 10,548,445. The average number of cars running had been 36·3 horse, 32 electric. The average number of passengers per car per week had been: Horse 6,072, electric 8,355. The average traffic revenue per car per week had been: Horse £28. 15s. 11d., electric £32s. 12s., against £28s. 2s. 8d. for 1899. The total revenue had been: For horse traction £57,330. 17s. 9d., electric traction £30,436. 17s.; total £87,767. 14s. 9d., against £58,594. 9s. 8d. for 1899. The working expenses had been:—Horse, £40,304. 4s. 10d.; electric, £23,961. 0s. 8d.; total £64,265. 5s. 6d. The number of passengers carried in the week ended Sept. 3, 1899, which was the last week of the entire horse traction, was 264,103, and of the following week, the first of joint horse and electric traction, the number was 417,299; and for the week ended June 10 they carried 733,374, which was a record. The committee recognised that they were not coping with the traffic, and in his judgment they would not be level with the traffic for 18 month or two years. With regard to the electrical portion of the undertaking in producing the energy, the actual cost of generating the electricity for the tramways at the Kelham power station was 0·824d. per unit. That was the average cost since the cars started running. The cost per unit from Sept. 4 to Dec. 25 was 0·871d., and from Dec. 25 to March 25, 0·777d. With all the charges for office expenses, interest, sinking fund, depreciation, rates, taxes and insurance added, the average total cost per unit was 1·513d., or about 1½d. That was an exceedingly satisfactory figure, and he hoped that for the corresponding period next year they would be able to produce energy at even a lower sum than that. The working expenses for the year had been £51,446, against £32,988 last year. The interest on loans had been £10,924. 11s. 7d., against £5,076. 12s. 11d., an increase of £5,847. 18s. 8d. The repayment of loans last year was £2,640. 4s. 11d., and for the year just ended £7,168. 9s., an increase of £4,528. 4s. 1d. The traffic and other receipts for the year ended March 25 was £87,767. 14s. 9d., against £58,594. 8s. 8d. The balance, after payment of all charges, with the exception of reserve and depreciation, had been close upon £18,228. 9s. 8d., against £17,789 2s. 1d. They had also written off on ordinary depreciation account £4,166. 3s. 7d., against £3,518 8s. 1d. They had set apart for reserve and for maintenance and renewals of tracks and lines £5,800 this year, which sum was absent last year, and for the maintenance of the electrical equipment and power station £2,852. 17s. 5d., which also was a new item, making a total increase of expenses and reserve fund of £19,676. 5s. 8d., compared with last year. The net surplus was £5,409. 8s. 8d., compared with £14,370. 4s. The profit made was more satisfactory than he anticipated, and in his judgment they had got over the critical time. He impressed upon the committee the necessity of keeping the net surplus (£20,000) in hand, because he foresaw that they might have to call up a portion of it to meet a deficiency upon the year's working of the electrical trams, as they had such a large amount of capital entirely unproductive. But he was glad to say that after providing for everything they had a profit of £5,000.

The Corporation on Wednesday adopted a scheme for the reorganisation of the staff of the electric tramway department. Mr. A. L. C. Fell, the present electrical engineer, has been made general manager, and his salary increased from £450 to £600 per annum. Mr. H. E. Yerbury, assistant electrical engineer will occupy the same position as at present, but will also superintend the Kelham power station, his salary being increased from £200 to £220 per annum. Mr. Joseph Dugdale will act as traffic superintendent under Mr. Fell's direction, and his salary has been increased from £150 to £200 per anuum. Various other alterations have been made, including the termination of the engagement of the manager of the undertaking, Mr. Henry Mallyon.

Southport.—It is anticipated that the electric tramway routes will be ready for working by the end of the month.

Southport and Cheshire Lines Extension Railway.—The *Engineer* states that a scheme has been formulated by Mr. R. H. Scotter for converting this railway into an electric railway for passenger service only, leaving the line to be worked by steam, as it now is, for long-distance and goods traffic. Current for working several miles of the line is to be taken from the Southport Corporation mains. To bring Southport into touch electrically with Manchester and Liverpool, Mr. Scotter proposes, by arrangement with the Cheshire Lines Committee, to also convert a piece of line running from the terminus of the extension system through Aintree, and turning off in a south easterly direction to Huskisson station, Liverpool, into an electric line; and further to immediately seek powers to construct two tunnels, suitable for electric passenger service only, from Huskisson under Liverpool to Central Station Low Level.

Swiss Telephone Service.—The revenue derived from the telephone service in Switzerland shows a steady increase. At Dec. 31, 1898, there were 31,918 subscribers, an increase of 3,072 over 1897. At Dec. 31, 1899, the number had increased to 35,056. The revenue in 1899 from subscribers was £95,200, compared with £83,312 in 1898, and the revenue from telephone conversations realised £107,800 in 1899, against £82,400 in 1898.

Sydney (N.S.W.).—The City Council have adopted the report of Major Cardew (Messrs. Preece and Cardew) on electric lighting, an abstract of which appeared in our issue of May 18.

Telephone Municipalisation.—After conferring with the Council of the local Chamber of Commerce the Bradford Telephone sub-committee recommend their Corporation to enter into a new agreement with the National Telephone Co. for wayleave facilities, such agreement being subject to determination on six months' notice. There is a desire to know the result of the Glasgow experiment before taking any steps to establish a municipal telephone exchange, and consequently this matter has been shelved for the present.

Telephonic Distribution of News.—According to the *Electrical World* of New York, companies have been formed in the States of Ohio, Indiana, and Illinois, for the collection of news in each State, and its distribution to the various newspapers by telephone. The daily papers in the smaller towns are said to have found the system very useful.

Tiverton.—A report on the proposal to establish electricity works will be considered at the next meeting of the Town Council.

Tunbridge Wells.—Last week the Town Council considered the report of Sir W. H. Preece (Messrs. Preece and Cardew) as to the alleged nuisance by smoke and vibration at the electricity station. The report stated that:

As regarded the smoke nuisance, the chimney erected in 1894 was 90ft. high and about 5ft. diameter. It was sufficient for working plant of 600 H.P. The present output of the station exceeds 450 kw., equivalent to about 700 H.P. It was, therefore, already too small to meet the enormous growth of the electric light undertaking, and this was undoubtedly one great cause of the trouble with the smoke. During last winter it had been exceedingly difficult at times to obtain good steam coal. The engineer (Mr. Horace Boot) had, therefore, been compelled to use coal of an inferior quality, which was bound to increase the smoke. Anything available had to be used, and nothing but Mr. Boot's energy prevented a stoppage. It was also unfortunate that the houses on the opposite hill were approaching the level of the top of the present chimney, and, therefore, when the wind was in a certain direction, any smoke produced was blown towards these houses. The fact that the station had been working practically with-

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out trouble for some five years showed that the chimney itself had done well, and it was merely a question of the station having outgrown the capacity of the chimney. The nuisance would now cease, for the heavy winter load was over. The remedies for overcoming this difficulty were simple. They were: (1) To erect a larger and higher chimney, (2) to use smoke consumers, and (3) to have plant in the station sufficient to meet the demand. He recommended them to erect a chimney 180ft. high and 8ft. diameter, which would cost about £2,000, and would be sufficient for a plant having a capacity of 2,000 H.P. It would be possible to economise by building an iron chimney, but such a chimney required painting at frequent intervals. He would suggest that estimates be obtained for both kinds.

Regarding noise, this was, in Sir W. H. Preece's opinion, entirely due to the exhaust steam. There was some vibration set up in the buildings from the Ferranti engine, but it was not communicated outside, and was not therefore a source of complaint. The exhaust steam was discharged into the air at a low level, and nothing had been done to modify in any way the constant thud produced by the enormous quantity of steam which was emitted at every revolution. A great deal of this could have been avoided by placing a damping cylinder of large diameter in the exhaust pipe, but as a large condensing plant had now been ordered the whole of the difficulty from the exhaust steam should be removed.

Regarding the plant in general, he was not at all pleased with the working of the Ferranti engine. It had not been taken over nor fully paid for, and he strongly recommended them to have a second 400kw. Willans Ferranti set ordered without delay, which would only be available for the winter of 1901-2. The present Ferranti engine and dynamo should be used as a stand-by or an emergency set. He estimated the cost of the additions to be: Chimney £2,000, new Willans-Ferranti set £4,600, and contingencies £500, making a total of £7,100.

Sir Wm. Preece further reported that he understood from Mr. Boot that considerable difficulty had been experienced with the Babcock and Wilcox boilers through bad water, and that the Council were going to instal two Lancashire boilers. There was equal danger with Lancashire boilers if bad water was allowed to be used. It appeared to him to be absolutely necessary either to change the source of supply or to have a proper water purifying plant (if one existed) installed, which should deal with the water chemically before it was used in the boilers. The present water could be used for cooling purposes. He did not consider that the site was applicable to a larger horse-power than the present additional 2,000. As soon as it was evident that the full capacity of the present station was being reached they should take steps to build a larger station well outside the town. Electric tramways would soon be required, and other demands on their station would be largely increasing. Heating and motive power for lifts in private residences, as well as for small industries and tools, were becoming quite fashionable. No one could predict the future of electrical development. The new station should be erected where there was a convenient water supply for condensing purposes, and where it would be possible to combine the boiler plant with a destructor. A second power house would be not only a great security against accident, especially from fire, but enable them to cover their area with a system of connected and self-supporting mains so as to reduce any cause of stoppage of supply to a minimum.

The Lighting committee, after considering the above report, advised the Council to at once proceed with the erection of an additional chimney and to obtain tenders for the execution of the work, to purchase a second 400 kw. Willans-Ferranti set with the necessary additional boiler, and also to employ Sir Wm. Preece to superintend the carrying out of the works on the usual remuneration of 5 per cent. on the outlay. Councillor Robb moved the adoption of the report, and said the committee had been continually harrassed by complaints during the past year, and in the interests of the undertaking it was to be regretted that one or two slight failures had occurred. They had been working with insufficient plant. Financial success had been obtained by putting undue pressure on insufficient plant, and the question was what they were going to do in the future? An increase in plant had already been decided upon, and part of it would be delivered in time for next winter's load. That would give a total capacity of nearly 2,000 H.P., and Sir Wm. Preece recommended a still further order of plant in view of continued growth, and the use of electrical energy was extending in all directions. The first thing to do was to have not only adequate plant, but spare plant. The present equivalent number of 8 c p. lamps connected was 32,500. The greatest demand on the works at any one time was 40 per cent., or 12,660. Their present plant was equal to supplying 30,000 lamps, and Mr. Boot was of opinion that the proposed addition would meet their requirements for some time to come, as this would give them a capacity of 45,000 to 50,000 lamps. Even taking the percentage in use at a given time, it would not exceed 50 per cent., so that there should be a margin. They would be incurring a great responsibility by disregarding the advice of their expert, but at the same time a large expenditure would be involved, and would bring the capital involved up to £17,000. He felt the site selected for the central station was unfortunate, but they had now to make the best of it. He put it to Sir William Preece whether the Council should remove their works and combine it with a destructor or tramway plant, but Sir William did not recommend that, because he considered the present nuisance was remediable. He feared they must not look for profits in the future as in the past now that they had this large additional expenditure to meet. It had been very nice to hand over profits to the reduction of the rates, but their plant must not be overdriven to make profit for the rates. A municipal undertaking was not to be regarded only for what could be made out of it. Councillor Dodd moved that the report be referred back. He considered the policy of purchasing plant, which would not be required for three years, was questionable. He objected to the employment of Sir William Preece as unnecessary. There was also the tramway question, and he wanted the committee to consider how that scheme would be affected by the present proposals. The Town Clerk said certain points had been raised by Mr. Boot in a letter addressed to the committee, and Sir William should have an opportunity of dealing with these points. It was then agreed that the report be referred back.

An additional main is to be laid from the electricity works to the Mount Pleasant sub-station at a cost of £516, and the main in the lower portion of Upper Grosvenor-road is to be extended at an estimated cost of £406.

Vladivostock.—The municipality of this city has prepared a specification and schedule for the construction and equipment of 20 miles of electric overhead trolley tramroads, and for the establishment of an electricity generating station for the lighting of the town.

Walker.—The Council has received sanction to borrow money for electric light and refuse destructor.

Water Power Utilisation in Italy.—Plant is to be put down by La Società Ferrovie e Tramvie Elettriche Varesine to utilise the water power of the Giona stream for the generation of electric energy. At first three large 500 H.P. alternators driven by turbines are to be put down, electric energy being utilised in the operation of the Luino-Varese electric tramway and for lighting and power purposes generally. Messrs. Brioschi, Finzi and Co., of Milan, have secured the contract for the electrical plant.

Water Power Utilisation in Spain.—It is proposed to put down a plant to utilise the water power of the river Ottaven, in Galicia, for the generation of electric energy and to distribute the same to a number of small towns in the district.

Whitby.—Sanction to borrow £26,000 for electricity supply has been received by the Council.

Wigan.—An agreement has been entered into with Messrs. F. W. Smith and Co. for wiring premises on the hire-purchase system.

Wolverhampton.—The Lighting committee have presented their report for the year ended March 31, together with an abstract of the accounts of the electricity undertaking for the same period. The net result, after payment of interest and sinking fund charge, is a profit of £402. 6s. 11d., against £1,004. 5s. 10d. in the previous year. The sum of £911. 15s. 4d. was also expended during the year out of revenue—viz., £256 for re-wiring armatures and £655. 15s. 4d. for altering fittings, &c., of 121 customers to suit the increased pressure of supply. The profit, together with the amount in hand from previous years (£416. 5s. 4d.), is to be set aside to form a reserve fund. The committee state that the past year has been one of exceptional difficulty. The alteration in the system of supply has necessitated two systems being in operation for the latter six months, involving considerable additional expenditure out of revenue on account of working cost, especially in the consumption of gas and fuel. The considerable increase in the cost of fuel has also had an adverse bearing upon the financial result. The delay in the completion of the battery room at the generating station has seriously handicapped the department, and has affected the efficient working of the undertaking. At the end of the year there were 364 customers, representing the equivalent of 25,184 lamps, connected, against 276 customers and 19,932 lamps in 1899. The units generated were 603,954, against 470,836 in 1899, and the number of units sold was 482,247, against 371,830. The demand for current for power is gradually increasing. At present there are 16 motors, ranging from ½ H.P. to 20 H P., connected. The total maximum supply demanded in 32 watt lamps was 25,184.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Extension of Time.—The date for sending in tenders for the supply, delivery, and erection of overhead equipment for about 16 miles of equivalent single track of tramways, for the Corporation of *Durban*, Natal, South Africa, has been extended. Tenders are to be sent in duplicate to the agents, Messrs. Webster, Steel and Co., 5, East India-avenue, Leadenhall-street, London, E C., by Friday, July 20, or to the town clerk of Durban, by mail delivery, on or about Monday, Aug. 13. See advertisement.

Dudley Corporation invite tenders for condensers, pumps, cooling tower, &c. Specification may be obtained at the offices of the con-

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sulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W., and tenders must be addressed to the town clerk (Mr. H. C. Brettell), Town Hall, Dudley, before 30th inst. An advertisement contains additional particulars.

Newcastle-upon-Tyne New Tramways committee require tenders for trolley wires and attachments. An advertisement contains additional particulars, and tenders must be delivered at the office of the town clerk (Mr. Hill Motum) by noon of 25th inst. Specification may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W.

Manchester Tramways committee invite tenders for the overhead equipment of three tramway routes. Specifications may be obtained from the general manager (Mr. J. McElroy), and tenders (addressed to chairman) must be in by 30th inst. An advertisement contains further particulars.

Shoreditch (London) Vestry require tenders for the supply of eight dry-back marine-type boilers, or eight water-tube boilers, with automatic stokers, &c., for their new generating station at Whiston-street. Tenders to Dr. H. Mansfield Robinson, Town Hall, Old-street, E.C., before noon of 19th inst.

London County Council require tenders for the supply (within three months of order) of about 70 arc lamp standards for lighting the Victoria Embankment. Tenders to clerk (Mr. C. J. Stewart), by 10 a.m. July 10.

The Vestry of St. Mary Magdalene *Bermondsey* (London), require tenders for the supply and laying of insulated electric mains, conduits, junction boxes, &c. Tenders before noon of June 18.

Glasgow Corporation require tenders for outside coal storage and steel structure for coal handling, and locomotive travelling cranes for outside coal handling, for their Pinkston power station. Tenders by 5 p.m. 21st inst.

The Guardians of *St. Saviour's* Union require tenders for the erection of electric fire alarms, telephones, &c., and laying fire mains at their infirmary, East Dulwich-grove. Tenders to clerk, John-street West, Blackfriars-road, London, S.E, by 5 p.m. on 21st inst.

Bury Corporation invite tenders for wiring the Art Gallery and Free Library. Tenders to town clerk, Corporation Offices, Bury, by 18th inst.

Tenders are invited for wiring the *Newcastle* Modern School, 6 and 7, Park-terrace, Newcastle-on-Tyne. Tenders to Mr. J. R. Sisling, 7, Park-terrace, by June 23.

Blackpool Corporation invite tenders for the electrical equipment of 15 single truck tramcars. Tenders by 18th inst.

Sutton Coldfield Corporation invite tenders for electricity generating plant. Tenders before noon of June 21.

Bradford Cleansing committee require tenders for five refuse destructors. Tenders by Sept. 8.

Heckmondwike District Council require tenders for the erection of electricity supply buildings. Tenders by 28th inst.

Limerick Corporation require tenders for electricity generating plant. Tenders to town clerk by July 4.

Trimdon (Co. Durham) Parish Council invite tenders for public lighting by electricity or acetylene gas. Tenders by July 17.

Morley Sewage Purification committee require tenders for wiring the new sewage disposal works. Tenders by 19th inst.

Torquay borough surveyor has been instructed to obtain particulars and prices of the most suitable type of motor car for dust collection.

Servian Post and Telegraph authorities invite tenders, till 21st inst., for 27,000 porcelain insulators, 35 tons of iron wire 4mm. dia. and 30 tons of silicium-bronze wire 3mm. dia. Tenders to Post and Telegraph Section of the Ministry of Works, Belgrade.

Spanish Post and Telegraph Authorities, Madrid, invite tenders until 22nd inst. for 10,000 zinc cylinders for electric batteries. Tenders to Direccion General de Correos y Telegrafos.

Galzada de Calatrava (Ciudad Real, Spain) municipality invite tenders for electric lighting concession for 20 years. Tenders to el secretario del Ayuntamiento by July 10.

TENDERS RECEIVED AND ACCEPTED.

Fulham (London) Vestry have received the following tenders for wiring the electric light works :—

Pyke, Harris and Co.	£1,181	0	0	Newsome, Pinching and Walton	795	0	0
Hailey and Co.	1,100	10	0	P. S. Taeker	781	10	0
F. G. Edey and Co.	1,025	10	0	F. Troy and Co.	762	0	0
Ditto	975	10	0	H. R. Gifkins and Co.	753	0	0
Alwyn and Craven	1,000	0	0	Concentric and General Contract Co.	740	0	0
G. Stegmann	980	0	0	T. L. Hellyar	618	7	6
Foote and Milne	874	0	0	Birmingham Installation Co.	487	0	0
National Electric Wiring Co.	840	0	0				
Ditto	812	0	0				

The tender of Mr. S. F. Davidson has been accepted by the Newcastle-on-Tyne Corporation for the erection of car sheds at Byker for £33,750, the whole of the work to be completed by Sept. 1, 1901, and the car body shed to be finished by December next. The following contracts were also sealed on Wednesday: British Thomson-Houston Co. (switchboards), £2,037; British Insulated Wire Co. (underground feeders), about £7,700; and Mr. Nuttall (construction of the tramway along Mosley-street, St. Nicholas'-square, Collingwood-street, and Neville-street to the power station), at schedule prices.

The following contracts were let by the Wigan Corporation at their meeting last week:—Dick, Kerr and Co. (Ltd.), tramcars; W. T. Glover and Co., cables and pilot wire; Askham Bros. and Wilson, points, crossings, &c.; J. Ross and Manx Granite and Silicia Quarries Co., granite setts; Thompson and Co., iron and steel; S. Marsden and Son, bolts; Taylor and Sayers, castings; and J. Elwell, corrugated iron.

Chester Corporation have accepted the tender of Messrs. Babcock and Wilcox for the supply of steam exhaust, feed suction and delivery, and condensing water pipes and valves. The other tenderers were Messrs. Aiton and Co., Alley and McLellan, G. H. Williamson and Co., Tingle and Co., and John Spencer (Ltd.).

Edmonton (London) Guardians have accepted the tender of Messrs. Preece and Co. for the supply of additional electric lighting plant at £1,600. The tender is subject to approval of Local Government Board.

Birkenhead Corporation have accepted the tender of Messrs. Babcock and Wilcox for the supply of steam exhaust, feed water and drain-pipe work, &c., for the tramway power station.

Leyton District Council have accepted the tender of the Western Electric Co. and the British Insulated Wire Co. for the supply of additional feeder cables.

Wimbledon District Council have accepted the tender of the Berrenberg Electric Lamp Syndicate (Ltd.) for the supply of 5,000 16 c.p. incandescent electric lamps at 1s. 5d. each, and that of Messrs. Foote and Milne for wiring the new isolation hospital at £321.

Stockton-on-Tees Council have accepted the designs submitted by Messrs. W. Macfarlane and Co. for arc lamp pillars at £9. 10s. each.

The Barnsley Town Council has accepted the tender of Messrs. Crompton and Co. for supplying and erecting 15 arc lamp posts and arc lamps and attaching incandescent lamps to the posts at £501. 14s.

The tender of Messrs. Crompton and Co. has been accepted for the supply of the whole of the generating plant for the Heywood electricity works.

Cheltenham Town Council have placed a contract with Messrs. Körting Bros. for the supply and erection of condensing plant for their electricity works at £2,100.

Perth Town Council have accepted the tender of Messrs. W. Lucy and Co. for the supply of 45 enclosed arc lamps and ornamental cast-iron and steel pillars, switch gear, &c., at £2,143.

Messrs. Crowther and Co., Manchester, have obtained the contract for the electric lighting of the new Bury (Lancs.) post office.

Battersea (London) Vestry have accepted the tender of Messrs. Norman, Beard & Co., for the erection of a Hope-Jones electric organ at the Town Hall for £1,912.

The tender of Mr. B. Thomas has been accepted by the Llandilo Council for the erection of electricity works at £2,415.

APPOINTMENTS VACANT AND FILLED.

The post of senior demonstrator in the department of electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session. The salary is £150, rising to £200. Applications for the post have to be addressed, in the first instance, to the principal of the college, Leonard-street, Finsbury, London, E.C., by June 29. An advertisement gives some further particulars.

There is a vacancy for an assistant superintendent in the Telegraph Department of the Government of India. Applications to Secretary, Public Works Department, India Office, Whitehall, London, S.W., by June 30. An advertisement contains further particulars.

Birmingham Corporation require two lecturers for the electrical and engineering departments of the municipal technical school in September next. An advertisement contains further particulars, and applications must be sent to the secretary (Mr. Geo. Mellor), Suffolk-street, by 30th inst.

The Council of the King's College, London, invite applications for the post of demonstrator in electrical engineering. Conditions of the appointment can be obtained of the Secretary, and applications must be in by 30th inst. See advertisement.

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The Board of Works for the Poplar (London) District are open to receive applications for the position of chief generating assistant at the electricity works now in course of establishment for the district, who will be under the direction of the engineer and manager of the electricity department. Commencing salary, £156 per annum. Applications must be sent to Mr. Leonard Potts, clerk, offices of the Board, 117, High-street, Poplar, E., by 18th June. See advtisement.

A shift engineer is required for the Leyton electricity department. Further particulars are given in an advertisement, and applications must be sent to the engineer and manager (Mr. F. Harman Lewis) by 22nd inst.

Carlisle Corporation require a clerk and switchboard attendant for their electric lighting department. Further particulars are set out in advertisements, and applications must reach the city electrical engineer (Mr. Charles D. Burnet), James-street, Carlisle, by Monday the 25th inst.

The South London Electric Supply Corporation require a pupil with previous technical training. Applications to secretary, 54, Bengeworth-road, Loughborough Junction, S.E. See advertisement.

Whitechapel District Board of Works require an arc lamp attendant and a plumbing jointer. Applications to the engineer, 27, Osborn-street, London, E. See advertisement.

The Municipal Electrical Association Council require a secretary to act under direction of hon. secretary. Applications to president (Mr. A. B. Mountain, borough electrical engineer, Huddersfield), by 14th inst.

An assistant master (for physics and mathematics) is required for the Day School of Science, Gravesend. Applications by 21st inst.

The Brush Electrical Engineering Co. have appointed Mr. Edward A. Leeson to be works manager at their Falcon Works, Loughborough, in succession to Mr. C. E. Hodgkin. After many years experience in the design, construction, and working of steam machinery with Messrs. R. and W. Hawthorn, Newcastle-on-Tyne, Mr. Leeson became successively works manager of Messrs. Hawthorn, Guppy and Co.'s works at Naples, and of the branch works of Sir William Armstrong, Mitchell and Co., at Pozzuoli, Italy. He recently returned to this country to take up the position of works engineer with Messrs. Hawthorn, Leslie and Co, Newcastle-on-Tyne. Mr. Leeson's wide experience of steam engine construction, and of the high-class workmanship associated with the names of the firms given above, will doubtless prove of great value to the Brush Company in connection with the increasingly large plants under design and construction for lighting, traction and power purposes at the Falcon Works.

Mr. W. J. Poole, who has been for two years superintending the erection of the plant at Port Dundas station, Glasgow, has been appointed to succeed Mr. John Christie as station superintendent at a salary of £200 per annum.

Mr. H. Bell, the present second assistant at Hull, has been appointed chief assistant at the Sculcoates-lane electricity works, in succession to Mr. H. Gray, who has received an appointment at Accrington.

Greenock Corporation have appointed Mr. W. M. Nelson, late assistant engineer at the Corporation electricity works, to be resident electrical engineer for the burgh in succession to Mr. S. E. Fedden, who was recently appointed to Sheffield.

Mr. Robert Leach, B.Sc., has been appointed teacher of physics and chemistry at the Gloucester Municipal School at a salary of £250 per annum.

BUSINESS NOTICES.

As previously announced, Messrs. Robert W. Blackwell and Co. (Ltd.) have removed their offices and stores from 39, Victoria-street, Westminster, and 133, Bermondsey-street, London, S.E., to central premises at 59, City-road, London, E.C. Telephone Nos. 1479 and 1480 London Wall. Telegrams: "Kurkee London."

On and after June 18 the registered offices of the Metropolitan Electric Supply Co. (Ltd.) will be removed from 29, Baker-street to 16, Stratford-place, London, W.

Messrs. Veritys (Ltd.) are removing their Glasgow offices to 40, Bath-street from June 18.

The offices of Mr. G. R. Peers, consulting electrical engineer, 96, Deansgate, Manchester, are now connected to the National Telephone Co's. system number 08507.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the principal creditors of Laing, Wharton and Down (Ltd.) (in liquidation) was held under the presidency of Mr. L. B. Warmington, liquidator, at 80, Coleman-street, London, E.C., yesterday. Creditors representing £7,800 were present. Mr. Warmington said a receiver was appointed on Oct. 4, 1899, and the company entered into voluntary liquidation on Oct. 10. The receiver was still in possession, and was carrying on the business as manager under the supervision of the Court pending the completion of certain contracts. From several of these contracts it was anticipated a small profit would be derived, but in the case of other contracts a loss would probably ensue. The contracts would be completed by the end of July, and though the Court had not definitely settled the time for the closing of the liquidation it was unlikely it would sanction any further delay. At May 13, 1900, the state of affairs was as follows:—

Assets.			
Book debts	£7,150	0	0
Contracts in hand (at cost)	3,365	0	0
Cash	1,255	0	0
Stock (estimated)	7,383	9	1
Office furniture, &c. (estimated)	1,490	0	0
Patents (estimated)	48	0	0
Total assets (estimated)	£20,691	9	1
Receivers' Liabilities.			
Running expenses (say)	£1,000	0	0
Debentures and accrued interest	10,801	0	0
	11,801	0	0
Net assets (estimated)	8,890	9	1
Total	£20,691	9	1

Sundry creditors stand for £1,250. Mr. Warmington stated that a cheque had recently been received from the London County Council with £2,700 deducted for defective work, and in connection with this contract an action was pending against the firm who supplied the cables. There was also another action pending against Clench and Co. Mr. Warmington further stated that there was a good general business still going on, and over £6,000 worth of work had been done in six months. There were no secured creditors beyond the debenture holders. About £30 per week was being spent in office and other salaries, and the question that remained was, what was to be done with the business, seeing that the Court would not allow them to continue much longer. A lengthy discussion ensued, especially on the point of the value of the stock, and it was ultimately agreed that a committee of inspection should be appointed, consisting of Mr. Geo. Sutton (Henley's Telegraph Works Co.), Mr. H. Oppenheimer (International Electric Co.), Mr. Teale (Keeling, Teale and Co.), and Mr. Barnard (Pfeil and Co.), who are to make an independent valuation of the stock and report.

The official receiver and liquidator of the Cox Thermo-Electric Co. (Ltd.) (Mr. H. Brougham) notifies that he is about to apply to the Board of Trade for his release. In the summary of receipts and payments now issued it is shown that the assets of the company (£257. 9s.) were covered by the debenture bonds, and also that the debenture-holders, whose claims amounted to £10,000, received nothing in respect of their security. It will be remembered that the directors of this company voluntarily offered to pay the trade creditors 13s. 4d. in the £ on the amount of their claims, and, while this offer was renewed to the official receiver, the directors, after protracted negotiations, declined to carry it out, which seems to require some explanation on the part of the directors, many of whom are well known in the electrical industry. In connection with the formation and promotion of the company, the official receiver states that there was nothing to justify an application for a public inquiry. The directors of the company were Mr. Roger Wallace, Q.C., Mr. Julius Möeller, Mr. J. Brown Martin, and Mr. H. B. Cox.

A. W. Hirst, electrical engineer (trading as Hirst and Co.), St. Michael's-road, Croydon, has been adjudicated bankrupt. The first meeting of creditors will take place on 21st inst., at 24, Railway-approach, London Bridge, and the public examination on July 16, at the County Court, Park-street, Croydon.

At the London Bankruptcy Court on Wednesday John Henry Crawford, financial agent, late of Cannon-street House, London, E.C., applied to pass upon accounts showing total liabilities £25,615, and assets valued to show a surplus. Debtor had previously failed in 1894 in the name of Grant Crawford, and recommenced business in 1895 with £600 borrowed capital. In 1897 he formed the London Provincial Electrical Co. (Ltd.), with a capital of £60,000. Early in 1896 he had purchased for £3,000 in cash and shares the business of a Birmingham firm of electrical engineers and patents relating to an arc lamp, the London Provincial Electrical Co. taking over the business and patents for £30,000. A winding-up order was made against the company in 1898, and it remained in liquidation until January last, when the creditors other than debtor received payment of their debts, and the company was released. Debtor stated that he had expended between £6,000 and £7,000 upon the company, which still has offices at Palmerston-buildings, E.C. Examination concluded.

A meeting has been called to consider the recommendation of the directors to wind up voluntarily, for re-construction purposes, Earle's Shipbuilding and Engineering Co. (Ltd.).

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For Sale.—In our advertisement columns Messrs. Wheatley Kirk, Price and Co. announce the sale by auction, at the Grays Engineering Works, Grays, Essex, on Tuesday, Wednesday and Thursday, July 3, 4, and 5, at 10 for 11a.m. prompt, the contents of the works, including a variety of tools, machinery, utensils, stores, &c. The whole may be viewed on Monday, July 2 and on the mornings of sale. Catalogues (6d. each) may be obtained on application at the works, of Messrs. Hatten and Asplin, solicitors, Bank Buildings, Grays, Essex, or of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester.

Business for Sale.—Large and well-equipped electrical engineering works, including 20 years' lease, are for sale. Applications should be addressed "Bargain," care of J. W. Vickers, 5, Nicholas-lane, London, E.C. See also advertisement.

Westinghouse Plant.—A booklet on the Westinghouse electro-pneumatic system for controlling railway and other motors has just been issued by the British Westinghouse Co. Illustrations which accompany the text include a two-car shuttle train equipped with this system, and the drawing of a two-car shuttle train showing motors and controllers with electro-pneumatic operating devices in position. The Westinghouse system is applicable to the simultaneous operation of any number of motor cars in a train, and it is claimed that the advantages of this system become more apparent as the number of motor cars in a train is increased.

General Electric Plant.—A new list of desk and ceiling fans for use on continuous and on alternating current circuits is issued by the General Electric Co., and also a new list of Crocker-Wheeler multipolar motors and generators for belt driving and direct coupling from 10 H.P. to 750 H.P. These sectional lists will be incorporated in the new edition of the company's full catalogue now preparing. The company will supply copies of the new lists on request.

Imports of Electrical Goods into the United Kingdom.—The accounts relating to the trade and navigation of the United Kingdom show that the value of electrical goods and apparatus imported during May was £78,350. The total for the five months ended May 31 was £334,082.

Fire.—A fire broke out on Thursday last on the premises of Mr. F. C. Allsop, 126, Queen Victoria-street, London, E.C. The contents of a large showroom on the first floor were destroyed. The damage is estimated at about £1,000.

"Burnand" Transformers.—A new price list of Burnand transformers is just published by Messrs. W. E. Burnand & Co., Ocean Works, St. Mary's-road, Sheffield. In addition to the usual particulars as to dimensions, efficiencies, &c., the list contains information regarding these machines and sectional drawings and photographs of interest.

Emery Grinding Machines.—Messrs. Poth, Hille & Co., 27, Leadenhall-street, London, E.C., are introducing the "Excelsior" improved stop foot-power emery grinding machine, which the makers claim will do all kinds of grinding in less than one-fourth the time required on an ordinary grinding stone, and can be attached to any work bench. The apparatus is simple and compact, and there are but few wearing parts.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 7 to June 12, with the ports of destination:—

Africa—Alexandria, £16; Beira, £597; Cape Town, £295; Durban, £80; Port Said, £15. *Argentina*—Buenos Ayres, £150. *Australasia*—Adelaide, £234; Auckland, £289; Brisbane, £81; Fremantle, £27; Melbourne, £393; Port Chalmers, £49; Sydney, £487; Wellington, £238. *Belgium*—Brussels, £55. *Brazil*—Rio Janeiro, £1,406 (including £1,369 telegraph material). *British Guiana*—Demerara, £57. *Burma*—Rangoon, £198. *Canada*—Halifax, £70. *Ceylon*—Colombo, £731. *China*—Shanghai, £442. *France*—Boulogne, £16. *Germany*—Hamburg, £400 (telegraph material). *Gibraltar*, £25. *Holland*—Amsterdam, £53. *Hong Kong*, £14. *India*—Bombay, £530; Calcutta, £842. *Java*—Sourabaya, £60. *Malta*, £789. *Russia*—Archangel, £361; St. Petersburg, £153 (including £52 telegraph cable). Total (for six days) £9,153, against £12,355 for one week last year (June 7 to 13).

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—Subject to audit, the directors have decided to recommend the payment of the following dividends, &c., for the year ended May 31:—Ordinary shares: A dividend of 5s. per share, of which 2s. per share was paid on account in December last, and a bonus of 4s. per share, making a present distribution of 7s. per share, or a total distribution of 9s. per share for the year. Founders' shares: A dividend of £30 per share and a bonus of £40 per share, making £70 per share for the year. The dividends will be paid on 27th inst.

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.).

The report of the directors of this company, for the fifteen months ended 31st March last, states that the profits, including £35,451. 13s. 8d. brought forward (but without taking into account the premiums, £160,529. 15s. 3d., received in respect of new share and debenture capital), amount to £159,122. 15s., and after deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, and interest on debenture stock, there remains a net profit of £130,174. 16s. 2d. The directors propose to reduce goodwill account by £5,000, add to reserve £20,000, reduce furniture account by £469. 1s. 9d., and to pay the dividend at the rate of 6 per cent. per annum on the preference shares (on account of which interim dividends have been paid to Feb. 15, 1900), absorbing £23,051. 18s. 9d., and a dividend at the rate of 8 per cent. per annum on the ordinary shares (on account of which an interim dividend at the rate of 6 per cent. per annum has been paid for the nine months ended Sept. 30, 1899, leaving a balance dividend payable of 11s. per share on Nos. 1—30,000, and 8s. 7½d. per share on Nos. 60,001—75,000), absorbing £37,869. 16s. 10d., carrying forward £43,783. 18s. 10d.

Since Dec. 31, 1898, the directors have issued 40,000 6 per cent. cumulative preference shares of £10 each at £12 per share, and 15,000 ordinary shares of £10 each have been allotted to the shareholders at £15 per share. There has also been issued £250,000 5 per cent. perpetual debenture stock at an average price of £120⅛ per cent. The total premiums received in respect of these issues, after deducting expenses, amount to £160,529. 15s. 3d., and the whole of this amount has been added to reserve. The subscribed share and debenture capital is now £1,300,000. Of the authorised share capital there is at present unissued 15,000 ordinary and 10,000 preference shares of £10 each, which the directors propose at an early date to allot to the shareholders. The whole of the present authorised share capital will then be issued, and the directors recommend that powers be taken to increase the nominal capital of the company by the creation of 80,000 shares of £10 each.

Contracts and Undertakings.—The total amount expended under this head, after deducting costs of undertakings transferred, and after writing off expenses incurred in respect of schemes not proceeded with, but including a proportion of general expenses, is £543,246. 12s. 4d.

Investments.—The total expenditure under this head, after deducting cost of securities sold or written off, is £950,280. 0s. 1d. There are certain contingent liabilities in respect of some of these investments.

Superannuation Fund.—The directors have had under consideration the desire expressed by officers of the company and of the associated companies that a superannuation fund should be established, and a proposal will be made at the forthcoming meeting of shareholders that £25 be subscribed by the company in respect of each official now in the employ of the company who elects to become a subscriber to the fund, and that the company should make certain annual contributions to the fund.

An appendix accompanying the directors' report and accounts gives particulars of the contracts and undertakings in which the British Electric Traction Co is interested, and of the nature and extent of the company's investments in these undertakings.

Chilian Electric Tramway and Light Co. (Ltd.).

The report of directors, covering the period since the incorporation of the company (May, 1898) to Dec. 31, states that on May 9, 1898, the company acquired the whole of the horse tramways in Santiago. The company at the same time obtained from the municipality a concession for 30 years for electric traction over the entire system, and also a concession giving the monopoly of supplying the city of Santiago with electric current for lighting for the same period. The company also purchased the suburban line from Santiago to Nunoa for ultimate conversion to electric traction. The profit and loss account shows a balance credit of £18,051. 16s. 11d., and from this the directors propose to pay the dividend of 6 per cent. per annum on the amount of preference shares called up to Dec. 31, 1899 (absorbing £10,871. 18s. 6d.), leaving £7,179. 18s. 5d., out of which various claims have to be provided for. The balance will be carried forward.

The tramways covered by the concession extend to a total length of about 117 kilometres of single track. Horse and mule traction have, up to the present, been used over the entire system, with the exception of a small distance between Calle Mapocho and Brazil; which being the first section converted to electric traction, was opened to public traffic on April 1, 1900. Reconstruction is proceeding rapidly over the entire system, and as the various sections are successively completed and in working order electricity will at once be installed. The concession allows, however, of ample time for the entire conversion of the whole system. During the twelve months from Jan. 1 to Dec. 31, 1899, the company carried 41,743,687 passengers, earning $1,819,143.16. For 1898 the number was 38,896,180, earnings $1,670,583.97. As the tramways were taken over in a very low state of efficiency, the expenditure for maintenance and working has been exceptionally heavy. It is confidently expected that, when the reconstruction is completed and the electric service is installed, there will not only be an increase of traffic, but also a diminution in working expenses. This is the experience in all cities where animal traction has been superseded by electricity.

As regards the concession for electric lighting, the directors believe that it has a very important and promising future before it. There is no reason for doubting that the success of the electric light in South America will be as assured as it is in Europe. The work of installation is being vigo-

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rously prosecuted, and a large number of cables have already been laid. The works, both for the conversion of the tramway system to electric traction and for installation of the electric light, have been entrusted entirely to the Allgemeine Elektricitäts Gesellschaft of Berlin, under special agreement concluded with the London board, which is a guarantee that the work in every respect will be carried out in the most efficient manner. Accompanying the report is a report of the Allgemeine Elektricitäts Gesellschaft, which gives an interesting resumé of the work that has been accomplished in connection with the conversion of the tramways and the electric lighting installation.

Mexico Electric Tramways (Ltd.).

The directors, in their report for the year ended 31st December, state that after placing £5,000 to a betterment fund, there is a balance profit of £29,852. A dividend of 12½ per cent. has already been declared by the Mexican Board on the ordinary shares of the Mexican Co., and the balance of £4,852. 3s. 6d. has been carried forward. This dividend covers the three years, 1897, 1898, 1899. The London board recommends a dividend of 6 per cent. on the preference shares and a further dividend of 5 per cent. on the ordinary shares, which will absorb £25,603. 13s. 4d., leaving £1,069. 5s. 4d. to be carried forward. During the year the company issued £130,000 6 per cent. debentures (balance of £400,000), to pay for the first section of reconstruction of the lines. This company is also now the owner of the total share capital of the Ferrocarriles Co. The results of the working of the tramways for the year show a considerable increase of traffic, which will increase as the proposed conversion of the system is completed. Of about 150 miles of single line of tramway track about 17 miles is operated by electricity, 19 miles by steam and 125 miles by animal traction. During the past twelve months the earnings were £190,347. 14s. 7d., against £179,523. 18s. 1d. for the previous twelve months. The expenditure, during the same period, shows a decrease of £1,880. 17s. 6d. Since that portion of the system which has been converted to electricity was opened to traffic, the monthly returns of passengers carried have shown a gratifying increase.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—A meeting was held at Liverpool on Friday. The Chairman (Mr. W. Chadburn) remarked that considering the increase in the turnover during the year the result was perhaps not quite so good as they might have anticipated, but adverse circumstances had prevailed in the continued abnormally high price of material, against which they could obtain no corresponding increase of price for their goods. They had a great number of orders on hand—in fact, the prospective work was quite as good as could possibly be expected, and the future was very promising.

CITY AND SOUTH LONDON RAILWAY CO.—A special meeting of this company was held on Tuesday to approve the bill now before Parliament to confer further powers on the Baker-street and Waterloo Railway Co. The chairman (Mr. C. G. Mott) said the bill provided for extending the Baker-street and Waterloo line to Paddington station, and, by a subway, to the City and South London Co.'s Elephant and Castle station. It would be very much to the interests of both companies, and also for the public convenience, thus to connect the traffic of north and south London. The bill contained powers for the two companies to make arrangements in the future for the joint supply of power or the working by the City and South London Co. of the Baker-street line. The resolution was carried. The chairman said that the Clapham and Moorgate-street extensions had been opened and both were going on satisfactorily.

SUSSMANN ELECTRIC MINERS' LAMP CO. (LTD.)—The report of the directors to Dec. 31 states that the Sussmann miners' lamp has become an accomplished working success. The first colliery to test the lamps on a large scale was the South Hetton (Co. Durham) Coal Co., who took 600 lamps on hire for upwards of 12 months. The result of the trial was that they purchased the lamps outright, and eventually ordered a further 400, making 1,000 in all. The adjacent collieries of South Moor and Craghead also placed an order to light one of their pits with 300 lamps on hire in Aug., 1898, which gave such satisfaction that they afterwards also purchased the lamps outright, and in March, 1899, ordered a further 400, making 700. A first order has been executed for an important colliery in New South Wales, while a trial order has been also given by a New Zealand colliery. The lamps have also been tested, with excellent results, in one of the large South Wales collieries. With all these satisfactory results there is a difficulty in inducing colliery proprietors to adopt electric lamps in lieu of existing oil lamps, partly from the greater initial cost and partly the inability of electric lamps to indicate the presence of gas. The directors have endeavoured to meet the first point by reducing the selling price. Sample orders have been executed for various Government departments, including the Royal Arsenal, the Royal Gunpowder Factory, H.M. Dockyards at Portsmouth and Devonport, all of which the directors believe have given complete satisfaction. It is evident, however, says the report, that either further capital must be found, or that the company must suspend operations and go into liquidation. The directors having in view the work that has been accomplished and the success that has been achieved in the lamp itself, believe that an issue of debentures is warranted, and propose an issue of £5,000. The sale of the French and Russian patent rights of the company have been for a long time under negotiation, and a sum of £500 has been paid for the right to acquire them. The prospects of the company that acquired the Belgian rights are reported to be satisfactory. The use of the Sussmann lamp is now expressly authorised by the Belgian Government in some of the principal mines of that country.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRIANNE ELECTRIC LAMP CO. (LTD.)—This company was registered on June 6, with a capital of £30,000, in £1 shares, to enter into an agreement with Mr. M. Hill for the acquisition of certain patents relating to electric lamps, and to carry on the business of electric and other lamp manufacturers, makers of electrical fittings, accessories, appliances, and apparatus, &c. The subscribers are W. Townsend, H. M. Delacour (engineer), Ella Dawson, W. W. Ellwood, H. Clegg, C. C. Willson, and S. Napier. The first directors are J. B. Whyte, M. Kilner, and W. Townsend.

GATESHEAD ELECTRIC AND MECHANICAL SUPPLY CO. (LTD.)—This company was registered on June 6, with a capital of £1,000 in £1 shares, to acquire the business carried on by J. A. M. Collier, and to carry on the business of electricians, suppliers of electricity, mechanical and electrical engineers, makers of electrical appliances, &c. The subscribers are W. E. Brown, S. A. Brown, J. A. M. Collier (electrical engineer), T. Romanis, J. B. Mennie, R. C. Twibell, and W. Brown. The first directors are J. B. Mennie, T. Romanis, and J. A. M. Collier (manager).

JOHN MARSTON'S CARRIAGE WORKS (LTD.)—This company was registered on May 25 with a capital of £75,000, in £1 shares, to carry on business as manufacturers of and dealers in electric, steam, oil, gas, and other motor cars and vehicles at Birmingham.

MOTOR WHEELS (LTD.)—This company has been registered with a capital of £100, in £1 shares, to manufacture and deal in electric and other motors, motor carriages, &c.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—According to the annual return to March 29 the capital is £199,500 in 27,900 ordinary and 12,000 preference shares of £5 each, of which 19,661 ordinary and 12,000 preference have been taken up. £5 has been called up on each of 18,661 ordinary and 12,000 preference, and £153,305 has been received.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The annual return to April 14, gives the capital as £50,000 in 10,000 shares of £5 each, all of which have been taken up and paid for in full.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—The annual return to April 13 gives the capital as £20,000 in 3,900 ordinary shares of £5 each and 500 founders' shares of £1 each, of which 2,488 ordinary and 500 founders' have been taken up. The full amount has been called up on each share and £12,942 has been received, including £2 paid on two forfeited shares.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The annual return to March 14 has been filed. The capital is £300,000 in 30,000 ordinary and 30,000 preference shares of £5 each, all of which have been taken up and paid for in full.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The annual return to May 14 gives the capital as £450,000 in 18,000 shares of £25 each, 17,000 of which have been taken up and paid for in full.

NORWICH ELECTRICITY CO. (LTD.)—The annual return to April 4, gives the capital as £100,000 in £10 shares, 7,000 of which have been taken up and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (June 14, 1900). Price of silver 27 1/16d. per oz. (June 14). Consols (2¾ per cent.) 101⅛—101⅝ for money, 101⅝—101¾ for account; 2½ per cent. 99—100 (June 14). Stock Exchange Settling Day: Consols, July 4; Stocks and Shares Continuation Days, June 26 and July 10; Ticket Days, June 27 and July 11; Pay Days, June 28 and July 12; Mining Share Carry-over Days, June 25 and July 9.

AKTIEN-GESELLSCHAFT ELEKTRICITATSWERKE VORM. O. L. KUMMER AND CO.—A dividend of 10 per cent. has been declared for the past year, against 11 per cent. in 1899.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register holders of debenture stock of this company will be closed from 18th to 30th inst. inclusive.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The transfer books of the preference and ordinary shares and debenture stock of this company are closed from the 13th to the 30th inst. inclusive, for the preparation of interest and dividend warrants.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.).—Notice is given that the transfer books and register of holders of the £400,000 5 per cent. redeemable debenture stock of this company will be closed from 18th to 30th inst. inclusive.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING CO. (LTD.)—Mr. C. H. Reynolds, C.I.E., late Director-General of Telegraphs to the Indian Government, has been elected a director of the Consolidated Telephone Construction and Maintenance Co. (Ltd.), the Anglo-Portuguese Telephone Co. (Ltd.), and the Edison-Gower Bell Telephone Co. of Europe (Ltd.).

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHT CO. (LTD.)—The transfer books and register of holders of debenture stock of this company will be closed from 18th to 30th inst. inclusive.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LTD.)—It is reported that the directors, with the exception of Mr. John A. Mylrea, have disposed of their shares and are no longer qualified. A petition is to be presented to the Deemster in Chambers for winding up the company, and asking for the appointment of Mr. W. H. Walker, one of the liquida-

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tors of Dumbell's bank, as liquidator. The meeting of shareholders stand adjourned till to-day (Friday).

MUNICIPAL ISSUES.—Bristol Corporation are making an issue of £500,000 £3 per cent. stock, a portion of which is to be utilised for electric lighting extensions.

London County Council has this week issued a 3 per cent. loan at £97 10s. for £5,000,000.

NATIONAL TELEPHONE CO. (LTD.)—The tranafer books of the 3½ per cent. and 4 per cent debenture stocks of this company will be closed from 18th to 30th inst. inclusive.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—Subscriptions are invited up to this day (Friday) to an issue of £150,000 3½ per cent. debenture stock in this company, offered at £96 per cent., redeemable at par on or after Jan. 9, 1931, at six months' notice, or at 102½ per cent. in the event of the voluntary liquidation of the company, or after Jan., 1911, at six months' notice. The company has a capital reserve fund of £74,493 employed in the business. The net profit earnings for the past five years has increased from £14,580 in 1895 to £31,834 in 1899. The sum required to pay interest on the £150,000 debenture stock now issued, when fully paid up, is £5,250 per annum. The whole of the share capital of the company (£300,000) has been issued and is fully paid, and the debenture stock now open to subscription is secured by a trust deed, which conditions that the company shall not create any mortgage or charge upon any of its freehold property in such a way that it shall rank *pari passu* or in priority to this debenture stock, for which the directors have power to issue from time to time a total amount equal to one-half the subscribed share capital of the company for the time being.

STOCK EXCHANGE NOTICES.—Wednesday, 27th inst., has been appointed a special settling day in 180,000 £1 fully-paid vendors' ordinary shares (Nos. 1 to 180,000) and 25,000 £1 fully-paid vendors' 7 per cent. non-cumulative preference shares (Nos. 115,001 to 140,000) of *Nernst Electric Light (Ltd.)*, and the further issue of 12,500 £5 fully-paid 6 per cent. cumulative preference shares (Nos. 27,501 to 40,000) of the *British Insulated Wire Co. (Ltd)* has been ordered to be quoted in the Official List.

SUNDERLAND TRAMWAY CO. (LTD.)—At an extraordinary meeting of this company on Tuesday it was resolved, consequent upon the purchase of the undertaking by the Corporation, to wind up voluntarily, and to appoint Sir E. T. Gourley, M.P., and Mr. G. Haswell (directors), and Mr. J. W. Alison (secretary) as liquidators. The lines are now being equipped electrically by the Corporation on the overhead trolley system.

WESTERN UNION TELEGRAPH CO.—The usual quarterly dividend of 1¼ per cent. is recommended. The statement of earnings, partly estimated, for the quarter ended June 30 shows net receipts $1,700,000, increase $47,000; balance after charges $1,475,000, increase $47,000; surplus after dividend $258,000, increase $47,000. The total book surplus is $8,556,000, increase $489,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways	June 9	5,503	+1,138	22	96,727	+ 5,867
Blackpool Corporation...	„ 7	1,316	+ 793	10	4,587	+ 383
Blackpool and Fleetwood	„ 9	1,833	-1,193	23	7,728	- 283
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 10	788	+ 388	10	4,921	+ 1,186
Brisbane Trams	Apl. 25	1,749	+ 438	4	7,117	+ 1,863
*Bristol Trams & Carriage	June 8	4,708	+1,549	23	65,458	+ 2,695
*Buenos Ayres & Belgrano	May 13	2,158	- 52	19	43,544	+ 5,205
City & South London Ry.	June10	1,501	+ 613	23	29,253	+ 5,172
Dover Corporation	„ 9	270	+ 88	10	1,928	+ 205
Dublin United	„ 8	4,353	+ 743	23	75,886	+13,689
Dublin Southern Dist...	„ 8	1,255	+ 160	23	18,536	
*Glasgow Corporation ..	„ 9	10,497	+ 610	...	...	...
Hull Corporation	„ 9	1,568	...	49	37,367	...
*Liverpool Corporation..	„ 2	7,829	+ 51	22	155,287	+18,716
Liverpool Overhead Rly	„ 10	1,781	+ 312	23	32,790	+ 995
*Sheffield Tramways	„ 10	2,828	+1,440	23	46,111	+14,323
*South Staffs. Trams...	„ 8	1,226	+ 581	23	15,561	+ 1,032

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 6.	Price Wednesday, June 13.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending June 13. Highest	Lowest
			TELEGRAPHS.						
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	103 10¼	100 10¼	3 17 4	January and July.....	...	...
26,000	10	...	Amazon Telegraph.....	... ...	... ...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£333,720	Stock	15/0	Anglo-American	62 65	61 64	5 15 5	Feb., May, Aug., Nov.	...	...
£3,038,640	Stock	30/0	Do. Preferred	114½ 115½	114 115	5 5 3	„ „	11½	11½
£3,038,640	Stock	27/0	Do. Deferred	13½ 14	13 13½	10 0 0	„ „	13⅞	13⅝
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 10½	102 10½	3 17 0	„ „	102⅜	...
16,000	10	6/0	Cuba Submarine Ordinary	7 8	6½ 7½	9 6 8	February and August	7	...
6,000	10	10/0	Do. Preference 10 per Cent.	16 17	15½ 16½	6 1 3	„ „	16¾	1⅝
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101% 105%	101% 105%	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	1⅞	11½
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100 103	101 103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	150 155	4 10 4	Jan., Apr., July, Oct.	152	150
£1,426,898	Stock	3½%	Do. 3½ per Cent. Preference Stock	97 100	97 100	3 10 3	„ „	93	...
£1,432,368	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	11⅛	...
250,000	10	6/6	Eastern Extension	15 15⅛	14½ 14⅝	4 14 11	Jan., Apr., July, Oct.	15⅛	14⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 117	113 117	3 9 2	February and August	...	...
£8,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb.,1900 (reg.) ...	100 103	100 103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	103% 103%	103% 103%	3 17 8	May and November ..	...	...
120,237	10	2/6	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11⅝	1⅛
120,042	10	3/0	Do. 6 per Cent. Preference	15½ 15⅝	15 15½	3 17 5	„ „	15⅝	15
150,000	10	15/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July.....	...	...
£86,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	100 103	100 103	4 8 0	June and December ...	...	...
17,000	25	37/6	Indo-European	53 57	53 57	4 7 9	May and November ...	55	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	103 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October.....	8⅛	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124 129	124 129	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
20,008	2½	...	West Coast of America	⅛ 1	⅛ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	103 103	3 14 7	January and July.....	...	...
98,321	10	1/0	West India and Panama	⅝ ¾	⅝ ¾	...	May and November ...	⅝	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7⅛	6½ 7⅛	8 0 0	„ „	6⅜	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	106	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	103 105	103 105	3 17 4	June and December ...	...	...
207,980	10	2/0	Western Telegraph (late Brazilian Submarine)	14½ 15½	14½ 15	4 13 4	Mar., June, Oct., Dec.	14⅛	14½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	103 108	105 108	4 13 10	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
324,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	... ...	... ...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¼ ½	¼ ½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National	4⅞ 5⅛	4⅞ 5⅛	5 17 1	February and August	4⅛	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 15	13 15	4 0 0	„ „	13⅛	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5½	5 5½	4 15 3	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	98 101	3 10 3	June and December ...	98	...
171,504	1	0/3	Oriental	⅛ 1⅛	⅛ 1⅛	4 14 1	April and October.....	1	⅛
58,000	5	2/6	United River Plate	4½ 5	4½ 5	4 10)	July	...	...
16,689	5	1/4	Do. 5% Cumulative Preference	4½ 5½	4½ 5½	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 108	103 108	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, June 6.	Price Wednesday, June 13.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 13	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7 7½	6¾ 7¼	...	...	6¾	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	8½ 9½	9 10	4 10 0	February and August	9⅛	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6	5½ 6	3 15 0	,, ,,	...	...
†34,000	5	3/6	Chelsea Electricity Supply Ordinary	6½ 7½	6½ 7½	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	109 112	4 1 10	June and December	110½	110
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	109 110	109 110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	9½ 10½	9 10	4 0 0	February and August	9⅝	9½
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½ 13½	12½ 13½	4 8 11	January and July	12¹⁵⁄₁₆	...
£100,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124 129	124 129	3 18 11	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½ 10½	9 10	4 0 0	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½ 12½	11½ 12½	4 16 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	110 113	110 113	4 1 1	...	113½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	7 7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1½ 2	1 1½	...	...	1⅛	...
49,840	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½ 14½	13½ 14½	3 9 0	April and October	14⅜	14
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	113 116	3 18 11	June and December	...	...
£125,000	Stock	2¼/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 99	97 99	3 11 6	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½ 7	6 6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	⅝ ¾	⅝ ¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15	...
21,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	,, ,,	...	...
14,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4 4½	3½ 4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	13½ 14½	13 14	4 12 10	March and September	13⅞	14½
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾ ⅞	¾ ⅞	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	¾ 1	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1⅛ 1⅛	1⅛ 1⅛	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4¾ 5¼	4¾ 5¼	...	...	...	...
90,060	2	1/2½	Brush Electrical Engineering	1¾ 2	1¾ 2	4 0 0	September	1⅞	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	2 2¼	2 2¼	5 6 8	,,	2	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 114	109 114	3 19 10	February and August	...	...
£103,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 5 9	June and December	...	...
20,000	5	10/0	Callender's Cable Construction Ord.	13½ 14½	13½ 14½	5 3 5	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	,, ,,	5⅞	5¹⁵⁄₁₆
£30,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 116	112 116	3 18 5	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 18 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞ 1½	⅞ 1½	5 6 8	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
32,098	3	1/9½	Crompton and Co. (Nos. 1 to 32,093)	3½ 4	3½ 4	4 10 9	January and July	3¹⁵⁄₁₆	3⅝
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 19 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2 2½	2 2½	7 3 9	February and August	2	...
17,139	5	2/9½	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord.(fully pd.)	4½ 5	4½ 5	6 0 0	Half-yearly	4⅞	4¹⁵⁄₁₆
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101 104	101 104	...	...	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2 2½	2 2½	5 6 8	January and July	...	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½ 3¼	2½ 3¼	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 103	103 103	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13½ 14½	13 14	6 15 9	February and August	13½	13½
30,000	5	1/6	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 13 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	2⅜	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	34 38	34 38	4 14 6	March and July	35½	36
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	11½ 12½	11½ 12½	2 16 0	...	1⅞	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	11 12	11 12	5 0 0	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7½	6½ 7½	4 2 9	,, ,,	6½	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	101 103	101 103	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½ 18½	17½ 18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102 104	103 104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½ 23½	22½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£3 paid)	8½ 8¾	8½ 8¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10¾	10½ 10¾	4 13 0	May and November	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15½ 15¾	15½ 15¾	3 12 9	...	16⅜	15⅝
15,000	10	...	Do. (Nos. 60,001 to 75,000)	15½ 16½	15½ 16½	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12 13	12 13	4 12 4	February and August	12¼	12⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126½	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	120 123	120 123	...	...	...	...
40,000	5	2/8⅜	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5 5½	5 5½	5 14 4	...	...	...
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 105	101 103	4 16 5	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stk. Prov. Certs (£57½% to be p.l.)	37 40	37 40	...	...	...	...
206,297	10	3/0	Central London Ordinary	10 10½	10 10½	2 17 2	June and December	...	...
£355,000	Stock	1¼%	City and South London Railway Con. Ordinary	65 68	65 68	2 15 2	February and August	67½	68
370,500	10	1/5⅛	Do. (Nos. 22,501 to 30,000)	6 7	6 7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	,, ,,	...	...
£200,000	Stock	5%	Do. (1893)	132 137	132 137	3 13 8	...	...	...
£214,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123 128	123 128	3 2 6	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½ 23½	22½ 23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debentures	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	⅜ ⅝	⅜ ⅝	32 0 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	½ ⅝	½ ⅝	19 4 0	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅛ 10⅛	9⅛ 10	5 0 0	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9¼ 9¾	9¼ 9¾	4 0 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13¾	13½ 13¾	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4	3½ 3¾	...	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4¾ 5¼	4½ 5¼	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 18	16 18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅝ 10¾	10⅝ 10¾	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100 103	100 103	2 18 10	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,153. [No. 9. Vol. XLV.] FRIDAY, JUNE 22, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 80fr., or 70m.

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NOTES.

As announced in our report on another page, the fifth annual convention of the Municipal Electrical Association opened last Wednesday at Huddersfield, under the able presidency of Mr. A. B. MOUNTAIN. Owing to the comparative smallness of the town selected, and the large body of members and guests who assembled, considerable difficulty was experienced in finding adequate accommodation, many having to seek quarters in the neighbouring larger town of Leeds, where the meetings of to-day and to-morrow are to be held. With a full programme this year, and a more evident intention on the part of the members to make the occasion less of a picnic than in former years, it is probable that the Huddersfield convention will yield results of solid and lasting value.

MR. MOUNTAIN, in his presidential address, contented himself with the useful service of placing on record the principal directions in which the Association has done good to the public and the profession in the past, and the ways in which it may increase its field of usefulness in the future. There is no doubt that the Municipal Electrical Association supplies a real want, and has abundantly justified its existence. We would, indeed, go further than Mr. MOUNTAIN and express the view that the time has now arrived when the Association should launch out into still deeper waters. A more ambitious career should be mapped out for it by those who have its destinies under their immediate control. To this end a greater degree of permanent organisation may be recommended. With a permanent local habitation, and under the direction of a permanent paid secretary possessing the requisite business and technical ability, the Association would speedily develop into a powerful organisation capable of safeguarding thoroughly the interests of the municipal electrical industries.

OUR readers will not have forgotten the extreme difficulty experienced a few years ago, even by the most skilled manipulators, in reproducing experiments with Hertzian rays with sufficient certainty to serve as lecture demonstrations. Familiarity with the means of producing and detecting electrical waves has now so much increased that, with comparatively simple apparatus, Dr. FLEMING was able to show with ease at the Royal Society's *conversazione* last night a number of the properties of ether waves of about 4in. wave-length. The radiator was simply a pair of brass balls at the end of brass rods, placed in a zinc box open at one end, and connected to the secondary of an induction coil through short choking coils of gutta-percha covered wire. These coils are an important detail, as, if they are absent, electrical radiations are emitted from the connecting wires and terminals of the coil and lead to disturbing effects. The receiver consisted merely of two wires dipping into a small ebonite box of nickel filings, placed in a similar box to the transmitter. The wires from the coherer to the metal box containing the relay and bell must be protected from the waves, although Prof. FLEMING found that the cover of this box could be left open without any disturbing effect. If, however, the connecting wires between the receiver and box are not covered throughout with a conducting sheath sealed into the metal box, they can collect waves and produce disturbance. Prof. FLEMING even experienced trouble when he employed flexible "steam-tight" tubing in place of ordinary lead tubing—probably owing to its electrical resistance being too high.

THE experiments themselves were those mentioned by Prof. FLEMING in our correspondence columns on June 1st. It was interesting to see that waves, which would pass through several dry bricks placed together, were absorbed by a single wet brick, a wet duster, a piece of metal foil, the hand, or even a fairly coarse metal grating. The opacity of insulating liquids with high dielectric constants, such as pure water and alcohol, was clearly shown, as well as a pretty experiment with a block of ice which was transparent only so long as its surface was dry. Tobacco in a

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dry condition being transparent to the waves, Prof. FLEMING suggested this test as a means of determining whether its contents of moisture exceeded the legal limit. Refraction and total reflection were clearly shown with 60deg. and right-angled prisms of paraffin wax of a size easy to handle, and the concentration of a beam by a wax plano-cylindrical lens was also quite successful. Reflection by sheets of metal, the hand, or a grating parallel to the lines of electric force was clearly demonstrated, and last, but not least, Prof. FLEMING exhibited to a select few the interference experiment (referred to in the letter already mentioned), of splitting a wave into two parts by metal mirrors at 45deg., and passing each through the two sides of a double U-tube of metal, one path being made half a wave-length longer than the other.

OTHER electrical exhibits at the *conversazione* can be mentioned only briefly. Prof. HELE-SHAW and Mr. HAY again exhibited their experiments in stream-line motion analogous to lines of magnetic induction; among which was a beautiful representation of the lines flowing through a toothed armature. They have made calculations and accurate measurements to determine the degree of correspondence between the two phenomena, and promise a Royal Society Paper on their results. Prof. S. P. THOMPSON repeated the curious demonstrations of the "aberration called coma," which he exhibited at the Physical Society last month, and Prof. DALBY's adjustable model to show the difference between a balanced and unbalanced 4-crank engine attracted much attention, the ease with which the piston masses and crank angles can be adjusted being particularly noteworthy. These exhibits vied for the ladies' approbation with a bullet in a leg of mutton, exhibited by Mr. J. MACKENZIE DAVIDSON with the aid of his "stereoscopic fluoroscope," which has undergone some improvements in detail.

ONE of the unsolved problems of the undulatory theory of light is the condition of the ether inside material bodies. This is a problem somewhat apart from that which Lord KELVIN discussed at the Royal Institution recently, when he sought a *constitution* for the ether capable of permitting the passage of light-waves through it, and yet apparently possessing no "drag" when matter moved through it. The experiments of MICHELSON and MORLEY, of LODGE and others, indicate, as clearly as modern experimental science is capable of doing, the absence of such "drag," and hence the difficulty of formulating a satisfactory constitution for the ether, a difficulty which, to Lord KELVIN's mind, appears to be insuperable.

M. G. SAGNAC, however, in the April number of the *Journal de Physique*, has put forward an hypothesis which appears to us so simple and easy of understanding, that we cannot but believe it must have already presented itself to other physicists. The characteristic feature of this method of viewing the question consists in regarding the ether inside material bodies as identical in wave-propagating capacity to the ether in free space. The retardation experienced by a ray of light in passing through a transparent body is then explained by assuming discontinuities of the waves at the surfaces of the molecules themselves, in consequence of which the rays are reflected to-and-fro and from molecule to molecule—the passage being a fortuitous one, the ray struggling, as it were, to find a path through the ether, which it only succeeds in discovering after numerous trials and exceeding great difficulty. The optical length of the path is increased during these wanderings, and accounts for the observed retardation. As in the ordinary wave-theory, the rectilinear propagation of a plane wave follows from the smallness of the molecule, compared to the wave-length. The size of the molecules is approximately of the order $10^{-3}\lambda$, or, if it be J. J. THOMSON's "corpuscles" which are concerned in obstructing the passage of the ray, the size is of the order $10^{-7}\lambda$—dimensions altogether too small to produce any appreciable diffraction effects. Reflection and transmission of light in bodies, as well as transparency and opacity, evolve themselves readily and simply from this fundamental hypothesis, and an expression for the retardation of a plane wave in passing through a thick plate is deduced which corresponds exactly with experimental results. The apparent absence of "drag" in the ether is also fully accounted for.

BUT it is all too simple. It seems unreasonable to expect that a complete and satisfactory wave-theory should be constructed on such modest and simple foundations. Scientific thought has made a very great advance in the present century, in that it has fully recognised that simplicity is not the necessary accompaniment of truth. The Ptolemaic system preceded the Copernican, and the emission theory of light gave place to the undulatory theory—the accumulation of scientific facts has introduced greater complexity into every science, as such, and we must anticipate complex theories in the case of a science whose range is at all extensive. This is brought home very forcibly in the case of M. SAGNAC's new theory briefly sketched above. No sooner is one difficulty brushed aside than another leaps up in its place; in attending to some only of the diseased organs, the others have made themselves more painfully evident. Although the absence of "drag" between ether and matter is accounted for by this hypothesis, we must remember that in other respects the hypothesis is unacceptable. An ether which is unaffected by the presence of gross matter is an anomaly, and is almost inconceivable. There must be some effect due to the loading of the ether by the molecules of matter immersed in it, which would have the effect of increasing the inertia—not the weight, for the ether has no weight—of the ether in the intermolecular, or, as J. J. THOMSON might say, inter-corpuscular space. There is no room for such an effect in M. SAGNAC's theory, and there will have to be considerable trimming of his sails before the barque which he has launched on the troubled waters of ether theories can safely steer clear of the rocks and shoals lying in its way, and at the same time carry on board all the known facts of optics.

THE report of the directors of the British Electric Traction Co. (Ltd.) (an abstract of which was published in our last issue) and the accounts of the company for the 15 months ended March 31st last, indicate a highly prosperous financial condition. The British Electric Traction

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Co. controls, or is negotiating for the control and working of, no less than 57 tramway undertakings in the United Kingdom, many of which are actually in operation or under construction. Besides this, the company is making arrangements for further development of this important industry by the issue of new capital. Having in view the extremely precarious nature of tramway enterprise in former years, when horse traction was in vogue, it is satisfactory to notice that dividends of 8 per cent. per annum on the ordinary shares, in addition to the 6 per cent. on the preference shares, have accrued from this extensive business, a fact which, should encourage capitalists and electrical engineers to push forward with the development of electric traction in this country.

While referring to the British Electric Traction Co. we may mention that the committee of the Associated Undertakings has recently drawn up a superannuation scheme which bears every indication of financial soundness and equity. It would be out of place here to describe the details of this scheme; they are, however, clearly set forth in a pamphlet drafted by Mr. W. G. Bond, who has had the matter in hand on behalf of the committee. Schemes of this character, by the consolidation of the interests of employers and employed, and by introducing a solidarity into the staff of a business extending throughout the entire United Kingdom, are well worth imitation by other engineering and industrial undertakings.

Society of Engineers.—About 90 members of this Society visited the Thames Ironworks yesterday afternoon in response to the invitation of The Thames Ironworks Co.

Central London Railway.—It is announced that the official opening of this line by the Prince of Wales will take place on June 27, after which date the line will be shut down and re-opened to the public on or about July 2.

Society of Arts Conversazione.—The annual conversazione of the Society of Arts was held at the Natural History Museum on Wednesday evening. The function was very well attended, but, probably owing to the Royal Society's soirée being on the same evening, several of the most eminent members failed to put in an appearance.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

Electrical Engineers (R.E.) Volunteers.—Among the casualties reported with the construction train at Leeuwspruit on the 14th inst. are the following: Severely wounded: 2nd Lieut. H. F. Bigge. Missing: Corporals G. Charlton, Sellon, A. Charlton, Colson, Landon, Pearl, and civilian servant Worcer.——The Corps of Electrical Engineers (R.E.) Volunteers will undergo its training in the Isle of Wight this year.

The National Physical Laboratory.—The Richmond Town Council have resolved "that in the opinion of this Council the proposal to erect a large physical laboratory and engineering shop in the Old Deer Park is highly objectionable." A deputation consisting of Aldermen Burt, Skewes-Cox, Roberts, and Councillors Duncan and Lucas, has been appointed to wait upon the authorities and support the objection.

The Sprague Motor Suspension Patent.—In connection with the case of the Electric Construction Co. *v.* Imperial Tramways Co., judgment on which was given in the Court of Appeal on Monday, and which is reported elsewhere in this issue, it is interesting to note that a decision in the reverse direction as to the validity of the Sprague Motor Suspension Patent was upheld in the United States Circuit Court of Appeals on May 28 in the case of the Sprague Electric Railway and Motor Co. *v.* the Nassau Electric Railroad Co.

The Electrostatic Capacity of a Tore.—In a Paper read before the Société Physico-Chimique Russe, and abstracted in a recent number of the *Journal de Physique*, a method is developed by M. Boulgakoff for calculating the value of a tore of certain dimensions. For a surface generated by the revolution of a disc 3cm. diameter, whose centre describes a circle of 30cm. radius, the capacity was calculated to be 10·8253 electrostatic units. Careful measurement gave, experimentally, the value 10·82, thus conclusively justifying the accuracy of the method of calculation. It is shown as a deduction from the experiments, that a value for v can be obtained which does not exceed 3×10^{10} cm. per second by as much as $\frac{1}{1000}$th.

The Society of Arts Medals.—The Society of Arts Albert Medal for the present year has, with the approval of His Royal Highness the Prince of Wales, President of the Society, been awarded to Mr. Henry Wilde, F.R.S., "For the Discovery and Practical Demonstration of the Indefinite Increase of the Magnetic and Electric Forces from Quantities Indefinitely Small"—the principle on which the invention of the modern dynamo is based. The Society's Silver Medals have been awarded to, among others, the following readers of papers during the session 1899-1900: Sir W. Martin Conway, for his paper on "Some of the Undeveloped Resources of Bolivia," and to Prof. R. W. Wood, for his paper on "The Diffraction Process of Colour Photography."

Cape Town Local Section of the Institution of Electrical Engineers.—The first annual meeting of the Cape Town Section of the Institution of Electrical Engineers was held on May 7. According to the report of the committee of the section, the membership stood at 25, and during the year nine meetings had been held, at which various Papers had been read and discussed. The committee had intended to give an official welcome to the Electrical Engineers (R.E.) Volunteers contingent on their way to the seat of war, but unfortunately it arrived unexpectedly. Other efforts to entertain the volunteers had also to be abandoned owing to the sudden departure of the force for the front. Mr. C. Proctor Banham was re-elected chairman of the section, and Mr. J. Denham honorary secretary. The meeting then discussed "The Cost of Steam Raising."

Liverpool Overhead Railway Co.'s Tramway Extension.—This line was inspected by Col. Yorke and Mr. A. P. Trotter, on behalf of the Board of Trade, on Tuesday, and was opened to the public on Wednesday. The line at present runs from Seaforth to Waterloo—about one mile—the remaining portion to Great Crosby not being complete yet. Ordinary girder rails are used, bedded in concrete, and the streets are paved with granite setts and cubes. The line is worked on the overhead trolley system, the trolley being suspended from bracket poles. Power is generated at the company's main generating station at the Bramley-Moore Dock at a pressure of 1,200 volts, and transformed at Seaforth to the line pressure of 500 volts. The new generating plant consists of a 1,500 H.P. Browett and Lindley engine, driving a British Schuckert 800 kw. generator.

The Ultimate Cost of Bad Wiring.—A correspondent signing himself "Dead Earth," writes in the *Belfast Evening Telegraph* as follows: "We continually hear complaints of the high price the Corporation charge for current. Now this, to a large extent, is a great fallacy, for if the consumer paid only for the current he used he would find his electric bill to be extremely moderate, but, alas! (I am sorry to be compelled to state it) in a large number of cases the poor consumer is paying for current he never uses, it going to earth or leakage." Then follows a just condemnation of cheap and nasty wiring. The "fallacy," however, is the writer's. Cheap wiring is dear in the long run owing to the perpetual cost of repairs and maintenance and the difficulty of making subsequent alterations and extensions. Before the leakage current seriously affected the meter reading, the consumer's house would probably either

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be burnt down or else have been cut off, as a nuisance, by the supply station engineer.

The Cost of Private Lighting Plants.—The following figures, given in a letter by Mr. G. R. Peers to the *Drapers' Record*, are of some interest. They are for the cost of the electric lighting of a large Manchester drapery establishment for 12 months:—

Comparison of Cost of Electricity from Corporation Supply and Generating Plant in Manchester.

Units consumed in 1893 from Corporation supply, 12,500 = total cost, £260.

1899—Capital outlay on generating machinery, £560.

Lamps installed, 42 10-ampere arcs, and 40 16 c.p. incandescents.

507,000 cubic ft. gas at 2s. 3d.	£57	
Water, oil, waste, and stores	10	
Renewal of brushes and repairs	—	
Depreciation on plant (£560) at 5 per cent.	28	
Interest on capital cost of plant at 5 per cent. on £560	28	
Extra wages for attendance at 10s. per week	26	
	—	£149

Total units generated by own plant during year, 16,700; total cost of generating expenses, £149; equal 2·15d. per unit.

The Royal Society.—The following is a list of the Papers down for reading yesterday: "On the Effects of Changes of Temperature on the Elasticities and Internal Viscosity of Metal Wires," by Prof. A. Gray, V. J. Blyth, and J. S. Dunlop; "On the Connection between the Electrical Properties and the Chemical Composition of Different Kinds of Glass. Part II.," by Prof. A. Gray and Prof. J. J. Dobbie; "On the Change of Resistance in Iron produced by Magnetization," by Prof. A. Gray and Prof. E. T. Jones; "Underground Temperature at Oxford in the year 1899, as determined by Five Platinum Resistance Thermometers," by Dr. A. A. Ramabut; "On the Kinetic Accumulation of Stress, illustrated by the Theory of Impulsive Torsion," by Prof. Karl Pearson; "Lines of Induction in a Magnetic Field," by Prof. Hele-Shaw and A. Hay; "On the Spectroscopic Examination of Colour Produced by Simultaneous Contrast," by G. J. Burch; "An Experimental Investigation into the Flow of Marble," by F. D. Adams and Dr. J. T. Nicolson; and "A Criticism of the Young-Helmholtz Theory of Colour Perception," by Dr. F. W. Edridge-Green.

Owens College Physical Laboratory.—The new physical laboratory at Owens College, Manchester, will be opened on the 29th inst. by Lord Rayleigh. The new laboratory will have a larger floor area than that of any other similar institution in the world, with the exception of the Johns Hopkins and the Strasburg Laboratories. Great efforts have been made to provide an equipment of the most modern apparatus for use in every branch of physical science, and to maintain conditions which would ensure their being used to the best advantage. The research laboratories are to be an important feature of the new buildings, and are certain to attract a large number of students. Another feature is the electro-technical wing, which is to constitute a John Hopkinson memorial, and will be formally handed over by the relatives of the late Dr. John Hopkinson, on the occasion of the opening ceremony. We understand that Dr. C. H. Lees, formerly chief assistant lecturer in the physics department of Owens College, will occupy the post of assistant director of the new laboratories, of which Prof. A. Schuster is the director, and that Mr. R. Beattie has been appointed lecturer in electrotechnics.

Optical Telegraphy.—At a recent meeting of the Elektrotechnischer Verein, after a demonstration of the Zickler ultra-violet wave telegraphy (see *The Electrician*, Vol. XLI., p. 720) had been given by Prof. Strecker, Herr J. H. West described another system of optical telegraphy which, he said, would fulfil almost the same purpose as Prof. Zickler's, except that it does not include a system of calling up. In Herr West's system the transmitting station consists of a strong source of light and a plate of quartz, and the receiving station is merely another quartz plate protecting the eye of the observer. In order to transmit Morse signals, the quartz plate at the sending end is turned through an angle of 90deg. Thus in one position the polarised light will be seen, while in the other position it will not. Messages are kept secret from the ordinary observer, as the beam of light will always appear the same to the naked eye. We do not envy the operators the intense eye-fatigue in trying to pick up signals by the variations of light due to a rocking analyser. All who have tried to quench intensely strong polarised light in this way will know how unsatisfactory a signalling device this would afford.

Incandescent Lamp Standards.—A report on the subject of standard incandescent lamps was presented at the meeting of the American National Electric Light Convention, held in Chicago last month, and contained the following recommendations:—"That the National Standardising Bureau, a bill for the establishment of which is now before Congress, be requested to issue authoritative standards of light to all who should desire them. Pending the establishment of such an institution, 16 c.p. incandescent lamps of 110 volts and 220 volts are to be prepared at the Columbia University, New York City, and will be available to all members of the association at the cost price of production." Attention is called, in the report, to the fact that photometers must be adjusted by rotating the standard lamp, at its rated voltage, in the same place as the lamps to be subsequently tested. The rotation of lamps about a vertical axis is at present considered sufficient, although when lamp filaments are made with more uniform characteristics than at present, arrangements for measuring the zonal distribution might be desirable. It is recommended, also, that greater variations from the nominal wattage of a 16 c.p. lamp than 2·5 watts on either side be not permitted. With respect to the sampling, the testing is recommended of 10 lamps, taken indiscriminately from any barrel, failure of any one lamp to comply with the limits heretofore adopted by the association rendering the whole lot liable to rejection.

The Schäfer System of Wireless Telegraphy.—At a recent meeting of the Physical Society of Frankfort-on-the-Main a description was given of a system of wireless telegraphy, said to be discovered by Herr Bála Schäfer. A sheet of tinfoil is pasted to a glass plate, and the foil is cut into several strips by a sharp knife. It appears that, in ordinary circumstances, there is no absolute electrical discontinuity between the first and last strips, and a resistance of 50 ohms existed in the example cited. As soon, however, as the plate was subjected to the influence of electric waves the resistance rose to 5,000 ohms, but as soon as the waves ceased the original value of 50 ohms was resumed. Herr Schäfer has, up to the present time, been unable to find the cause of this phenomenon. He first thought it might be due to moisture on the plate, but finds that the same effect is obtained in a vacuum. In later apparatus he has replaced the tinfoil by silvered glass, the metal being divided up by several cuts, the sum of whose widths are only a few hundredths of a millimetre. The sensitiveness of the apparatus increases with the width and number of cuts up to a certain point, and then again diminishes. Either a telephone or a Morse inker can be used in the local circuit of the receiving station. It is stated, in the report of the Paper published in the *Elektrotechnische Rundschau*, that experiments were made across the Bristol Channel in the presence of officers of the British Post Office, and that the British Government has decided to make use of the Schäfer system. We learn on enquiry, however, that the latter part of this statement is not correct. Successful transmission is also said to have taken place between the shore and a moving ship in the Adriatic sea up to a distance of nearly 60 miles, a 30 cm. induction coil and a vertical wire 20 metres high being employed.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, June 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "Notes on Gas Thermometry," by Dr. P. Chappuis; (2) "A Comparison of Impure Platinum Thermometers," by H. M. Tory; (3) "On the Law of Cailletet and Mathias and the Critical Density," by Prof. J. Young, F.R.S.

TUESDAY, June 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

9 p.m. Annual Conversazione at the Natural History Museum, Cromwell-road, S.W.

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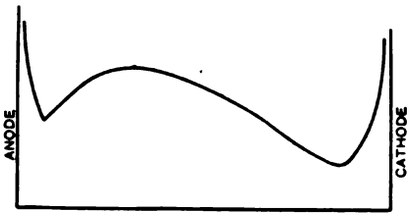
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Balloon Telegraphy.—An obstacle in the way of telegraphic communication with free balloons has been thought to lie in the impossibility of earthing the receiver. But some experiments made by J. Vallot and J. and L. Lecarme have proved that such connection is not necessary, even at great distances. No attempt was made to send signals from the balloon, on account of the danger of igniting the gas with the exciter sparks. The balloon carried a wire 50 metres long attached to the car, and the wire attached to the transmitter was held up by a small balloon. No attempt at alphabetical signalling was made, the only indicator used being an electric bell. At first the balloon ascended straight upwards, so that the two wires were in one line. This did not interfere in the least with the signalling, a fact which shows that the vertical wire is unable to produce a purely horizontal wave. Signals were received up to an altitude of 600 metres. When the balloon was at a horizontal distance of 5 kilometres, with an increase in the sensitiveness, they were perceived at a distance of 6 kilometres and a height of 800 metres. In conformity with the results obtained by the same authors in their experiments on Mont Blanc, the difference of potential between the sending and receiving stations had no influence upon the signals.

[Vallot and Lecarme, *Comptes Rendus*, May 14, 1900.]

Conductivity in a Vacuum Tube.—The apparent anomalies in the conductivity of rarefied gases are due to a variety of causes which do not come into play in the case of liquids or solids. Fundamentally, the processes of electric conduction are probably the same, and even in a wire inserted in a circuit of different material we have anything but a uniform conductivity along its whole length, owing to thermo-electric complications. Such complications, in the case of liquids, lead to an accumulation of the swifter ions in the



neighbourhood of the opposite electrode. In gases, the current also leads to the concentration of conducting particles at the anode. But this concentration is marked by the constant production of new ions at the cathode, by the activity of the cathode rays in lowering the resistance of the gas, and by heat effects. The production of undiffused ions leads to a large increase of resistance at both the electrodes. Neglecting the heat effects, which cannot be at present precisely determined, the author gives the annexed diagram as a typical representation of the specific conductivities at various points between the anode and cathode. He verifies it by sending a transverse current through auxiliary electrodes.

[J. Stark, *Ann. der Phys.*, No. 5, 1900.]

Irregularity of Liquid Interrupters.—On the strength of some mutographic records of the discharge of an induction coil worked with a Wehnelt interrupter, J. H. West (see *The Electrician*, Vol. XLIV., p. 71) maintained that the interruptions are by no means regular, and that the discharge often fails to take place for three or four successive interruptions. This defect, which is indicated by the unmelodious noise of the interrupter, might be attributed to the spark-gap of the coil rather than to the liquid of the interrupter, especially as the resistance of an air-gap is subject to rapid fluctations. To clinch the matter, E. Ruhmer has taken mutographic records of the sparks in the interrupter itself, both Wehnelt's original and Simon's improved pattern. The results show that both these interrupters are subject to considerable variations in the rate of interruption. The variations amount to 17 per cent. in the Wehnelt pattern and 24 per cent. in Simon's pattern, the excess in the latter being due to currents in the liquid not produced by electrolysis. Besides these variations, the interrupters also fail to interrupt occasionally, or at least to break the current completely. The author counted 16 failures in every hundred in the Wehnelt interrupter and nine in the Simon interrupter. So far, then, Boas's turbine interrupter has a great advantage where regularity is concerned.

[E. Ruhmer, *Elektrotechnische Zeitschrift*, April 26, 1900.]

Revolving Magnetic Flag.—Under this curious name G. Jaumann describes an ingenious apparatus for demonstrating the existence of a magnetic whirl in the interior of a conductor carrying a current. The conductor in question is a beaker filled with mercury, and the indicator is a small magnet attached with one end at right angles to a glass rod running along the axis of the beaker and mounted on pivots. Thus the "magnetic flag" is capable of rotation in a plane at right action to the direction of the current. The beaker is inserted in a tight-fitting copper vessel which furnishes the return circuit and abolishes the external field due to the current. The bottom of the beaker is perforated to admit an electrode which plunges into the mercury. To ensure that only the magnetic whirl inside the mercury influences the motion of the flag, the earth's magnetic field is compensated by suitable permanent magnets, and the glass rod or flagstaff is weighted so as to insure neutral equilibrium even out of the vertical. When the current is turned on, the flag rotates with uniform velocity, the north-seeking pole following the lines of force. The considerable work spent in overcoming the resistance and viscosity of the mercury is taken out of the current, and shows itself in a counter E.M.F. impressed upon the circuit. This counter E.M.F. disappears as soon as the mercury has acquired the angular velocity of the flag. It re-appears, but with the opposite sign, when the flag is artificially stopped, until the mercury itself has come to rest again. The flag rotates whether it is lacquered or left in the bare metallic state.

[G. Jaumann, *Ann. der Phys.*, No. 5, 1900.]

Tuning of Wireless Receivers.—The construction of receivers "tuned" so as to respond to one particular kind of wave only is subject to the difficulty that every receiver yet devised is found to respond more or less to every wave impinging upon it, owing to the excessive damping to which the wave-train emitted is unavoidably subjected. This damping does not, so to speak, allow the proper periodicity of the wave-train to assert itself. A. Blondel describes a system which he believes to possess notable advantages over those of Lodge, Marconi, and other less promising ones. The principle adopted is that of synchronising the frequency of interruption of the exciting coil and of a "monotelephone" attached to the receiver. The group of strongly damped high-frequency waves acts as a simple percussion upon the slowly vibrating telephone, and there would indeed be no difficulty in applying Mercadier's device for multiplex telegraphy to the receiving apparatus. An automatic coherer, such as that of Tommasina, is placed in series with a collecting wire, and in a branch circuit parallel with the coherer is inserted the telephone, a battery shunted by a condenser, and, if necessary, an inductance. The capacity of the condenser is so chosen that the usual relation

$$\left(\frac{2\pi}{T}\right)^2 LC = 1$$

is fulfilled where T is the frequency of charge of the mast-wire at the emitting station. There is then a kind of resonance between the branch circuit and the transmitter. If required, additional receivers with different frequencies can be branched off in the same manner, or they can be attached to special collecting wires. In this manner the same signal station may be made to receive messages from different quarters, and none of these messages can be read by an instrument not tuned to unison in the same manner.

[A. Blondel, *Comptes Rendus*, May 21, 1900.]

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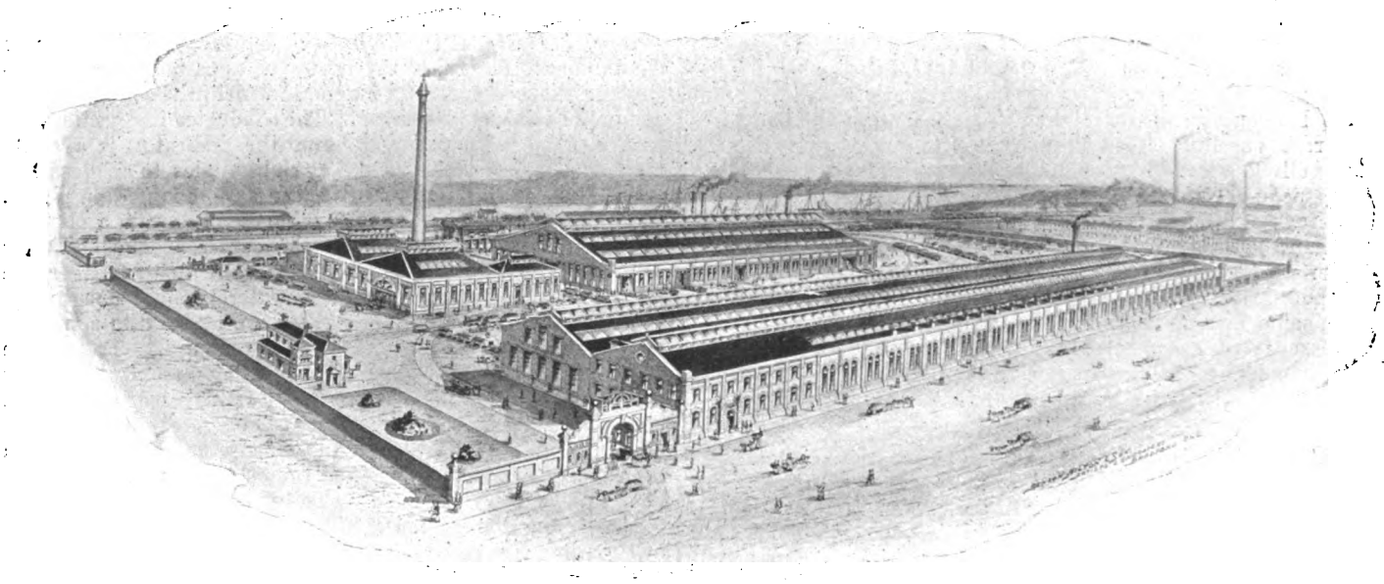
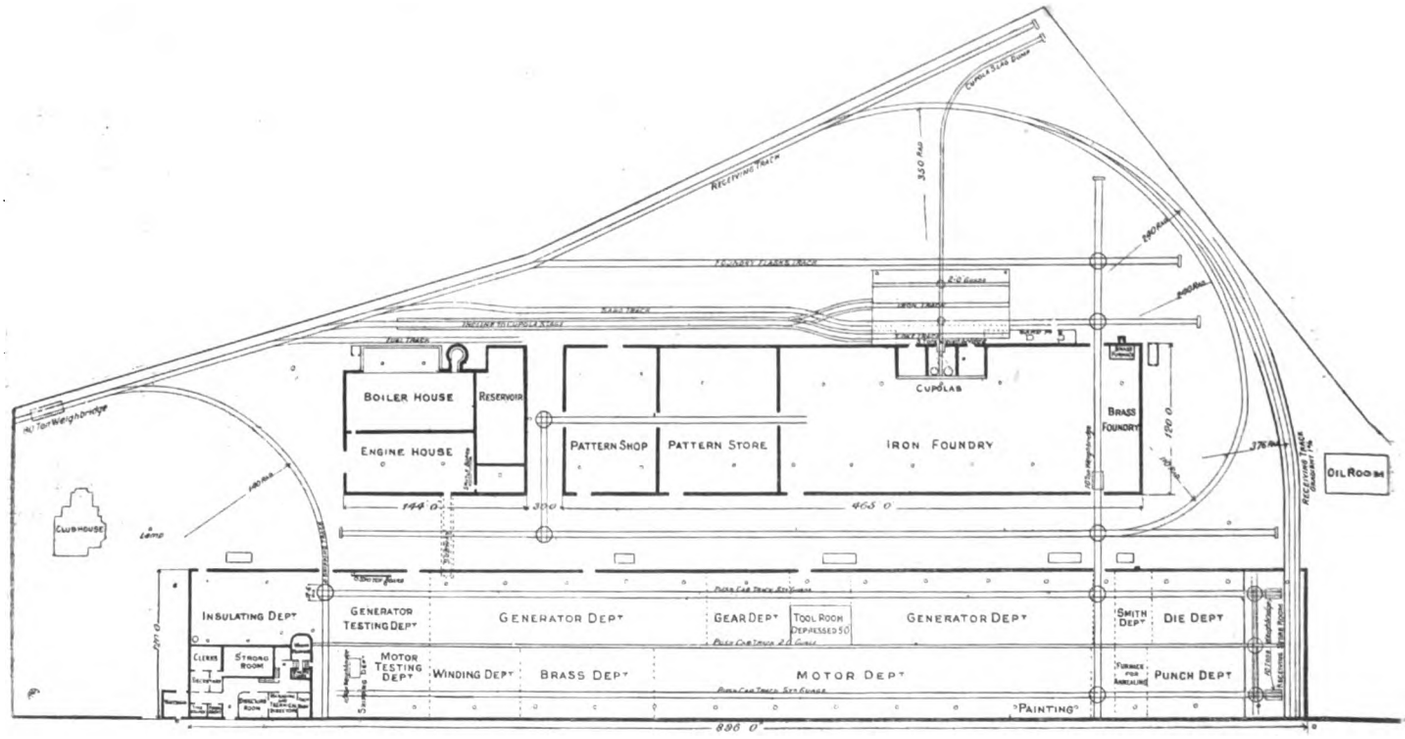
THE NEW WORKS OF THE ENGLISH ELECTRIC MANUFACTURING CO. AT PRESTON.

Organisation.—Our readers who are interested in electric traction are aware that less than two years ago certain gentlemen closely connected with traction undertakings, foreseeing the extent to which the demand for tramway rolling stock was likely to exceed the supply from existing number of the shareholders in this undertaking were equally desirous of embarking in the collateral but much more important work of manufacturing the electrical portion of the equipment required for traction work. At the same time it was perfectly realised that to meet the competition of the



Bird's-Eye View of the English Electric Manufacturing Co.'s Works at Preston.



Plan of the English Electric Manufacturing Co.'s Works at Preston.

shops in this country, even when augmented by American importations, organised the Electric Railway and Tramway Carriage Works (Ltd.), at Preston, and on an excellent site of 14 acres on Strand-road, near the docks, erected a large and thoroughly well equipped plant for the manufacture of car bodies and trucks. These shops, the equipment and management of which were placed in the hands of experienced and competent tramcar builders from America, have been entirely successful both in the quality of their output and in the volume and satisfactory nature of the business done. A enormous American electric shops, with their long experience and excellent equipment for the work, it would be necessary to proceed on precisely similar lines to those which had given our transatlantic competitors their predominant position in this branch of manufacturing. Manifestly to obtain this result the first step was to secure the co-operation of an American engineer and designer of the first rank who could supply manufacturing and engineering experience unobtainable in this country, yet essential to the success of the enterprise. It was at this juncture that, in the course of one of the

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periodical manias for amalgamation which take possession of our American cousins, the Walker Co., the third of the three great electrical organisations in America, was "consolidated" with one of its rivals, thus practically completing the formation of the great electrical "pool" which controls the industry in that country. The hands of Mr. S. H. Short, the managing director and technical head of the Walker organisation, whose brilliant works dating from the beginnings of electric traction in America, in 1885, is known to electrical engineers throughout the world, were thus left free to carry out a long-considered project of contributing to the further development of the industry on this side of the Atlantic. At a meeting between Mr. Short and some of the future shareholders of the English Electric Manufacturing Co. (Ltd.), an arrangement was made by which the new company was to commence operations on a large plant for the manufacture of electric traction apparatus from his designs and under his patents, and at the same time that he was to join the board as technical director to design the manufacturing plant and take full charge of its engineering and manufacturing organisation. At the end of May, 1899, all the plans for the works had been completed, and orders placed for the most complete equipment of tools and machinery which money could buy or experience suggest for the purpose. On June 14 (just one year from the opening of the finished works) excavation for foundations was commenced, and since that time the work has proceeded without a moment's delay. In this connection we may say that the completion of so large an undertaking within one year from the date of its commencement is not only without precedent even amongst our "hustling" American friends, but even more significant as indicating the aggressive energy with which the future operations of the company will be carried on.

Site.—For the site of the new works the company secured over 12 acres of level ground situated between Strand-road and the Preston Corporation docks on the river Ribble, the factories of the Electric Railway and Tramway Carriage Works being located immediately across the street. The selection of Preston as the site for the works was finally arrived at after a careful consideration of the relative advantages offered by different localities. Situated in Lancashire and therefore in immediate contact with the great producing centres for coal, iron, and other raw materials required, it possesses exceptionally good shipping facilities for the finished product of the works. It is centrally situated with respect to the home market with two great railway systems radiating in every direction, and at the same time in a position where advantage can be taken of the proximity of the great port of Liverpool for export trade to the colonies and abroad. Another and most important reason for the establishment of the works at Preston was the fact that a suitable site could be obtained alongside the Electric Railway and Tramway Carriage Works. The tramcars and trucks manufactured at these works are therefore ready to receive the motors and electrical equipments from the shops of the Electric Manufacturing Co., with the unique advantage of enabling the joint product to be completely equipped and tested before leaving the works; the advantages of this arrangement are obvious.

Buildings.—Of the 12 acres of land embraced in the company's manufacturing site, about 5 acres are under roof. The buildings, which in accordance with the practice of to-day are one storey high throughout, except in the offices, are laid out on the lines of the most modern American engineering works, a steel frame being first erected to carry the cranes and roof structure, and the sides and ends independently walled in. The foundations for the steel stanchions for the buildings themselves and for the machinery in the works are much more solid and massive than is usual for work of this kind. The principal buildings are three in number—the machine shop, with the offices; the foundry, with pattern and pattern storage shops; and the power house. Before entering in detail into a description of the equipment of the works and the method in which the various operations in the manufacture of traction machinery are carried out it is essential that we should note the facilities which are provided for receiving, shipping, and handling material.

Receiving and Shipping Tracks.—By reference to the accompanying plan it will be noticed that all incoming and outgoing goods pass in at the railway entrance over an 80-ton weighbridge. The tracks diverging from the weighbridge are, taken in order—first, the machine shop track, over which all goods are shipped out; second, the fuel track; third, the inclined track to the elevated foundry cupola staging; fourth, the sand track; fifth, the foundry flask track which can be used for storage or relief; and finally, the receiving track, on which will be noticed a side track for the storage of waggons. Following round the large curve of the receiving track it will be noticed that it enters the receiving store room at the rear end of the machine shop, the track at this end being depressed so as to bring the truck platforms level with the machine shop floors. For the handling of waggons within the yards as well as for the railway connection, and in to the yards of the Electric Railway and Tramway Carriage Works, electric locomotives are provided. The works are connected by sidings with the Lancashire and Yorkshire Railway, the London and North Western Railway, and the Preston Corporation Docks.

Machine Shop.—The largest and most important of the buildings making up the works is the machine shop, which in itself is a structure of imposing dimensions, 900ft. in length by 120ft. wide, 85ft. high in the clear, and with 25ft. head room under the cranes. From end to end, throughout the centre of this building, passes a line of double lattice work stanchions which support the roof, the crane girders, and the line shafting. In the general arrangement of the works, and especially in the detailed plans of the machine shop, it has been Mr. Short's chief object to avoid, wherever possible, the handling and re-handling of the various parts of the apparatus during the processes of manufacture. Raw materials delivered at one end of the main building pass through the successive operations always moving in one direction, and emerge at the other end finished and tested apparatus ready for loading upon the railway trucks. Exceptional attention has been paid to the matter of facilitating the progress of the material through the shops by means of powerful high-speed electric cranes supplemented by pneumatic hoists and tracks in every building. Each of the four motor cranes used in the works is arranged to be provided with lifting magnets in order that all suitable material and parts of apparatus made of iron or steel may be picked up and carried to any part of the shop without other manipulation than that of the operator handling the crane. By means of jib cranes and pneumatic hoists the men operating machines will be able to lift into their tools pieces weighing from 1 ton to 2 ton each. Down each bay of the shop is laid a push car track with an additional track in the centre of the shop running between the stanchions which support the counter-shafts, cranes, and roofs. It will thus be seen that in addition to the four large cranes provided in the machine shop there are three tracks running its full length, thus giving seven methods of handling material up and down the shop. To facilitate communication between the various parts of the works a telephone system is provided extending from the offices to all departments. Compressed air at 100lb. pressure is distributed to every part of the works, and used in the operation of pneumatic drills, hammers, &c., as well as for operating the pneumatic hoists.

The machinery throughout the works is operated by electric power from the generating station. The limits to which the principle of sub-division of power into small units could be advantageously extended has been most carefully considered. The resulting arrangement in so far as the machine shop is concerned represents entirely new practice, and is worthy of being described in some detail. As has been stated, a sectional line shaft extending the full length of the machine shop is supported from the line of centre stanchions between the two bays of the shop. The sections of this shaft are driven by individual 50 H.P. motors, direct connected to them by means of a quill shaft and clutch. The 800ft. of shaft is divided into eight sections; any section of the shafting can be driven by its own motor, or the whole can be driven by any one or more motors. All of the machine tools used in both bays of the shop are thus driven from the one line shaft, except in the case of the larger tools, where individual motors

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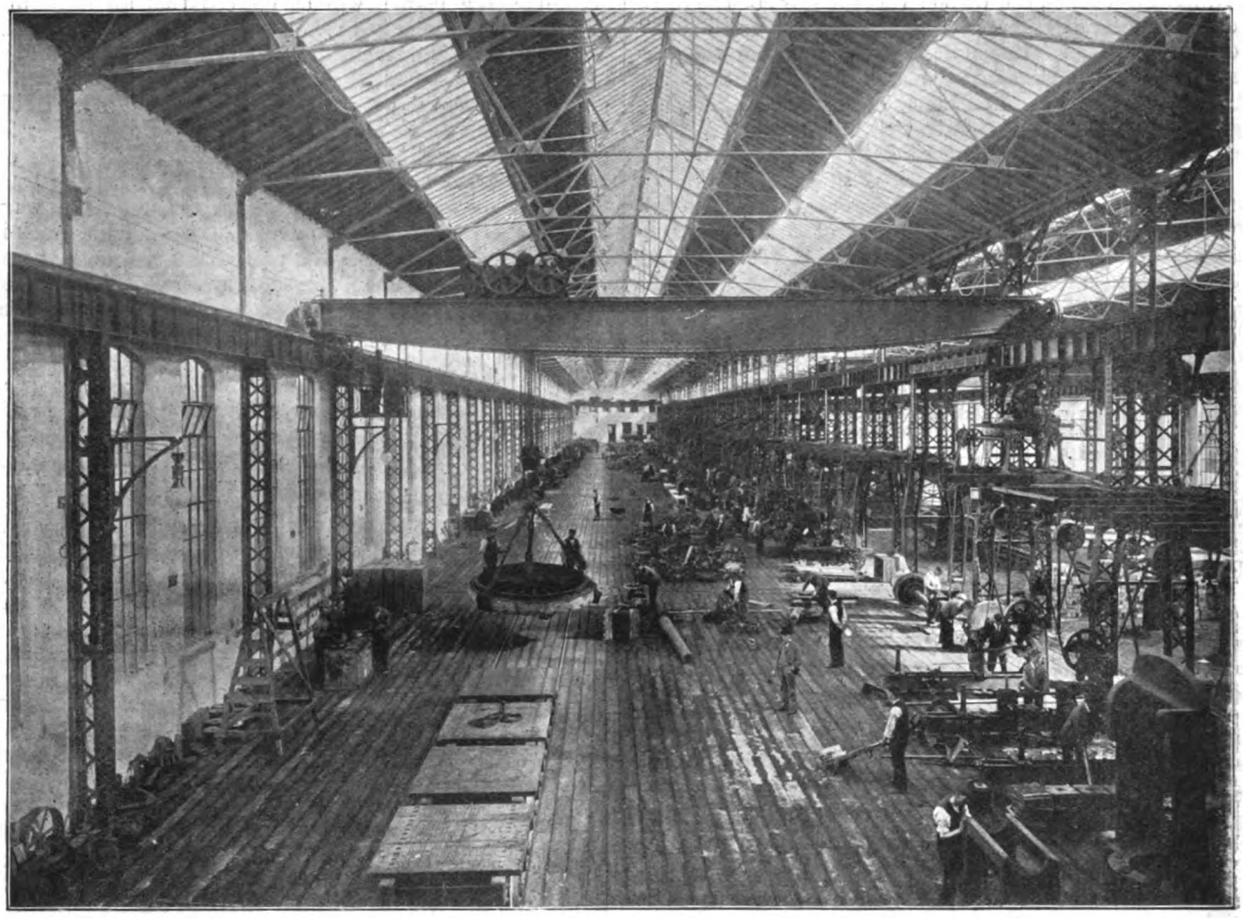
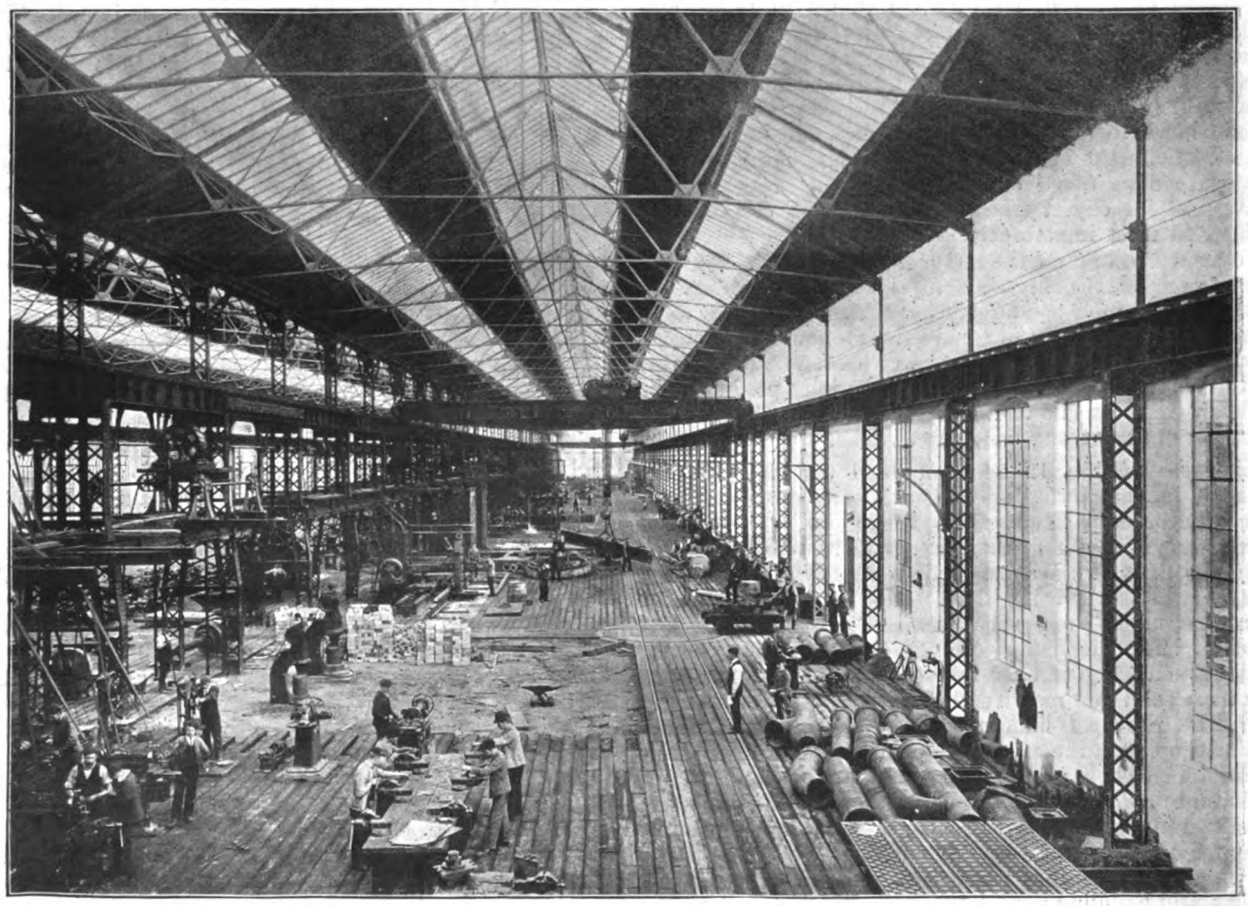


MACHINE SHOP: MOTOR AND FITTINGS BAY.



MACHINE SHOP: GENERATOR BAY.

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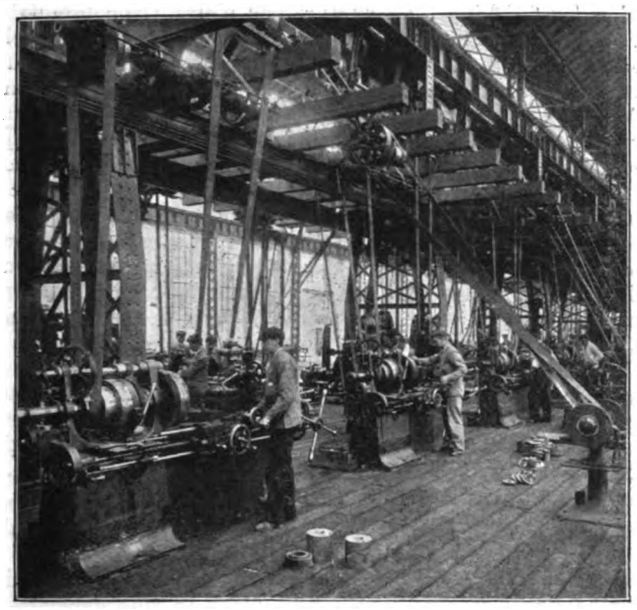
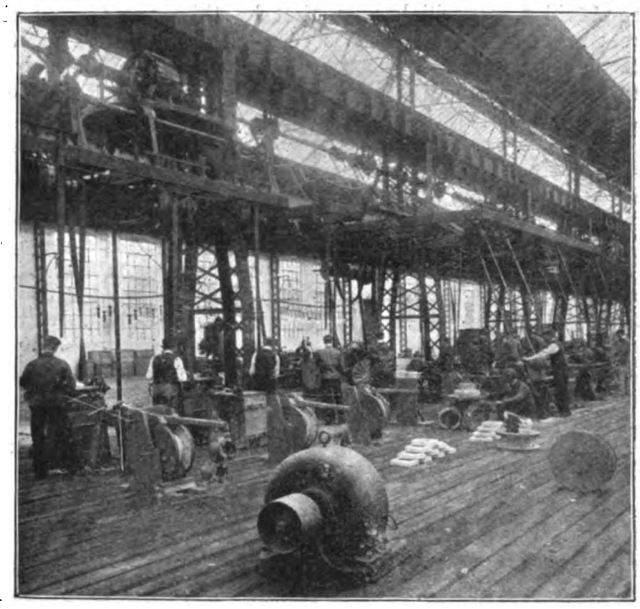
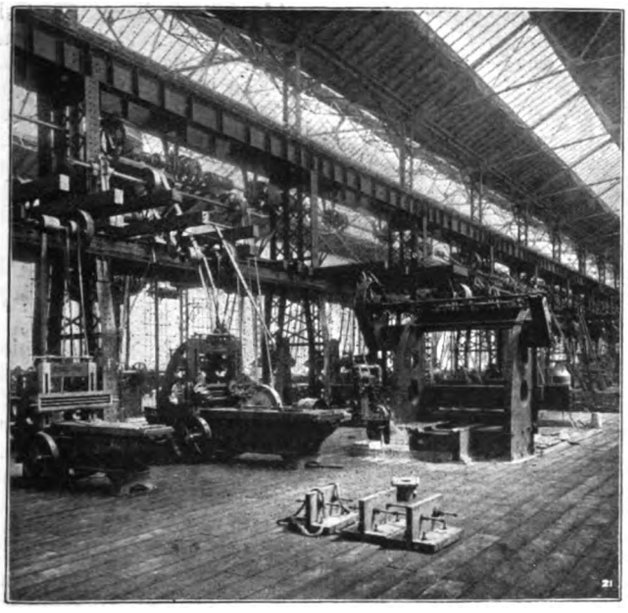


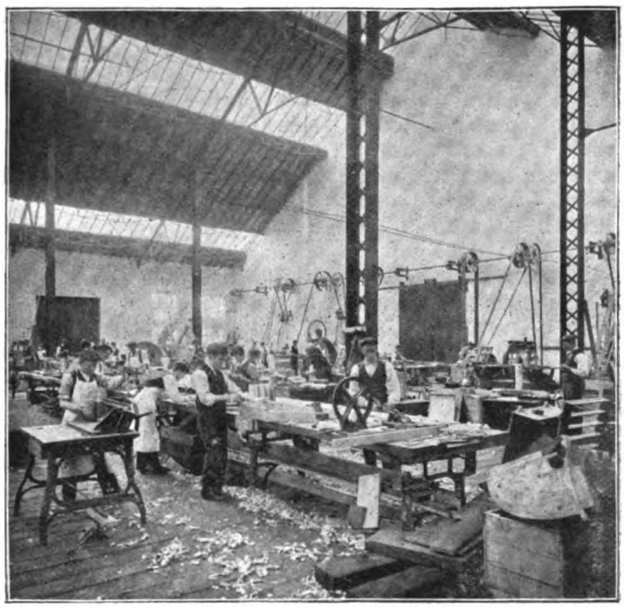
MOTOR AND LATHES DEPARTMENT.



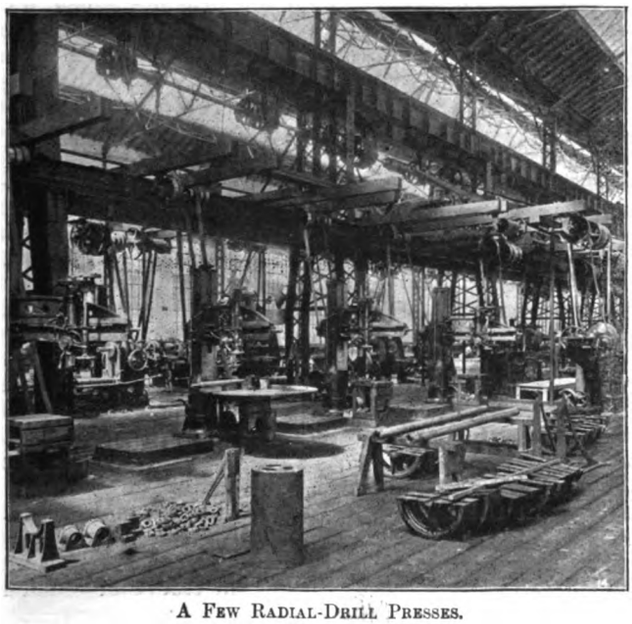
WINDING DEPARTMENT.



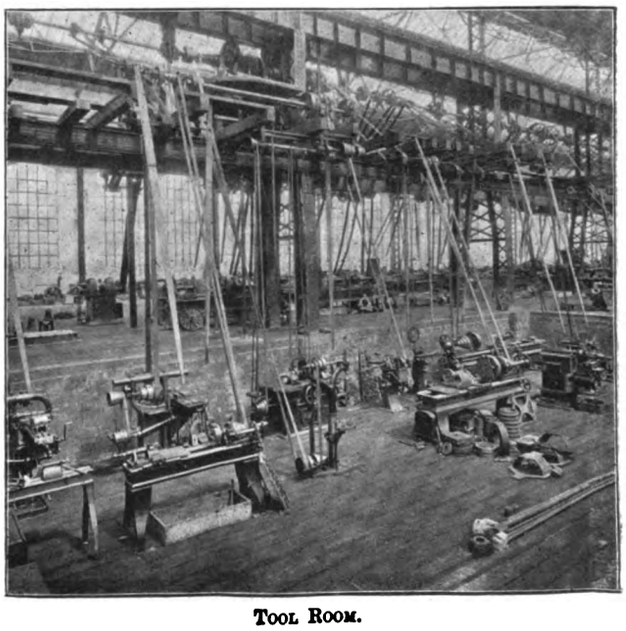
A GROUP OF PLANERS.



PATTERN SHOP.



A FEW RADIAL-DRILL PRESSES.



TOOL ROOM.

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are provided. It will be seen that by this arrangement the greatest possible efficiency is secured in the drive of the machinery, since the grouping of the tools of both bays together allows the use of comparatively large and therefore efficient motors, and friction losses are cut down to a minimum.

As will be seen from our illustrations, the machine shop is divided into two enormous bays, one on either side of the centre stanchion. One of these bays will be devoted entirely to the manufacture of traction motors and details of equipment, while the other will be used for the production of heavier machines such as large dynamos, alternators, rotary transformers, &c. In order to obtain a clear idea of the machine tool equipment of the shops, and of the operations which are carried on, the simplest method will probably be to follow the incoming raw material through the various departments through which it passes up to the point of shipment as finished apparatus. The following is a list of these departments, proceeding from the south end of the building:—

Receiving and Store Room.

Die department.
Punch department.
Smith department.
Annealing department.
Painting department.
Motor machine department.
Brass department.
Field winding department.
Motor testing department.
Generator department.
Tool room.
Gear department.
Generator testing department.
Insulating and armature winding department.

Referring to the plan, at the north end of the shop will be noted the receiving and store rooms into which the receiving track passes. These rooms are fitted with divisions and bins for the various materials. The electric cranes in the two bays unload the materials from the railway trucks and distribute them to the various parts of the store room. From this store room the materials are distributed to the various departments of the works as required.

The first group of tools after leaving the store room constitute the punch and die departments, in which the steel discs required for building up armatures, field-magnet cores, &c., are punched with dies into the required shapes. The machinery used in this department is automatic throughout and of the latest pattern. Immediately near to the punch and die departments is a completely equipped smith shop with power-driven hammers, &c., for shaping the steel from which the dies are made. The delicate process of tempering the dies after completion is also carried on at these forges. This department is fitted with a full equipment of standard lathes, shapers, and drill pressers. Worthy of notice, too, are the grinding machines for grinding the dies with flat cutting surfaces, these moving the piece of work back and forth solely while the large grinding cylinders roll rapidly, and at the same time move along their axes at right angles to the movement of the work, thus ensuring perfectly flat surfaces. Next comes the annealing process, where the armature discs are packed into iron cases and covered with sand to exclude the air. The discs are then placed in ovens where they are raised to a dull red heat and slowly cooled, afterwards being passed through the painting machines, which cover them with the thinnest possible layer of varnish. Issuing from the varnish rolls they are dropped on a moving chain bolt which passes them through a drying oven and delivers them in the assembling department to be built up into cores ready for winding.

Moving down the shop we now come to a second railway track entering the machine shop from the foundry. By means of this track the castings of motor and generator frames are delivered directly to the respective departments equipped for their completion. The first process with the motor castings is to place them on the vertical milling machines which face the two halves to form a perfect magnetic joint. Next in line are the radial drilling machines which drill all the holes in are motor frames. After being bolted together the frames the placed on the horizontal boring mills, which finish the bearings for the armature and axle and bore out the frames to receive the pole-pieces. The frames are now completed and ready for delivery to the motor assembling section. Next beside this group of magnificent boring mills are the motor shaft lathes and special machines for grinding the armature shaft bearings. Then come the massive turret lathes for finishing the armature end plates, the commutator heads, and the bearing shells. The next group of tools, comprising lathes, planers, shapers, milling machines, and many special tools, constitutes the brass working department, where the controllers, rheostats, trolleys, commutators, and brush holders are made. Next is the field-magnet winding section, where the motor and generator field-magnets are wound, insulated, and baked, and the armature coils placed on the motor armature cores. The motors and controllers have now reached the assembling and painting department, from which they are delivered to the testing department, where they are subjected to tests for insulation, &c., and run under full and over load conditions for the specified time. After the tests are completed the temperature of each part is taken, and a thorough examination made as to the quality of workmanship, &c. If perfect in every respect the completed machine is taken charge of by the shipping department, where it is loaded into trucks on the shipping track, which enters the building at the opposite end from the receiving track.

The armature winding, insulating, and mica department for motors, dynamos, and alternators is separate from the main portion of the machine shop, occupying a position at the extreme south end of the generator bay. A brief description of the operations which take place in this department will be of interest. The armature coils which are wound or formed entirely by machinery must be thoroughly insulated with mica, paper, and cotton braiding. They must be properly dried, dipped into special varnish, and then baked in order to exclude all moisture. Afterwards they are pressed into exact shape and formed to size so that all coils and windings may be interchangeable. The mica rings and tubes for commutators are moulded under great pressure while being heated. The presses in which this work is being done have their various parts heated by steam pipes from the boiler house to this portion of the machine shop. Nearly all the winding, insulating and mica moulding in the department is done by girls. Its separation from the main portion of the shop obviates the possibility of metallic chips or filings getting into the insulation.

Returning now to the point where the foundry track enters the machine shop, and coming down the *generator* side of the shops, we find the largest and finest tools in the plant for machining and finishing. The generator frames, after coming from the foundry, are first placed on an enormous planing machine to be faced at the joints. The bed of this planing machine is 24ft. long, and will receive castings up to this length. This tool weighs over 75 tons, and is driven by its own separate motor. The next tool—the largest in the works—is a boring mill, swinging 24ft., used to bore out armature heads to receive the engine shafts, to finish the armature end rings for large generators, and to make the large commutators for these machines. This mill weighs over 100 tons. Next comes a universal boring and milling machine, which, while not so heavy as the boring mill last mentioned, occupies more room, its table flush with the floor being 24ft. square. Along one side of this table travels an upright pillar about 10ft. high. To this pillar is attached a spindle, which can be moved to any position, vertical or horizontal, within the limits of the tool. Generator frame castings are placed upon the table of this machine and all the holes being bored, surface milled—in fact all the remaining machine work—is finished without moving the casting. For the armature heads of large dynamos and alternators portable slotting machines are provided, each with its own motor, to cut the keyways for the engine shafts and the dovetailed slots for fastening the armature laminations. The machine work on the generator frames is now finished, and the material next proceeds to the assembling department opposite the shipping track, where they are erected for test, each generator being thoroughly tested for insulation, output, temperature and commutation. In the testing room there is arranged a complete switch board about 48ft. long, with an assortment of testing instruments of wide range. In the testing department live steam is provided from the boiler house, so that complete engine-dynamo sets can be fully tested. Midway down the generator bay are located two important departments, the tool room—sunk 4ft.

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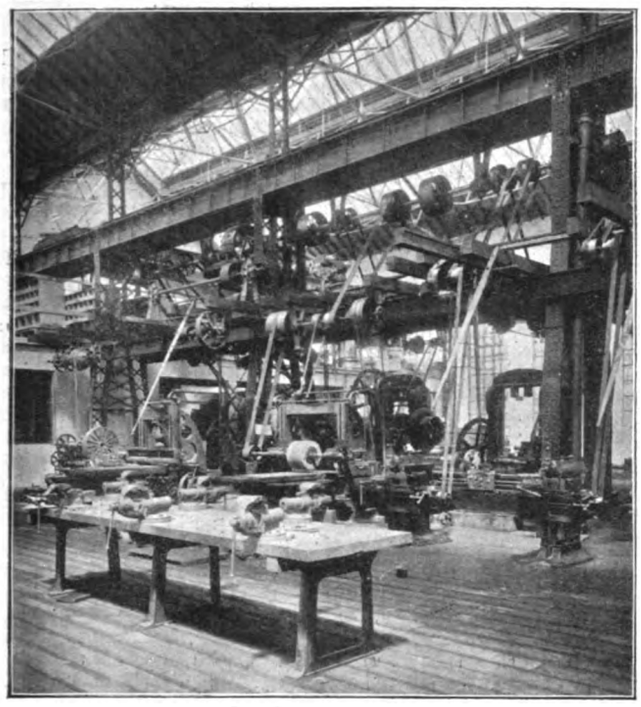
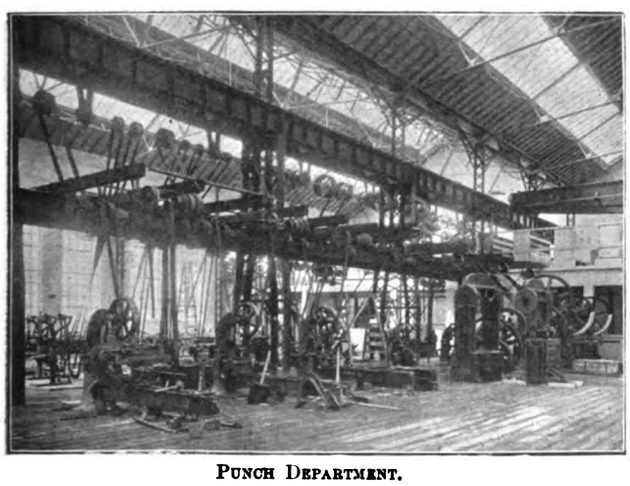
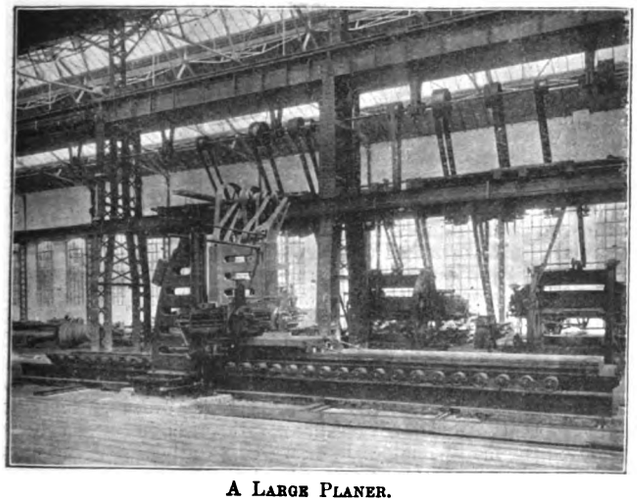
below the floor level so as not to interfere with a clear view of the shops—and the gear cutting department. In the latter is comprised a group of special tools by which all the operations involved in he complicated and tedious operation of cutting the gears are performed automatically and with absolute precision.



DIE DEPARTMENT.



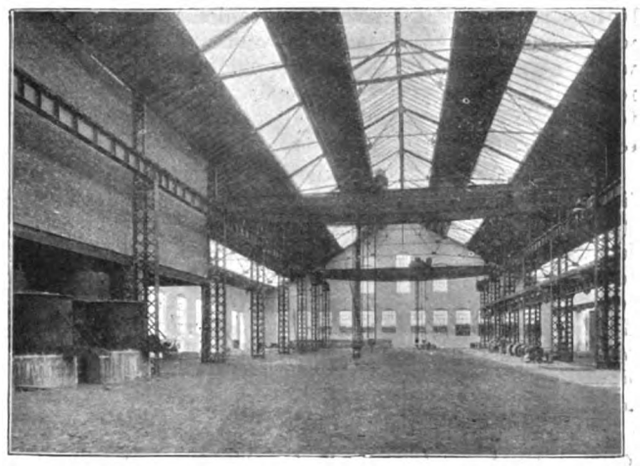
PUNCH DEPARTMENT.



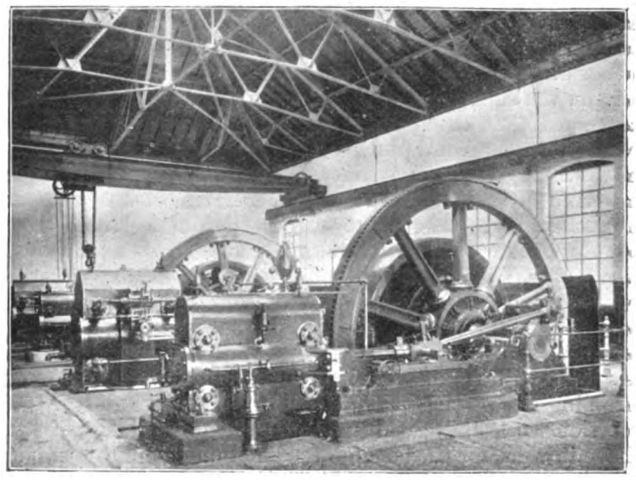
A LARGE PLANER.

Offices.—In the south-east corner of the machine shop building are located the offices on the ground floor, the engineering department occupying the first floor with a thoroughly equipped laboratory for testing all materials entering into the finished product. The drawing offices and a complete photographic department are also located on this

WINDING MACHINES.



IRON FOUNDRY.



POWER HOUSE.

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floor. Both the offices on the ground floor and the engineering department are provided with large fireproof strong rooms for books and drawings. On the second floor the company has provided club rooms, consisting of reading rooms and library, dining room and kitchens, for the use of the works staff.

Foundry.—The foundry building is parallel with the machine shop building, with a space of 60ft. between the two. It is 465ft. in length and 120ft. wide, and is equipped with two 30-ton and one 15-ton electric cranes. In this building are contained the iron foundry department, the brass foundry department, the pattern shops, and the pattern storage shops. Two cupolas are provided for moulding iron, and there are five brass furnaces for making brass parts. In both the brass and iron foundries the machine tools provided are driven by independent motors. The pig iron and coke for charging the cupolas is delivered directly from the railway tracks upon the lift cupola staging, on the same level as the cupola charging doors.

Power House.—The power house is at the south end of the foundry with a clear space of 30ft. between the two. It is 144ft. long and 120ft. wide, and is divided into a coal storage room, boiler room, engine room, battery room, and reservoir. The boiler room contains at present three 500 H.P. Lancashire boilers, with ample space to receive an additional three boilers of the same capacity. A Green's economiser is provided together with the necessary boiler feed pumps. The engine room at present contains two cross-compound Corliss engines each direct connected to a generator of 400 H.P. capacity. There is, therefore, 800 H.P. available at the present time with a possible over-load capacity of 25 per cent. Space is left to receive a 1,000 H.P. unit, which will shortly be installed, and the generator for which will be made at these works. The battery room contains a 500-volt chloride accumulator set which is used for supplying light and power throughout the works at night when the power plant is shut down. The reservoir, with a capacity of 60,000 gallons, receives its supply from an elaborate system of roof drains. A cooling tower is erected over one portion of the reservoir.

Lighting and Heating.—All the buildings and grounds are lighted most thoroughly, arc lamps being used for the general lighting, with incandescent lighting suitably arranged for the individual tools. The heating and ventilation of the buildings is amply provided for, so that the temperature can be kept uniform at any point from 60°F. to 70°F. throughout the year. In the offices the direct radiating method is used, while for the shops the hot air system is employed, accomplishing the double purpose of providing not only for heating but for an adequate supply of pure air at all times.

Other Arrangements.—Within the grounds there has been erected what will be known as the directors' club house, provided with a dining room, kitchens, bed rooms, &c., for the accommodation of the directors and their friends while remaining over night at the works. Special attention has been paid not only in the laying out of the plant itself but in other directions for the comfort and means of entertainment of the workmen in the shops. Alongside the foundry it is arranged that extensive bathrooms will be erected, provided with hot and cold plunges, &c., and in which each of the men employed in the foundry will have his own special locker reserved for his private use. A portion of the company's funds is being devoted to the erection of a large group of comfortable workmen's dwelling-houses upon a site close to the works. It is also intended to erect a large club-house with gymnasium and reading rooms, &c., for the men. In this connection it may also be added that the directors of the company, recognising the important part in which the young engineer with a fair technical education and a sound practical training has played in the building up of the industry in connection with the great German and American companies, have in view, for the benefit of such young engineers employed at the works, the delivery of a regular course of lectures on electrical engineering subjects throughout the year, this being a matter to which Mr. Short himself attaches the greatest possible importance as a factor in the continued future success of the undertaking.

THE MUNICIPAL ELECTRICAL ASSOCIATION, PRESIDENTIAL ADDRESS BY MR. A. B. MOUNTAIN, AT HUDDERSFIELD.

In presenting to you my Presidential Address, I avail myself of the opportunity of very sincerely thanking you for the great honour you have done me in electing me your President. I would remind you that this is the fifth Convention the Association has held, and while reminding you that the Association is only five years old, I feel it will interest you if I briefly give you its history, and review some of the work it has already accomplished. Many present may remember that the Board of Trade proposed in 1895 to issue new regulations for controlling the supply of electricity; the engineers of the various municipalities affected met together, and by combined efforts were enabled to persuade the Board of Trade to modify considerably the regulations which were finally issued in 1896. The engineers who were in consultation while the Board of Trade regulations were under consideration, decided to form this Association, feeling that by combination they would be stronger and better able to bring those interested in municipal electricity supply undertakings together for the purpose of interchanging ideas and experiences, and if necessary take action to further or protect the interest of the undertakings in their charge. The Association at its first meeting had only 24 members who were electrical engineers, being permanent officials of municipalities. Mr. Arthur Wright was elected the first President, and the address he delivered to the Association at its first convention, held in London in 1896, clearly outlined a programme of most useful work which the Association had before it; many of the subjects mentioned in that address have had your consideration, and I believe that the discussion of these matters by the engineers, chairmen, and other members of electricity committees has very largely assisted to promote the process and achieve the results which have been obtained. But since the Association was first formed it has grown year by year in the most satisfactory manner: there are now 74 committee and 84 electrical engineer members, three associate members, and 57 associates. The work accomplished by the Association in the past has, I feel certain, been very much appreciated by the Local Authorities interested, and although we may with a certain amount of pride look back upon past achievements, yet the future work of the Association must be of still more importance to all those interested in electricity supply works owned by local authorities.

One of the first subjects discussed by the Association was the control of both the gas and electricity undertakings by one committee. In 1896 several corporations owning both undertakings, had placed them under the charge of one committee, although it was even then recognised that the work was quite of a different character and that the departments must be in a manner competitors; now with very few exceptions the electricity supply is controlled by a special committee, and judging by the progress of both departments during the last few years, it would seem conclusive that the healthy competition has been in the interest of both undertakings. At our first convention two or three corporations had attempted to increase the pressure of supply to consumers and the pressure usually delivered was 100 volts or 110 volts, now it is quite unusual to find any three-wire system delivering a supply with a less pressure than 200 volts or 220 volts; in some cases the declared pressure is 250 volts. It is interesting to think of the enormous saving in copper which this increase in pressure has effected; indeed it would have been impossible for many of the municipalities to have extended their undertakings to any great extent without the alteration of pressure, and the saving of capital has no doubt in a great measure assisted the achievement of the magnificent results which have been obtained. One of the subjects discussed by the Association in 1896 was the question of extension to outlying districts. It largely influenced those members who attended our first convention to appreciate the fact that the residential lighting was worth cultivating, and that the best way to obtain it was to extend mains as rapidly as possible to all the outlying residential sections of a town, and I consider the rapid increase in the demand for electricity is largely due to the spirit of enterprise exhibited by municipalities in encouraging a demand rather than waiting until the demand necessitated the extensions. The consideration of wiring regulations which would be applicable to the whole of Great Britain was discussed at our first meeting, and has since occupied the time of the Association considerably. The rules which have been prepared by the Institution of Electrical Engineers, embodying the views of this Association, are of very great value. Time has not, however, removed the man who does jerry work, indeed it seems as if those workmen who are fit for nothing else become infatuated with wiring, and are really the cause of the bad work which is being done in so many towns. One way out of the difficulty would be to organise a system of examination in connection with our Association, so that good men with a knowledge of their work could obtain a certificate, this would, I am inclined to think, check the engagement of

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unqualified men, and if the certificate could be withdrawn upon conclusive evidence of bad workmanship it would add to its value. I believe this system would be much appreciated by the better class of workmen, and there would be no great difficulty in organising a system such as that suggested, which would weed out the incapable men. Perhaps, however, some may think it necessary to go further and weed out some of the incapable wiring contractors. Another subject which has been very freely discussed by the Association is the supply of electrical energy for tramways and the advantages of combination over separation, the conclusion of the Association was that municipalities could combine, such combination would tend to reduce the cost of production of energy for both the lighting and traction. Although it is perhaps early to draw conclusions it is interesting to notice that the cost of production in those works where a combined supply is generated is enormously reduced, and that the committees have in some cases been enabled to materially reduce the price of energy to the consumer of electricity, and although there are three municipalities who, having had the opportunity of combination, have preferred entirely separate works, on the other hand it is pleasing to find that 45 have accepted the views of the Association. As an instance of the value of combination, I would remind you of the special meeting of the Association, held in January, 1897, to consider the subject of fire risks. Owing to fires taking place at two of the London companies' works, the fire insurance companies increased the rate of insurance throughout the country from about 5s. per cent. to about 15s. It was pointed out at the meeting that our works consisted of brick and iron, and that fire insurance was unnecessary, therefore the result of our meeting was, that many corporations who had insured discontinued to do so, and the companies very soon afterwards reduced their premiums.

The formation of the defence fund, for resisting the patent action brought by Mr. Rucker against the London Electric Supply Corporation for the use of the alternating-current system of electricity supply, is another instance of the success of combination, individual action would almost certainly have resulted in failure.

To endeavour to touch upon even all the important work of the Association during the last five years, would be impossible in the time at my disposal, but when one contemplates the progress of the various undertakings, the questions and difficulties involved can more easily be appreciated. When we held our first convention there were very few engineers responsible for works having 50,000 lamps connected to the mains, and the output of very few generators exceeded 300 kw.; owing, however, to the constantly increasing number of lamps connected year after year, it has become necessary to adopt larger units of plant, and now generators having an output of 1,000 kw. are quite usual, in fact in many towns it has been found best to take out generators of small size and replace them with plants of very much greater capacity; this has entailed a large waste of capital, and I am inclined to think the Association might well devote its time to the consideration of the size of plant which should be adopted for new works and extension of existing ones. Unfortunately we are very much in the same position as gas works were 25 years ago, we are constantly extending without being able to form any very correct idea of the ultimate size of our works, but with the experience we have had, and with the history of gas before us, it cannot be very difficult to arrive at some useful figures. I would suggest as a moderate figure 15 8 c.p. lamps per head of the population of the area supplied; this would mean that a town having a population of 100,000 would ultimately have approximately 1,500,000 8 c.p. lamps connected to its electricity works. If we disregard for the moment the energy which will be required for driving motors, tram cars, and for many other purposes, which we should largely depend upon to find employment for our machinery during the day-time, and which would not materially increase our maximum load, we find that to supply energy to these lights, assuming one-third to be in use at the same time, we shall require, including spare plant, not less than 20 1,000 kw. generators. This would be an unnecessarily large number of generators, and undoubtedly much more economical results would be obtained by employing 10 generators having an output of 2,000 kw. each. One can only earnestly hope that when the demand for larger units arises our manufacturers of electrical plant will be in the position to supply thoroughly reliable machinery.

You will agree, I feel sure, that I have not in any way magnified the work before us, and I hope that we shall be able, by careful consideration and mutual exchange of facts and experience, to so arrange our works that extensions will not again necessitate the radical alterations which have had to be made in the past at such great expense. When we consider the probable growth of our works, one is forced to think seriously of the various systems in operation and endeavour to ascertain the probable alteration or extension which will be necessary to meet the demand for energy in the future. Simplicity is, I think, the important point we should keep in view: it means reduced capital expenditure, reduced works costs, and reliability of supply. I think the future demand in any town having a population exceeding 75,000 will necessitate the erection of generating works outside the central or densely-populated portion of the town, and that such works will, if the town has a continuous current supply, generate alternating current, either single, two or three phase, which will be converted to continuous current in suitably situated sub-stations, if, however, the town has a single-phase alternating-current system, I think it will have a distinct advantage over its neighbours having continuous current in the fact that it will have a less complicated system, the capital expenditure upon which should be less, the cost of distribution due to the saving of labour should be lower, and the reliability of the system greater unless accumulators are employed upon a large scale. The facts and figures at present obtainable relative to two and three-phase alternating-current systems are not, in my opinion, sufficiently proved to be of much value, and we should watch with the greatest interest the results of some of the systems now being installed. In my opinion, the complications completely outweigh any advantage which two or three-phase systems may have over single phase. We are, I think, too much inclined to follow fashions which can usually be traced to individuals who are in some way interested, and as engineers we should think for ourselves and apply the facts and figures we may obtain to the local conditions we have to deal with, and must not let our engineering enthusiasm make us forget that we have to put down works for distributing electrical energy suitable for all purposes, at the lowest possible cost to the consumer.

During the last and present year much has been heard upon the subject of municipal trading, and the welfare of our electricity supply undertakings are largely involved. It would seem, however, that the sins of local authorities are those of omission, when one considers that provisional orders for electric lighting have been granted to above 300 local authorities, and that only about half are beyond the period of consideration, it must be granted that enterprise is being seriously retarded, and that the idea of obtaining an order and then waiting Micawber-like for something to turn up is neither in the interest of the would-be consumers or the industry, and it can scarcely be surprising to find Parliament considering the granting of powers to companies to supply over large areas and also contemplating competition. There are, however, two strong factors impeding electrical enterprise in the areas of small local authorities, both of which are having the attention of the Council of this Association. The first is that no period being allowed for this construction of works necessitates an immediate payment if interest on capital and sinking fund contributions; the second point is that the period of 25 years allowed for the repayment of capital is unnecessarily short and increases the annual proportion of the sinking fund. The consequence is that some local authorities anticipating loss by the department during the first year or two are anxious to avoid the risk of adding a burden to the rates. I am, of course, aware that this is an excuse and not a solid reason for delaying the commencement of the work for years, and one can scarcely understand why the smaller local authorities who have obtained powers at considerable expense should not have proceeded with the work; their want of enterprise has, in my opinion, brought into existence the larger companies who propose supplying electricity over extended areas. A combined effort to alter the present regulations of the Local Government Board and obtain, if possible, a longer period for the repayment of loans and also a period for construction of works can only be productive of good results, and will certainly enable many councils who are now hesitating to at once put down works and develop the supply of electrical energy for all purposes. It would also have another beneficial result in the fact that it would remove the temptation to reduce the initial capital expenditure by putting in very small plant unsuitable for the works in a few years time, but by the employment of which it may be possible to avoid a loss at the commencement.

While one is forced to the conclusion that the want of energy of many of the smaller local authorities is likely to produce unfortunate results, it is a pleasure to review the general progress made by electricity supply undertakings, and the following figures representing the capital expended upon municipal and companies' works in the United Kingdom are most interesting:—

	1895.	1896.	1897.	1898.
Municipal	£1,772,323	3,392,229	4,662,909	6,979,150
Companies ...	£4,335,357	5,370,134	6,338,744	7,996,591

I am sure our consumers will be interested to hear that the average cost of producing the unit of electrical energy, exclusive of capital charges, is being reduced year by year, and in municipal works was, during 1898, 2·12d. per unit as against 2·7d. per unit in companies' works, and that the average price obtained by municipalities during the same year was 4·35J. per unit as against 5·51d. per unit obtained by companies. These results must be considered highly satisfactory and it is interesting to notice the causes of the reduction in the average works costs. The chief reason for the reduction of costs is due to the reduction in the selling price. This has induced consumers to use more energy per lamps fixed. The second important factor is the more general use of electric motors, which has helped very largely to increase the quantity of energy sold, and has found employment for a portion of our plant during the day-time. The supply of electricity for tramway purposes has also materially

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assisted the load factor, and has consequently reduced the average cost of production, and as the demand for energy for motive power and tramway purposes is developed so will the cost of production be reduced.

Another opportunity of improving the load factor seems fairly near realisation—that is, the charging of accumulators for motor cars. When considering the various types of motor cars at present upon the market, one is inclined hastily to imagine that electricity is of little use, because with accumulators the length of run is limited to about 40 miles with one charge, and that the difficulties of charging will impede its application. These difficulties disappear if one thinks of the real commercial use which will certainly be made of motor cars. Tradesmen require something reliable for conveying their commodities to various points—usually within a few miles of their premises—and do not require to cover more than about 20 miles per day. For these purposes the electric motor car is most suitable, and the fact that its propelling machinery has no reciprocating parts should add to its reliability and reduce repairs, and if municipalities will arrange charging stations in convenient positions such cars should be speedily adopted, and if the charging is done during the night and early morning the energy used could be supplied at an exceedingly low price, and would still further reduce the average cost of production. The long distance motor cars using petroleum would still for the present appear to have an advantage over electricity owing to the difficulty of charging in out-of-the-way places. In Edinburgh and in other places, motor cars are running in competition with tramways, and one is bound to consider what competition will mean. Motor cars running upon the ordinary road escape the heavy expenditure required for the permanent way of an electric or steam system of tramways, and consequently, in a district having a scattered population unable to support a frequent service of cars, would have an immense advantage in the fact that the capital charges would be very much reduced. This is, in my opinion, an extremely important point, as the financial charges upon a tramway undertaking frequently represent from 25 to 40 per cent. of the total expenses, and it is not at all unusual to find this important item neglected when the cost per car mile is being discussed.

The last subject I will mention is the municipalisation of the telephone system. The Association and the Council have devoted considerable time to the consideration of this subject, and now that Parliament has granted powers to local authorities to municipalise the local system there should be an immediate effort made to make the telephone more popular. This can, I think, only be done successfully by the local authorities, who cannot help being keenly interested in anything which aids or adds to the convenience of its residents. They would undoubtedly be able to give a more efficient and cheaper service than that at present in existence. It is sincerely to be hoped that Corporations will assist the Post Office to develop the service, and will not be either dismayed or delayed by the difficulties which may appear, and which will vanish as soon as a few Corporations have their systems in operation. In conclusion, I regret that, owing to the amount of work before the Association, it is impossible for me to touch upon many very interesting subjects which I should otherwise, had time allowed, have thought it desirable to bring before your notice.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Transformatoren für Wechelstrom und Drehstrom." By Gisbert Kapp. Second Edition. Revised and Enlarged. (Berlin: Julius Springer.)

"Chemistry an Exact Mechanical Philosophy," by F. G. Elwards. (London: J. and A. Churchill). Price 3s. 6d.

"Up-to-Date Domestic and Industrial Applications of Electricity." By "Alpha." (London: S. Rentell and Co.) 1s.

"The Elementary Principles of Electric Lighting." By A. A. Campbell Swinton. Fourth Edition. (London: Crosby, Lockwood and Son.) 1s. 6d.

"Il Telefono." (Conferenza Sperimentale Tenuta Presso la R. Scuola d'Applicazione per Gli Ingegneri di Roma il 6 Maggio, 1900). By Dr. J. Brunelli. (Rome: Tipografia, Elzeviriana.) 75 c.

"The Official Gazette of the United States Patent Office." No 10, Vol. XCI. Published by authority of Congress. (Washington: Government Printing Office.)

"Electric Tramway Traction." By Albert D. Greatorex. (London: St. Bride's Press.)

The Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute has been arranged to be held at Paris, under the auspices of the Société d'Encouragement pour L'Industrie Nationale, on Tuesday and Wednesday, Sept. 18 and 19.

ELECTRICITY WORKS ACCOUNTS.

Liverpool Municipal Electric Supply Works.

The two accounts which we analyse this week are both interesting examples of the effect of a combined traction and lighting load on the costs of electricity supply. The period of working covered by the Liverpool accounts for 1899 is the first to show the full influence of the tramway load on this undertaking.

In 1898, of the total output of 2,915,695 units sold, 210,492 units or 7·22 per cent. was supplied for public lighting, and 104,815 units or 3·6 per cent. for traction purposes. In 1899, however, out of the total output of 5,729,477 units sold, the tramways took 1,888,728 units, or no less than 32·9 per cent., while the proportion of 201,574 units or 3·5 per cent. was taken by the public lamps. It will thus be seen that to the tramway load was not only chiefly due the splendid advance of 96·5 per cent. in the output of 1899 as compared with 1898, but also the large load factor of 12·7 per cent., as compared with the 9 2 per cent. of the previous year, 1898.

The increase in the lamp connections of nearly 29 per cent. is a most healthy sign for the future.

The costs column shows that full advantage has been taken of the favourable alteration in the conditions of output and load factor. We are happy in being able to record a material diminution in all the items of expenditure, notwithstanding the fact that the 1898 costs were already most satisfactory. At present the results are so uniformly excellent that we are unable to single out one feature from the rest as calling for special commendation.

With a total revenue from all sources of no more than about 3d. per unit, the ratio of costs to revenue of only 42·9 per cent. and a working profit of £41,536, representing 6·11 per cent. on the mean capital, are most excellent results in every way.

Bradford Municipal Electric Supply Works.

Although the proportionate increase of the traction load at Bradford was nothing like so large as at Liverpool, yet both the output and the load factor of 1899 at the former place made an advance but little less striking than in the first undertaking noticed in our comments, while the financial results are even better.

Comparing the position of the Bradford undertaking in 1899 with that in 1898, it will be noticed from our figures that the total equivalent lamp connections had increased from 94,255 8 c.p. lamps to 132,631, or by no less than 40·7 per cent. The output also shows the splendid advance of 70·2 per cent. As a result of the large increase in the motor and traction load on the station, the load factor has been greatly benefited, having risen from 10·2 per cent. to 13·7 per cent. In 1898 the output sold for traction was 202,019 units or 14·2 per cent. of the total sold, while the output to the public lamps was 82,291 units, representing 2·27 per cent. of the total. In 1899 the tramways supply was 618,282 units, being 25·6 per cent. of the total output; the motor load called for a supply of 463,630 units, or 19·2 per cent., and the public lamps for 59,004 units, or 2·44 per cent. of the total.

As in the case of the Liverpool undertaking, the effect on the costs of the large increase in the output and load factor has not been missed. The excellent total costs figure of (1·61d. per unit) of 1898 has fallen to 1·18d., and not only has the total revenue also been reduced to 2·9d. per unit, but the working profit has increased.

The costs column shows that all the chief items of expenditure have diminished excepting the fuel charge. The slight increase in this department was to be expected, in view of the low figure of the previous year, and of the coal prices during the period. Nevertheless this item, and indeed all the other items of works costs, including the management of property charges, present figures well below the average of previous practice, even considering the order of the output and the favourable load factor.

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	LIVERPOOL.		BRADFORD.	
Undertaking Worked by	Liverpool Corporation.		Bradford Corporation.	
Date of Commencement of Supply	1883.		September, 1889.	
System of Supply	Continuous-current 2 and 3-w. with batteries.		3-w. with batteries on one side only, other side [thro' motor generator.	
Chief Engineer	A. B. Holmes.		A. H. Gibbings.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	—	—	1,568,459	2,853,841
„ SOLD (TOTAL)	2,915,695	5,729,477	1,419,306	2,416,130
„ sold to consumers	2,705,193[a]	5,527,903[k]	1,387,015[a]	2,357,125[i]
„ sold for public lighting, &c.	210,492	201,574	32,291	59,004
„ used on works	—	—	33,369	287,794
UNITS SOLD PER 8 C.P. LAMP CAPACITY	19·5	25·9	16·4	21·2
Maximum supply demanded	3,633 kilowatts	5,160 kilowatts[l]	1,589 kilowatts	2,010 kilowatts
Number of public lamps	137 arc	142 arc	20 arc 11 glow	51 arc 12 incd.
Number of consumers	2,279	2,842	850	1,075
Connections to mains in 8-c.p. lamps	184,648	237,952	94,255	132,631
CAPACITY OF PLANT IN 8-C.P. LAMPS	149,600	221,000	86,600	99,700
CAPACITY OF PLANT IN KILOWATTS	4,790	7,090	2,769	3,189
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— —	— —	£165,194 £59·7	£218,381 £63·5
Share	— —	— —	— —	— —
Loan (including Debenture charges)	— —	— —	165,194 59·7	218,381 63·8
RECEIVED (TOTAL)	£556,000 £116	£350,000 £49·4	163,571 59·1	203,323 63·8
Share	— —	— —	— —	— —
Loan (including Debenture charges)	556,000 116	350,000 49·4	160,787 58·1	199,787 62·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— —	— —	4,407 1·59	18,594 5·83
Share (unissued)	— —	— —	— —	— —
Share (uncalled)	— —	— —	— —	— —
Loan (including Debentures)	— —	— —	4,407 1·59	13,594 5·83
REPAID (TOTAL)	— —	— —	17,920 6·47	21,770 6·83
RESERVE OR SINKING FUND	38,255[b] 7·99	55,069[n] 7·78	2,392 0·864	5,358 1·68
DEPRECIATION FUND	17,376 3·63	23,720 3·35	— —	— —
EXPENDED (TOTAL)	591,587[c] 123	769,589[c] 109	166,976[b] 60·3	206,239[b] 64·6
Lands and buildings	— —	— —	27,861 10·1	31,040 9·73
Plant	— —	— —	56,186[c] 20·3	69,394[g] 21·8
Mains	— —	— —	73,157 26·4	85,839 26·9
Miscellaneous	— —	— —	9,772 3·53	19,967 6·26
BALANCE OF CAPITAL ACCOUNT	−35,587[d] −7·43	−419,589[d] −59·2	−3,406[d] −1·23	−2,916[d] 0·914
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£57,987 4·773d.	£72,696 3·044d.	£22,204 3·751d.	£29,206 2·903d.
Revenue from supply	51,003[e] 4·200d.	67,016[o] 2·806d.	21,299 3·603 l.	28,133 2·795d.
„ meters, &c.	1,319 0·109d.	1,687 0·071d.	641 0·108d.	839 0·083d.
„ public lighting	2,631 0·217d.	1,925 0·081d.	— —	234 0·023d.
„ sale of lamps, &c.	2,864[f] 0·236d.	2,068 0·087d.	106 0·018d.	— —
„ miscellaneous sources	170 0·014d.	— —	159 0·027d.	— —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£21,575 1·776d.	£31,161 1·305d.	£9,525 1·610d.	£11,866 1·180d.
WORKS COSTS	14,180 1·168d.	21,813 0·914d.	5,301 0·896d.	8,236 0·820d.
Generation of electricity	*11,810 0·972d.*	*18,343 0·769d.*	*4,694 0·794d.*	*7,334 0·729d.*
Fuel (including cartage, &c.)	5,865 0·483d.	10,116 0·424d.	1,932 0·327d.	3,579 0·356d.
Oil, waste, water, stores	1,262 0·104d.	1,636 0·069d.	461 0·078d.	640 0·064d.
Wages at station	3,072 0·253d.	4,542 0·190d.	1,562 0·264d.	2,003 0·199d.
Repairs and maintenance at station	1,611 0·133d.	2,048 0·086d.	739 0·125d.	1,112 0·111d.
Distribution of electricity	*2,370 0·195d.*	*3,470 0·145d.*	*479 0·081d.*	*649 0·065d.*
Wages, &c.	1,306 0·108d.	1,371 0·057d.	263 0·045d.	296 0·029d.
Repairs, renewals of mains, &c.	1,064 0·088d.	2,099 0·088d.	216 0·037d.	353 0·035d.
Public lighting	— —	— —	*128 0·022d.*	*253 0·025d.*
Attendance	— —	— —	} 128 0·022d.	253 0·025d.
Renewals	— —	— —		
MANAGEMENT AND PROPERTY CHARGES	7,395 0·609d.	9,318 0·392d.	4,224 0·714d.	3,629 0·361d.
Royalties	— —	— —	— —	— —
Rent, rates, taxes	*2,064 0·170d.*	*2,878 0·121d.*	*1,142 0·193d.*	*928 0·092d.*
Management	*5,331 0·439d.*	*6,470 0·271d.*	*3,082 0·521d.*	*2,701 0·268d.*
Salaries	3,764 0·310d.	4,947 0·207d.	1,025 0·173d.	1,164 0·116d.
Stationery, &c.	406 0·033d.	395 0·017d.	142 0·024d.	184 0·018d.
Establishment charges	613 0·050d.	448 0·019d.	459 0·078d.	693 0·069d.
Law charges, &c.	549[g] 0·045d.	679[p] 0·028d.	1,456[e] 0·246d.	660[k] 0·066d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£36,412 6·54%	£41,536 6·11%	£12,678 8·29%[j]	£17,339 9·30%[j]
Sum carried to Depreciation Fund	4,000 0·718%	5,206 0·765%	3,249 2·12%[j]	3,816 2·05%[j]
Sum carried to Reserve or Sinking Fund	12,890 2·31%	17,722 2·61%	4,750 3·09%[j]	6,747 3·62%[j]
Net interest on loans (incl. Debenture charges)	13,086 2·35%	18,582 2·73%	3,350 2·19%[j]	4,875 2·61%[j]
BALANCE FROM LAST ACCOUNT	2,014 0·361%	1,555 0·229%	9,425 6·16%[j]	10,327 5·54%[j]
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	2,555[h] 0·458%	1,000[q] 0·147%	10,327 6·75%[j]	11,641 6·24%[j]
Deficit	— —	— —	— —	— —
ORDINARY DIVIDEND PAID	— —	— —	— —	— —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	37·2%	42·9%	42·9%	40·7%
Expenditure per kilowatt capacity	£4. 10s. 2d.	£4. 7s. 11d.	£3. 8s. 10d.	£3. 14s. 5d.
REVENUE PER KILOWATT CAPACITY	£12. 2s. 0d.	£10. 5s. 0d.	£8. 0s. 5d.	£9. 3s. 2d.
Expenditure per 8-c. lamp capacity	2s. 10½d.	2s. 9¾d.	2s. 2½d.	2s. 4½d.
REVENUE PER 8-C.P. LAMP CAPACITY	7s. 9d.	6s. 7d.	5s. 1½d.	5s. 10½d.
REVENUE PER 8-C.P. LAMP CONNECTED	6s. 3½d.	6s. 1½d.	4s. 8½d.	4s. 4¾d.
Price charged for lighting, per unit	5d. to 4d.[i]	4d.	4½d.[f]	4½d.[f]
Price charged for power, per unit	2 l.[j]	2d. to 1d.[m]	2½d. to 1d.[f]	2½d. to 1d.[f]
Price charged for public lighting	3d. per unit.[j]	2d. per unit.	—	—

LIVERPOOL—REMARKS.—*a* Of which 104,815 units were supplied to the tramways at 1d. per unit. *b* Includes £15,096 balance of renewals fund account. *c* Separate items not available as the concern was purchased in 1896 for £400,000 in addition to £36,474 being capital spent by the company but not included in the share capital. *d* Over-expended. *e* Includes £437 from tramways. *f* Being £21,818 from sales and repairs less £18,954 wages and material. *g* Includes £356 to insurance and £193 certification of meters. *h* After deducting £5,895, cost of changing pressure of supply. Out of this £2,555, £1,000 is contributed to the City fund. *i* After April 1, 1899, the charge was 4d. per unit. *j* After April 1, 1899, the charge for power was from 2d. to 1d., and for public lighting 2d. per unit. *k* Includes 1,883,728 units sold for tramways. *l* Being maximum supply given at Christmas. *m* On maximum demand system 2d. for first 3,000 units per quarter and 1d. per unit in excess thereof. For tramway supply the charge is 0·9d. per unit. *n* Includes £19,521 balance of renewals fund account. *o* Includes £7,362 from tramways for energy supplied. *p* Includes £355 to insurance and £522 certification of meters. *q* Contributed to the City fund.

BRADFORD—REMARKS.—*a* Includes 202,019 units for tramways. *b* After deducting depreciation on machinery and mains. *c* Includes £1,174 to public lamps. *d* Over-expended. *e* Includes £669 to incandescent lamps for free supplies, £89 to insurance, and £698 to bank interest and commission. *f* Subject to 2½ per cent. discount within two months. *g* Includes £2,032 on public lamps. *h* Includes £257 on lamps, £279 bank commission, and £124 insurance charges. *i* Includes 1,275,214 units for private lighting, 463,630 units for motive power, and 618,282 units for tramways. *j* Per cent. to mean capital less depreciation.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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A complete set of "THE ELECTRICIAN" (1878-1900) can now be supplied. These sets are very scarce, and early application should be made.

AMERICAN ENGINEERING COMPETITION.

"An Englishman visiting the United States at the present time can hardly fail to be impressed by his own countrymen's want of knowledge of the growing manufacturing industries of America and the indifference displayed by British manufacturers towards the increased rivalry to which they may any day be subjected from across the Atlantic—a rivalry which will surely come as soon as the present excessive home demand in America slackens."

Thus recently commenced a series of articles in *The Times*, from the pen of a special correspondent who had spent much time in the United States in investigating the local conditions which have created a formidable and increasing competition with the home and foreign engineering industry of the United Kingdom. The attitude of British engineers and engineering manufacturers towards this competition is diversified. Some deny its existence to any large extent; others belittle its significance, while admitting that much American engineering plant is sold in this country; some regard it as the inevitable decline in the industry of Britain; others view it without alarm, and predict that the depression in British engineering enterprise will prove but transitory. It is important, when seriously approaching this question, to have regard to its three main aspects—viz., the fact of the competition, its significance, and its remedy as regards the retention and recovery of British industrial prestige. Intelligent electrical engineers—those who are watching, for example, the development of electric traction in this country—should need no more proof than their own observation affords, as to the fact of the alleged serious competition with British manufacturers. Should any reader require additional evidence we commend him to the series of articles in *The Times*. With regard to the significance of the competition, there probably is room for greater latitude of opinion with respect to its actual existence. Nevertheless, we think that there are strong indications that the American invasion of the British machinery market will make it more and more difficult for the home manufacturer to hold his ground. Attention, in this connection, should be paid to the pertinent remark which closes the above quotation from *The Times*. Should a time arrive when the American home demand in, say, electrical plant shall have perceptibly slackened, the huge momentum of their manufacturing business can hardly fail to be directed against British industry, even at lower

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prices than at present. Doubtless a healthier reaction would follow, and British manufacturers, having lost heavily in the race, would put their shoulders to the wheel, and make up for lost time. But it would be far better to take time by the forelock, and see to it they never slackened nor lost an inch.

The remedy for the existing state of affairs, therefore, presses for consideration. We thoroughly endorse the remark of the writer in *The Times*, that "in spite of distance, and in spite of ancient prestige, we shall be beaten unless some of us wake up to the fact that obsolete appliances, old, slow methods, and the carelessness of customers needs must give place to something more businesslike and more intelligent." The remedy, in the first instance, is for the leaders of our engineering industry to travel and see what is being done abroad; next, for them to ascertain truly and without bias or prejudice the comparative merits of what they see; and lastly, for them to bring their methods and plant up to the standard of the best practice possible. It requires a belief in the possibility of foreign industrial superiority to induce them to travel; so, many of them stay at home. It requires courage and foresight to scrap costly existing plant and erect more costly and newer plant; so, many of them plod on in the old, old way of their forefathers. They bury their heads ostrich-like in the sand, and willingly are ignorant of the storm that must overwhelm them. Fortunately, not all of our British leaders of engineering industry are thus foolishly-minded. There are some who are willing to recognise what in American methods is superior to our own. These, too, instead of regarding this superiority as an evidence of British degeneration, are actively endeavouring to assimilate these improvements to British soil and circumstance. An excellent example of this is afforded in the organisation of the English Electric Manufacturing Co., whose works at Preston have been started during the past week. Here British capital and, largely, British labour have been combined with American technical skill and organising ability to produce a group of workshops which strike the keynote of the newer electrical manufacturing engineering in this country. Our readers will find an illustrated and detailed description of these works in our present issue; and we venture to think that the impression they will derive from its perusal will not greatly differ from that of the large gathering of visitors at the works last week, namely, that the harmonious blend of American skill and experience with British financial enterprise on British soil is a real and effective solution of the problem of American engineering competition.

MUNICIPAL ELECTRICAL ASSOCIATION.

Wednesday, June 20th.

The fifth annual Convention of the Municipal Electrical Association was inaugurated on Wednesday last at the Technical College, Huddersfield, under the presidency of Mr. A. B. Mountain, the Corporation electrical engineer at that town. There was a large and representative assembly of municipal electrical engineers and chairmen of electricity committees, besides a good sprinkling of visitors. The proceedings commenced at 10 a.m. with an address of welcome by the Mayor of Huddersfield, Mr. Alderman Helliwell, after which the Associates' prize was presented to Messrs. J. R. P. Lunn and P. S. Thompson. Mr. A. B. Mountain then read his presidential address, which we reprint on another page and comment on in our editorial columns.

The business for the morning included two Papers on "Means for Stimulating the Demand for Electrical Energy," by Ald. W. Potter, of Taunton, and Mr. H. C. Bishop, of Wigan. At the close of a long debate on these Papers a brief hour was devoted to the reading and discussion on two Papers on "Electricity Works for Small Towns," by Mr. C. S. Vesey Brown of Lincoln, and Mr. G. M. Harris of Bray. The debate on the first batch of Papers was opened by Mr Faraday Proctor, of Bristol, who criticised several of the popular means for stimulating demand. He considered that the usual system of so-called free-wiring is on a wrong basis, as it tends to discourage the long-hour consumer. Public lighting charges, he considered, ought to be divided into two distinct items—the charge for the energy consumed, and the charge for maintenance. Only in this way could a fair comparison be made with other charges. Messrs. Wilmshurst, Nisbett, Newington, Edgcome and Chamen, besides several chairmen of committees, joined in the discussion, and expressed a great diversity of opinions on the questions of free-wiring and kindred matters affecting stimulation of supply. Mr. Newington denied that in Edinburgh they were in need of stimulants; and several other speakers testified to the difficulty in coping with the rapidly-growing demand for current. We shall give a report on this discussion in our next issue. The remaining two Papers were taken less seriously, partly owing to lack of time. We hope to publish a full report of the joint discussion on these two Papers in an early issue.

In the afternoon, after luncheon in the Town Hall, the Association divided into a number of parties and paid visits to electrical and other works in the neighbourhood and at Bradford. In the evening the Association was entertained at dinner by Mr. Joseph Hopkinson in the Town Hall.

(*To be concluded.*)

FREE WIRING.

BY E. E. HOADLEY.
(City Electrical Engineer, Worcester.)

In a great many places in England there are stations that have been in operation for five or six years, and are now getting into that condition in which their maximum load or their lamp connection does not increase so quickly as it did in the first two or three years of their existence; in other words, the chief public buildings, business premises, hotels and those private houses whose occupiers can well afford to pay for their installations are already taking a supply, and some inducement is necessary in order to get the smaller shopkeeper and occupiers of the smaller houses to use electricity. The chief obstacle to its use by this class of people is undoubtedly the large amount of money which must be spent to cover the first cost of wiring and fitting up their premises, premises of which, in many cases, they are only quarterly tenants.

That it was desirable to assist this class of consumer was recognised some years ago, and for this purpose (among others) the National Free Wiring Co. was formed. This company has started operations in a great many towns in this country, and by its efforts a very large number of consumers have been connected to the mains by the various companies and municipalities; consumers who in all probability would not otherwise have become users of electricity. Here in Worcester the Free Wiring Company started in 1898, but owing to various causes has not met with as much success as elsewhere; in 1898 only 18 consumers were obtained by the company, in 1899, 17; and this year down to the present date, when the company's connection with Worcester ceased, nine.

These results can only be looked upon as disappointing; investigation and inquiry from consumers have elicited the following as the probable causes. The business was worked in conjunction with another town in which the supply was just being started, and where customers were plentiful; for this reason business in Worcester did not receive that amount of "push" which was necessary if many consumers were to be obtained. Consumers complain that the clauses in the agreement relating to purchase of the installation are unnecessarily harsh, and that the extra charge of 1d. per unit on all electricity consumed is practically an addition of 25 per cent. to their electricity bills, and in the case of publicans is even more, being very nearly 30 per cent.

Last autumn the Free Wiring Company gave the Corporation notice that, in order to make things pay in Worcester

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they would be unable to wire bedrooms, &c., on the free wiring system, and could only wire them if they were paid cash for such lights, and asked to be allowed to amend their agreement to that effect. To this the Corporation would not agree, as the larger proportion of the free-wired consumers were drawn from the occupiers of private houses, and the system would not be of much benefit to these unless a man could have his bedrooms wired. To this action of the Corporation the Free Wiring Company replied by giving the necessary six months' notice to terminate their agreement.

At this stage, as I was convinced of the benefit of helping a consumer to wire his premises, I induced my committee to go in for a scheme of free wiring for themselves. A scheme was prepared by the town clerk and myself, approved by the Council, and, as considerable doubt was expressed as to whether the Local Government Board would grant a loan for such a purpose, a letter was written to the Local Government Board asking if they would entertain an application for a loan for free wiring. The Board replied that they were prepared to consider such an application, but if they did grant a loan it would have to be repaid in ten years. After this reply, application is now being made for a loan of £1,000 for free wiring purposes in the City of Worcester.

In the scheme set out below, the chief points that were kept in view were: (1) To make it as cheap and attractive as possible to the consumer; (2) To allow the consumer to pay for the installation in almost any way that suited him best; (3) Not to interfere in any way with the trade of the local contractors, but to further the putting in of good work and well-designed accessories; (4) In cases where the consumer only hires the installation, to charge him a rent calculated at a certain sum per lamp installed, and not to add a certain sum to his electricity bill for every unit of electricity consumed. That there is a good deal to be said for and against each method I am well aware, but an experience of both methods has led me to believe that the charge per lamp installed is the better way. The chief objection to this is that it is possible that a tradesman may only instal lamps in his window or shop where he uses them but a very little time per day, and may not instal them in dark passages, &c., where he will use them many hours per day. This objection, however, will in some measure be overcome, as each installation will be planned, &c., by an official of the Corporation electricity department, who will advise the consumer how to use his lamps to the best advantage. By the other method the best customers of the Electricity Works are penalised most, and many people who would be profitable consumers from the works' point of view, *i.e.*, would use a large number of units per lamp installed, are deterred from having their premises wired.

Below are copies of the circular that will be sent to probable customers and of the agreement they will be required to enter into:—

CITY OF WORCESTER.

WIRING PRIVATE HOUSES, &c.

The City Council being desirous of extending the use of electric light, and especially of enabling those citizens who do not live in their own houses to enjoy the advantages derivable from its use, has decided to undertake the wiring of private houses, &c., and the installation of the electric light therein. The Council does not propose to carry out the work by means of its own staff in the electricity department, but to entrust it to some of the local wiring contractors, who can be safely trusted to give satisfaction. The mode of proceeding, and the terms on which the Council will undertake the work, will be somewhat as follow:—

Any citizen desiring an installation of electric light in his house, shop, &c., can obtain from the electricity department a form of application. This must be filled up, signed, and forwarded to the electrical engineer. The premises will then be inspected, and the applicant's views ascertained; and the electrical engineer will prepare a specification of the work and an estimate of its cost. For this service the applicant will be charged a fee at the rate of 10s. for the first £5 or part thereof; 10s. for the second £5 or part thereof; and 10s. for every subsequent £10 or part of £10 of the engineer's estimate.

It may here be mentioned that the Council's installation will only include plain fittings, but the applicant can substitute any more expensive fittings he likes at his own expense; or, by special arrangement, the extra cost can be liquidated by a small increase in the instalments of purchase money or rent, as the case may be.

The specification having been prepared, the Council will proceed to obtain tenders from local wiring contractors to carry out the work. The tenders will be submitted for the applicant's consideration. He may, at this stage, abandon the proposal to instal the light if the lowest tender is much in excess of the electrical engineer's estimate. Assuming, however, that the applicant decides to proceed, the Council will accept one of the tenders, and the applicant must decide whether he will purchase or rent the installation. To enable the applicant to decide, the following terms for a purchase or a rental have been approved by the Council.

1. *Purchasing the Installation.*—The purchase may be on either of the following methods: (*a*) By one payment in cash, including the sum to be certified by the electrical engineer as payable to the wiring contractor, and the Council's fee for the specification. This method avoids all complications and needs no consent on the part of the owner of the property if the applicant is only a tenant. (*b*) By deferred payments. The applicant will be required to pay down one-tenth of the cost of the installation, *i.e.*, the amount certified to be due to the wiring contractor and the Council's fee for the specification, as soon as the electrical engineer gives his certificate of completion of the installation, and the balance can, at the applicant's option, be spread over three, five or seven years, and be paid by 12, 20 or 28 quarterly instalments, including interest at 4 per cent. on the amount for the time being remaining unpaid.

It need hardly be explained that until payment of all the instalments the installation will remain the Council's property, and that the consent of the owner of the premises is essential to this arrangement. A statement is appended (see Schedule A on page 327) showing what an applicant would pay on this method for an installation costing £20 where the payments are spread over five years.

2. *Renting the Installation.*—Under this method, the applicant must pay to the Council the annual sum of 1s. 3d. for every lamp installed in his premises, but where two or more lamps are fitted to one point the annual charge for one will be 1s. 3d. and for each of the others 6d. per year. The applicant must in addition, of course, pay the charge for the electricity he consumes; and the installation will remain the property of the Council. If the applicant prefers to instal expensive fittings at his own expense, the Council will allow the sums mentioned in the list set out in Schedule B. The consent of the owner is essential to this arrangement also. An applicant who commences to pay for an installation on the rental basis will be permitted to purchase the installation at the end of any year, on terms to be specially arranged.

Whether the applicant decides to pay for the installation by deferred payments, or to rent it, the following conditions will apply:—

(1) The Corporation will guarantee the efficient working of the installation (except in case of accident, wilful damage, or the occurrence of fire, storm, or tempest) for 12 months from the electrical engineer's certificate of its due completion; but the Council is not to be liable to replace any worn-out or defective lamps.

(2) The owner of the property must be a party to the arrangement, and sign the Council's form of agreement.

(3) The Council will render to the applicant quarterly a statement of the amount due from him up to the preceding quarter day.

(4) The applicant must sign the Council's form of agreement providing for the observance of the terms herein mentioned, and such other terms as the Council has found necessary.

N.B.—Forms of the agreements referred to can be obtained at the Electrical Engineer's Office, Guildhall, Worcester. The electrical engineer will superintend the execution of the work by the contractor whose tender is accepted, but the Council makes no charge for this supervision..

AGREEMENT.

AN AGREEMENT made the ..... day of ..... 19..... between .....of ..... Worcester (herinafter called "the Consumer"), of the first part ..... of ..... (hereinafter called "the Landlord") of the second part, and THE MAYOR, ALDERMEN, AND CITIZENS OF THE CITY OF WORCESTER (hereinafter called "the Corporation") by ..... their electrical engineer of the third part, WHEREAS the landlord is owner of the house known as ..... situate at ..... Worcester, and the consumer is the tenant thereof, AND WHEREAS the consumer and the landlord are desirous of having the said house installed with the electric light, and have applied to the Corporation to wire the said house, which they have agreed to do, subject to the following terms and conditions. NOW IT IS HEREBY MUTUALLY AGREED as follows:—

The Corporation will wire the said house for electric light, with fittings and the first set of lamps complete, for.....lights in accordance with the terms of the specification deposited at the electricity department of the Corporation. The consumer need not take the fittings allowed him by the specification, but he may, if he prefers it, provide his own, subject to their being passed by the electrical engineer for the time being of the Corporation (hereinafter called the electrical engineer), before they are used in the installation; and in that case the Corporation will make the consumer allowances according to the prices specified in the schedule to this agreement, to be deducted from the consumer's payments hereunder. The cost of the installation shall be such sum as the electrical engineer shall certify to have been the cost thereof, and shall include the electrical engineer's fee for preparing the specification, and supervising the execution of the work. Such cost is hereinafter referred to as "the cost of the installation." All the fittings except such, if any, as are provided as aforesaid by the consumer, shall remain the property of the Corporation.

The consumer will pay to the Corporation so long as he occupies the said house the sum of 1s. 3d. per annum for each of the said lights, and a similar sum for each further light which may hereafter be installed in the said house; but where two or more lights are fitted to one point the annual payment for each light after the first shall be 6d. Such payments shall be made quarterly—on January 1st, April 1st, July 1st, and October 1st in every year—the first payment or a proportion thereof to be made on the first of the said days which follows the completion of the original installation. The consumer will, in addition, pay the Corporation's charge for electric current, and will abide by the conditions upon which the Corporation now supply, or may hereafter supply current to ordinary consumers. The

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consumer will also observe and abide by any rules and regulations made by the Board of Trade or other competent authority, and the passing by Parliament of any Act inconsistent with this agreement or any part thereof shall not, unless expressly so provided, invalidate this agreement, but the same shall continue in force so far as its provisions remain unaffected, unless the Corporation consent in writing to its termination.

The consumer will keep and maintain all the fittings in the said house, whether provided by the Corporation or the consumer, and the whole installation, in good order and condition. The consumer will, on ceasing his occupation of the said house, leave the installation in good order and condition, and hand over to the Corporation all their fittings in the said house, complete and in good repair and condition as aforesaid.

The Corporation shall have power, on giving 24 hours' notice, and at reasonable times, by the electrical engineer or other properly authorised official, and with or without workmen or others, to enter the said house to view the state of repair and condition of the fittings whether provided by the Corporation or the consumer, and of the installation; and of all defects and wants of reparation then and there found in such fittings or installation, to give or leave on the premises notice in writing to the consumer, and he will within the space of three weeks after such notice or sooner if required, repair and make good the same. If the consumer shall make default in repairing and making good any of the said defects of which notice in writing has been given as aforesaid, the Corporation may enter on the said house and repair the same at the consumer's expense, and the expenses of such repairs as certified by the electrical engineer, whose certificate shall be final, shall be paid by the consumer to the Corporation and shall be a debt due from him to them.

The landlord or the consumer may purchase the installation on either of the following terms:—

(*a*) By paying to the Corporation the cost of the installation in cash; or

(*b*) By paying to the Corporation in cash one equal tenth part of the cost of the installation, and the balance of such cost by equal quarterly instalments extending over ..... years from the date of the first payment, and with each instalment interest at 4 per cent. per annum on the amount for the time being remaining unpaid.

Whichever method of purchase is adopted the annual payment of 1s. 3d. per light or 6d. per light, as the case may be, must be paid up to the date on which the whole cost of the installation, or the first instalment thereof, as the case may be, is actually paid to the Corporation. Upon payment to the Corporation of the whole cost of the installation, with interest where payable, and all charges for electric current supplied to the house, the installation shall become the property of the landlord or consumer who pays for the same.

In case the consumer elects to purchase the installation and after payment of one or more instalments of the purchase money, ceases to occupy the house, he shall be liable to pay a proportion of the current quarterly instalment, with interest, up to the date of his so ceasing to occupy; but he may, with the landlord's consent, obtain and deliver to the Corporation a duly stamped agreement, signed by the person to whom the landlord may let the said house in immediate succession to the consumer, agreeing in such manner as the Corporation require, to carry out the consumer's obligations under this agreement; and in such event, the said incoming tenant shall be entitled to the advantages and be subject to the liabilities of the consumer under this agreement. While either landlord or consumer is purchasing the installation, all the clauses of this agreement shall continue in operation, but the due and punctual payment of the instalments of purchase money shall be deemed to be instead of the payment of the said yearly payment of 1s. 3d. per light, or 6d. per light, as the case may be.

Any notice, demand, or other writing to be served under this agreement shall be deemed to be duly served on the consumer when the same has been left at his usual or last known place of abode, and on the Corporation when the same has been left at the office of the electrical engineer. In case any of the conditions herein contained shall not be observed by the consumer, or a receiving order shall be made in respect of the estate of the consumer, or the consumer shall compound with his creditors or execute an assignment of his effects for the benefit of his creditors, or the consumer shall commit or suffer any act of, or take any proceeding having effects or results similar to bankruptcy; or the said wires or fittings of the Corporation, or any portion thereof, shall be seized or taken in execution (or shall be attempted so to be) under any process of any Court, then and in any of such cases the whole cost of the installation, where the consumer is paying an annual sum per light, and in every other case the whole of the balance of such cost, after deducting any instalments of the purchase money which have been paid, shall immediately become due and payable to the Corporation.

In case any payment to be made to the Corporation under this agreement is more than 14 days in arrear, the Corporation may, if they please, and without losing their right to sue for the said unpaid payment, enter the said house and remove the installation and all their fittings, and any damage unavoidably caused thereby to the said house, which the Corporation are hereby bound to pay to the landlord, may be also recovered by them from the consumer. In case the occupier of the house for the time being is not a consumer of electricity supplied by the Corporation, the Corporation may, if they please, enter the said house and remove the installation and all their fittings, making good any damage unavoidably caused thereby to the said house.

The landlord agrees to such of the above provisions as affect his rights, and he also agrees not to disturb the said installation without the leave of the Corporation in writing, which shall not be unreasonably withheld, or to distrain upon the said fittings, and further that he will permit their removal by the Corporation at any time subject to the terms of this agreement, the Corporation making good any damage caused thereby to the said house. Nothing in this agreement shall in any way affect the powers, rights, or remedies of the Corporation as the local authority under the Electric Lighting Acts, 1882 and 1888, or any order or regulations made thereunder, with respect to the said wires and fittings, but the said powers, rights, and remedies shall be and remain exercisable by the Corporation in every respect as if this agreement had not been entered into.

THE SCHEDULE REFERRED TO.

Ceiling rose	1s.
Flexible cord	3d.
9in. opal shade	6d.
Lampholder	1s.

[This is to be signed by the consumer, landlord and electrical engineer].

SCHEDULE A TO CIRCULAR.

Approximate cost of an installation of 25 16 c.p. lamps, to be repaid by 20 equal quarterly payments, with interest at 4 per cent. on balance:—

							Payments.		
							£	s.	d.
Average cost			£20	0	0				
Specification, &c.			1	0	0				
Total			21	0	0				
10% on completion			2	2	0				
			18	18	0				
1st year.—1st quarter			0	18	11	Interest 3 9 ...	1	2	8
			17	19	1				
2nd	„		0	18	11	„ 3 7 ...	1	2	6
			17	0	2				
3rd	„		0	18	11	„ 3 5 ...	1	2	4
			16	1	3				
4th	„		0	18	11	„ 3 3 ...	1	2	2
			15	2	4				
2nd year.—1st	„		0	18	11	„ 3 0 ...	1	1	11
			14	3	5				
2nd	„		0	18	11	„ 2 10 ...	1	1	9
			13	4	6				
3rd	„		0	18	11	„ 2 8 ...	1	1	7
			12	5	7				
4th	„		0	18	11	„ 2 6 ...	1	1	5
			11	6	8				
3rd year.—1st	„		0	18	11	„ 2 3 ...	1	1	2
			10	7	9				
2nd	„		0	18	11	„ 2 1 ...	1	1	0
			9	8	10				
3rd	„		0	18	11	„ 1 11 ...	1	0	10
			8	9	11				
4th	„		0	18	11	„ 1 8 ...	1	0	7
			7	11	0				
4th year.—1st	„		0	18	11	„ 1 6 ...	1	0	5
			6	12	1				
2nd	„		0	18	11	„ 1 4 ...	1	0	3
			5	13	2				
3rd	„		0	18	11	„ 1 2 ...	1	0	1
			4	14	3				
4th	„		0	18	11	„ 0 11 ...	0	19	10
			3	15	4				
5th year.—1st	„		0	18	10	„ 0 9 ...	0	19	7
			2	16	6				
2nd	„		0	18	10	„ 0 7 ...	0	19	5
			1	17	8				
3rd	„		0	18	10	„ 0 5 ...	0	19	3
			0	18	10				
4th	„		0	18	10	„ 0 2 ...	0	19	0
						£1 19 9	£22	19	9

SCHEDULE B.

The following allowances will be made where a consumer desires more expensive fittings.

Ceiling rose	1s.	9in. opal shade	6d.
Flexible cord	3d.	Lampholder	1s.

N.B.—The Council reserves the right to withdraw or modify the foregoing scheme at any time, or to decline to act under it in any particular case.

In conclusion I should like to express my thanks to the town clerk of Worcester (Mr. Samuel Southall), and to Mr. C. D. Taite, borough electrical engineer of Southport, for their kindness and help in the preparation of this scheme.

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A FRICTIONLESS MOTOR METER.*

BY S. EVERSHED.

(*Continued from page 285.*)

Description of Frictionless Meter.—The essential working parts of the author's meter are shown in Fig. 7. The armature A, brake dish F, and train-driving coils D_1 D_2, are mounted on a mild steel axle *a*. The axle has a hard steel point at its lower end, resting in a jewel cup, J; its upper end has no mechanical support, but is main-

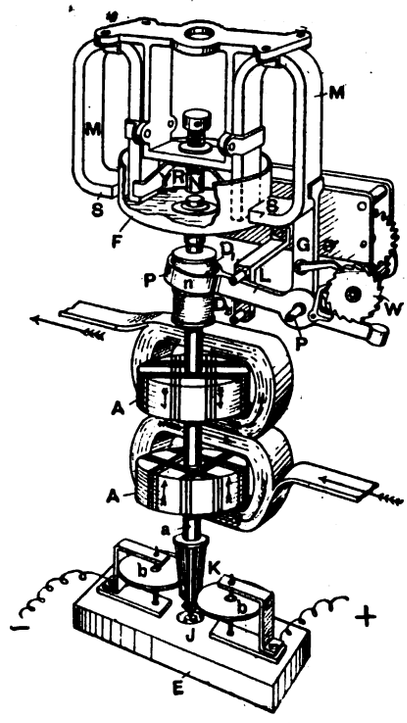
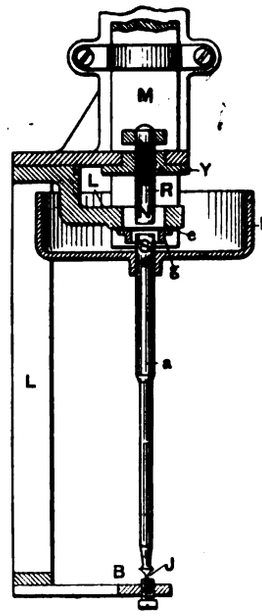


FIG. 7.—General Arrangement of Astatic Frictionless Meter.

tained in position by the magnetic attraction of an iron rod, R, which is magnetised by the brake magnets M M through an iron yoke, Y, and forms the supporting pole. The distance between R and the end of the axle is adjusted by screwing R in the yoke Y until the vertical force nearly suffices to lift the whole weight of the arma-



M. Brake magnet; *Y*, iron yoke between the brake magnets.
R. Iron rod forming supporting pole *N*.
a. Iron axle having upper end *S* beneath pole *N*.
e. End-plate (non-magnetic).
g. Guard ring to prevent axle from being displaced.
F. Brake dish.
B. Step bearing with jewel cup *J*.
L. Axle bearing frame.

FIG. 8.—Axial Section showing Details of Magnetic Suspension in a Frictionless Meter.

ture, brake, and other parts attached to the axle. The arrangement is more clearly seen in Fig. 8, which is a section through the magnetic pivot. A magnetic pivot of this type may easily be made to support a weight of from 100 to 200 grammes.

* Paper read before the Institution of Electrical Engineers, May 10.

The commutator K is placed beneath the armature, and the wheel brushes *b b* are pivotted in frames attached to an ebonite plate E. The commutator and brushes are shown on an enlarged scale in Fig. 9. The segments are fine iridio-platinum wires supported at one end in an ivory collet and entirely free at the other end, where they impinge and roll on the brush wheels. The commutator is about 3mm. in diameter at the rolling circle; the wheels are about 36mm. diameter, so that they make one revolution to twelve revolutions of the commutator.

The pressure current is led to the brush wheels through their frames, and to ensure good contact between frame and wheel the step bearing of each wheel is an iridio-platinum pivot resting on a flat plate of the same metal.

A drum-winding is used for the armature, a break being made, in the ordinary course of winding, in each parallel, in order to insert the two little coils D_1 D_2. Thus D_1 is in series with one of the two parallels of the drum-winding, and D_2 in series with the other; they are consequently each traversed by one half of the whole armature

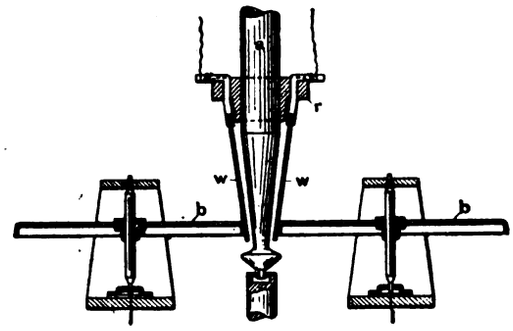


FIG. 9.—Elastic Commutator.

a, Axle; *r*, Insulating collet; *w w*, Iridio-platinum wires forming commutator segments; *b b*, Brush wheels; *p p*, Iridio-platinum pivots; *I I*, Iridio-platinum bearing plates.

current, and since they are, electrically, a part of the armature-circuit, the current in them is reversed twice in each revolution of the axle. D_1 and D_2 are inserted at corresponding points of the drum-winding, so that their currents reverse at the same instant, and they are coupled up so that the two currents flow in the same direction and to all intents and purposes D_1 and D_2 behave like one coil.

Fig. 10 shows the connections of the train-driving coils in diagrammatic form, a Gramme winding being substituted for the drum for the sake of clearness. Surrounding the train coils D_1 and D_2, but not touching them, is a ring of soft iron P (Fig. 7), forming part of an iron lever L, mounted on an horizontal axle *p*. L is magnetised by induction from one of the brake magnets, an iron bar G serving to complete the magnetic circuit between S and *n*. The induction leaves the ring pole P, and passes radially through the train coils into the axle, and P consequently experiences a vertical

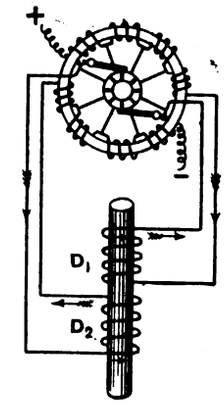


FIG. 10.—Diagram of Connections between Armature and Train Coils.

force alternately upwards and downwards as the currents in the train coils periodically reverse. The result is that L oscillates on its axis, making a double stroke or complete cycle once in every revolution of the armature. The motion of the lever is limited by stops, and is communicated by means of a pawl to a ratchet wheel, W, which is attached to the first axle of the counting-train T.

It will be seen at once that this device opposes no retarding moment on the armature axle. The only mechanical force called into play is in a vertical direction, and has no component tending to turn the axle. The train coils and magnetised lever form a reciprocating electric motor, and, during the time the ring pole is moving up (or down) there is a back E.M.F. in the train coils, and the product of this back E.M.F. into the armature current and the time gives the consumption of electrical energy per stroke. It is, of course, equal to the mechanical work done—product of force on P

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into length of stroke. The force actually provided is far greater than that necessary to drive the train. The friction of an ordinary train is just overcome by a turning moment of about 4 dyne cm. applied to the worm or pinion commonly used on a meter axle to gear into the first wheel of the train; 6 dyne cm. will generally keep a train running at a speed a good deal higher than anything save a short circuit can produce. The author has tested many trains taken out of different electric meters, and curiously enough they differ very little as regards friction.

Now, if the train were geared to the axle in the usual manner, and required a moment of 6 dyne cm. to keep it going, the work done by the meter in driving the train, being, of course, 2π times this moment in each revolution, would be about 38 ergs. The stroke of the train-driving lever is about 1·0 cm., so that the force upon it must be at least $\frac{38}{1·0} = 38$ dynes. The force actually obtained is about 750 dynes, which leaves an ample margin for accidental friction. It is assumed that the lever does no useful work on its return stroke.

A number of different forms of this train driver have been designed, and several of them have been tested in actual work. Fig. 11 shows a modification characterised by the same fundamental principle, namely, a coil producing an alternarely upward and downward force upon the free end of a lever. In this modification the two train coils D_1 and D_2 are coupled back to back, so that they produce a consequent pole in the space between them, and the movable coil attached to the end of the lever is alternately forced up and down. This coil forms part of the series resistance in the armature circuit, and carries the whole of the pressure current. Fig. 11 is intended for alternate current meters, where a permanently magnetised lever would, of course, be useless.

There are other features in the design of the meter which will be of interest to station engineers, but which are hardly of sufficient general interest to warrant such a detailed description as has been given of the means adopted to reduce friction. The whole of the working parts of the meter, with the exception of the main current

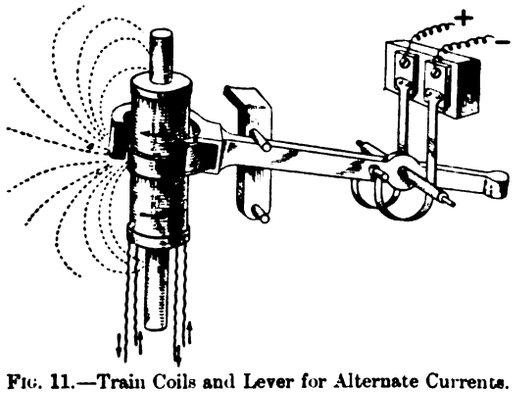

Fig. 11.—Train Coils and Lever for Alternate Currents.

coils, are attached to a light framework, which is bolted to the top of the casting which forms the back, top, and bottom of the meter case. The other three sides of the case are formed by a bent sheet of zinc, which is screwed and sealed to the casting. The terminals project below the bottom and are covered by an insulating box, which may be sealed after connecting up on the consumers' premises. The Foucault brake is in the form of a shallow dish, and the two brake magnets are fixed in positions which make it impossible for any excess of current in the main coils to demagnetise them. Their stray field is at right angles to that of the main coils.

Range of Frictionless Meter.—A meter in which frictional resistance is so small as 3 dyne cms. will obviously have an unusually long range, even if nothing be done to correct the small remaining friction error. If the same limits are imposed as were assumed in making up Table I.—namely, about 1 volt drop in the main coils and 3 watts wasted in the pressure circuit—the meter may be wound to give a maximum driving torque of 15,000 dyne cms. The friction is then only 0·02 per cent. of the full-load torque. The resulting range and uncorrected errors are set out in Table II.

It will be seen that the standard range of this uncorrected meter is 1 to 250. The range may be greatly extended by introducing a device to compensate for friction, and the very long range of such compensated meters may be useful in special cases. The author believes, however, that if advantage is taken of the enormous reduction in friction to improve the meter in other ways, even at a sacrifice of some part of the long range, a more generally serviceable instrument will be secured. An examination of the available statistics with regard to numbers of consumers and the lamps (or equivalent load) connected to the mains of the supply undertakings of this country shows that on an average about 50 8 c.p. lamps or their equivalent are wired per consumer. If we assume these to be 40-watt lamps, the maximum load of the average consumer will be

Table II.—*Errors of Uncorrected "Frictionless" Meter.*
Maximum Driving Torque = 100, Friction = 0·02. Full Speed = 100; Arbitrary Units.

Driving moment. M.	Friction *f*.	Speed (numerically equal to M − *f*).	Percentage error.
0·02	0·02	0	inf.
0·04	0·02	0·02	− 50
0·10	0·02	0·08	− 20
0·40	0·02	0·38	− 5
1·00	0·02	0·98	− 2
10·00	0·02	9·98	− 0·02
50·00	0·02	49·98	− 0·04
100·00	0·02	99·98	− 0·02

Standard range = 1 to 250.

about 2,000 watts and his minimum about 40 watts. Now, although the maximum demand of the consumer will not much exceed half this amount (the "maximum demand" for nine of the largest undertakings in London is 46 per cent. of the total load connected), the meter installed may be assumed to be wound for 2,000 watts, so that, if the meter is to register correctly at the smallest load, its range must at least be 1 to 50. It is, of course, quite probable that within a few years consumers will be using lamps taking far less power, but there is no reason to believe that the ratio of smallest load to maximum load will be much, if at all, affected by the introduction of more economical lamps. The standard range may then be reduced to 1 to 50, but any further decrease will be at the expense of revenue.

A reduction of range enables us largely to reduce the power wasted in the armature circuit, but a limit to this reduction is imposed by the fineness of the wire it is possible to employ upon the armature and in the series resistance. On this account it is at present not advisable to reduce the pressure current below 0·01 amperes, and this value has therefore been adopted for all voltages. The waste of power in the armature circuit is then one watt for 100 volts, two watts for 200 volts, and so on. The voltage drop in the main coils may be left at one volt, this being only one-half per cent. on the 200-volt supply which is now being rapidly adopted. An additional improvement in accuracy has been secured by making the meter astatic, so that it is not affected by external magnetic forces.

Astatic Meter.—The astatic meter has its armature divided into two equal portions, placed one above the other, on the axle, as shown in Fig. 7. These two parts, although physically separated, form one complete drum-winding connected to a single commutator. Following the process of winding a drum, the first coil will be wound on the lower spider; the second will be wound on the upper spider in exactly the same position as regards azimuth as it would ordinarily occupy if wound on the lower armature, but it is wound in the opposite sense. The third coil is on the lower spider; the fourth on the upper and reversed in sense. Thus numbering the coils in succession, all the odd numbers will be found on the lower half armature and all the even numbers will be found on the upper half. Each half armature is surrounded by its own pair of main-current coils, the two pairs being coupled so that the current flows in them in opposite senses, their magnetic fields being in opposite directions. This reversed coupling is, of course, necessary to drive both parts of the armature the same way, but it has the incidental advantage that it greatly reduces the stray field of the main coils, and so renders the brake magnets doubly secure against excessive currents.

The advantage of an astatic armature is, however, only gained at the cost of a reduction in driving torque, for a little consideration will show that when a non-astatic drum armature is converted to the astatic form shown in Fig. 7, and one-half of the copper on the main coils is taken off and made up into a second pair of coils, so that each of the two parts of the armatures may be driven, the field in which the armature rotates is halved although the number of turns on the armature itself remains the same as before. Probably very few consumers possess the requisite combination of knowledge and knavery to enable them to attempt a reduction of their electric light bill by the use of a strong magnet placed near the meter, but meters are always liable to be fixed in positions where stray fields exist, and the author is inclined to believe that the astatic armature will prove to be a clear gain.

To sum up—the astatic meter is wound to give a driving torque of about 2,000 dyne cm. at full load; the current in the armature circuit being 10 milliamperes and the drop in the main coils 1 volt. The frictional resistance is about 2 dyne cm. when the meter is new, and the tests to be presently referred to show that a frictionless meter will run for many million revolutions before any serious increase in friction takes place.

Compensation for Remaining Friction.—The initial value of friction is compensated for by means of a little strip of sheet iron placed within the field of the main coils. When once magnetised by the main current the coercive force of the iron is sufficient to provide the very small driving moment required to overcome friction. As has already been pointed out, compensation for friction will cause a meter

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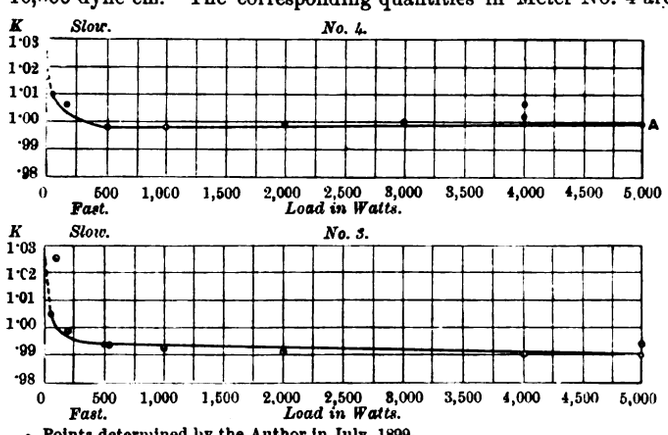
to run at no load if it is subjected to vibration ; but when friction is only a very minute fraction of the maximum driving torque, the over-registration of a corrected meter would be quite negligible even if it could occur, but, as a matter of fact, the elastic commutator has a directing moment upon the axle which prevents the meter from running until the driving torque is two or three times as great as the moment of friction. Hence it is impossible for the compensator to start the meter or to keep it running. The corrected meter starts with from $\frac{1}{500}$th to $\frac{1}{300}$th of full load, and has a standard range of about 1 to 200.

The range and accuracy of a corrected meter are well exemplified by the two curves given in Fig. 12, which show the variation in the constants of two meters having a ratio of about 1 to 1,250 between friction and full-load torque. This happens to be approximately the same ratio as that it is proposed to adopt as a reasonable compromise between the conflicting elements of accuracy and waste of power, so that although these meters have a much larger frictional resistance than is now obtained, yet as regards accuracy and range they are very nearly identical with the astatic meter. The latter has much less driving torque, but its frictional resistance is smaller by a corresponding amount.

The larger friction in meters Nos. 3 and 4 arises from the fact that they were made before the adoption of the elastic commutator and other improvements They are fitted with very small commutators with rigid sections made of iridio-platinum wires, which form a sort of squirrel-cage round the axle. The diameter of the commutator is about $\frac{1}{16}$in. Fine wire brushes are used, pressing very lightly upon the commutator. The frictional resistance in Meter No 3 is 7·9 dyne cm , and the driving torque at full load is 10,000 dyne cm. The corresponding quantities in Meter No. 4 are



• Points determined by the Author in July, 1899.
⊙ Points determined by Mr. Rennie at the Board of Trade Laboratory, September, 1899. At *A*, Mr. Rennie's observation falls exactly on a point determined by the Author.
N.B.—The horizontal lines are drawn at intervals of one per cent.

FIG. 12.--Curves for Meters Nos. 3 and 4 showing Variations of Constant with Load.

approximately the same, but they were not accurately measured. These meters are corrected by a thin steel rod having the necessary coercive force, and, as will be seen on reference to the curves they are both slightly under-corrected. The Board of Trade limits are, however, nowhere exceeded throughout the whole range from 0 to 5,000 watts.*

(To be concluded).

MEANS OF STIMULATING THE DEMAND FOR AN ELECTRICITY SUPPLY.†

I.—BY ALDERMAN POTTER, J.P.
(Chairman of Electrical Committte, Taunton.)

What are the hindrances and difficulties in the way of an extension of electricity supply? And by what means may they be overcome so as to sweep away any lingering prejudices, and to create within the public mind a preference for electricity over every other kind of illuminant? These are questions not only of great interest to all who are in any manner concerned in its financial success, but which have been from time to time answered in various ways, with more or less beneficial results. In acceding to the request of the Council to write a Paper on this subject, I wish it to be clearly understood that I disclaim all idea of being able to bring forward any new or original suggestion, but having seen the results attending some of the suggestions which have from time to time been made, I am hopeful that my experience may be of some use, especially to those who are connected with small electrical undertakings in poor districts which have not attained a profit-making stage.

In the earlier stages of electric lighting one of the most serious hindrances to its extension was its extremely erratic character and unreliability, *e.g.*, it so frequently went out at most inconvenient times, causing such confusion and annoyance, that many persons otherwise favourably disposed would have nothing to do with it; but this uncertainty has become a thing of the past. The improvements that have taken place in electrical machinery, and the increased efficiency of electricians generally, are so great that where a generating station is equipped with modern plant, worked by a competent staff, anything beyond a very occasional, partial, or temporary failure is unknown, and its intermittent character no longer operates on the public mind as a hindrance to its growing demand. At the present time the initial difficulty that has to be overcome in order to stimulate the demand for an electricity supply by securing additional customers is that relating to the cost of electricity as compared with gas or oil. The advantages claimed for the electric light over every other kind of artificial illuminant, such as being more conducive to health, its cleanliness, convenience, and the saving effected through its use in painters and paperhangers' bills may not be denied, but they will fail in accomplishing the desired end unless it can also be shown that these advantages can be obtained with little or no additional increase in the light bill. Persons who have become accustomed to the use of electricity learn to appreciate its undoubted advantages so highly as to be willing to pay more for it than they formerly did for gas or oil, but in the case of a new consumer the advantages often appear somewhat mythical or remote, whilst the *cost* is present and real. The only way of meeting this difficulty appears to be that of charging as low a price per unit as possible, *after providing for all necessary expenses.*

In most instances it is found necessary to receive some assistance from the rates for the first year or so of an undertaking; but the aim of those having the management of municipal works should be to do without such assistance as speedily as possible. The wisdom of doing what some corporations do, charging one price for private lighting and a much lower price for public lighting, supplementing it year by year by a contribution from the rates, is very questionable; better charge both public and private lighting with its fair share of costs, and make the undertaking self-supporting. There is but little for a municipal undertaking to accomplish beyond this; there is nothing really gained to the ratepayers by making large profits if the price charged is high. Its aim should be, especially in the earlier years of the undertaking, not so much to realise a profit, to be applied to a reduction of the rates, as to supply the light, both public and private, at the lowest possible price, after meeting all expenses and providing for all contingencies. By so doing not only are the ratepayers directly benefited, but it is a means of stimulating the demand for an electricity supply, as also does the giving of rebate, after the current has been used a specified time, if care be taken to fix the time limit so as to include all who use the light for any reasonable time within its sweep The public do not understand the impracticability of taking a graduated discount off an electricity account, as is done off water or gas; therefore, when a consumer, who having a large number of lamps installed, but uses them only a short time, finds that he gets no rebate, though the amount of his bill be larger than that of his neighbour, who with fewer lamps installed, yet using them a greater number of hours, gets a rebate, he is dissatisfied and feels aggrieved.

At Taunton, the system first adopted was that of giving a discount according to the amount of the consumer's bill, but finding that that was a wrong principle to go upon, the demand indicator system was adopted, charging 6d. per unit for the first two hours' demand, and 3½d. after; the result being that few of the principal shopkeepers, living away from their business premises, exceeded the two hours' average, and therefore got no rebate; this gave rise to a great deal of dissatisfaction, and many threatened to give up the light. Some 18 months ago, the Electrical committee saw their way to reduce this time limit from two hours to one, with this result, that nearly all charged under this system get a rebate; all grievance is removed, and there has been a large increase in the number of lamps installed, not only through an increase in the number of consumers, but also by reason of the extension of the light in premises in which only a few lamps had been previously installed.

Another difficulty is connected with the cost of installation, especially in premises which are held for a short tenancy only, and in which gas is already laid on. Though the cost of installation has been very much reduced within the last few years, still many find themselves unable to bear the expense, and others are, not without reason reluctant to do so when they are only tenants of the premises they occupy. But this difficulty is effectually met by adopting the system of free wiring, which is also often the means of securing a most desirable class of consumers, small shop-keepers and householders, whose means are such that they could not afford the expense of having their premises wired. The National Electric Wiring Co.

* Meters Nos. 3 and 4 are in use in the meter-testing department of the Manchester Corporation as standards for checking the accuracy of other meters intended for commercial purposes, and the author is indebted to Mr. Wordingham for his permission to make use of the curves which accompanied the Board of Trade certificate. He desires also to thank Mr. Rennie, who very kindly supplied a copy of the tests made at the Board of Trade Laboratory.

† Papers read before the Municipal Electrical Association, at Huddersfield, June 20.

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have gone in extensively for this. Although they do a large amount of contracting work, the backbone of their business is free wiring, and in this direction have been of immense service to many a struggling electrical undertaking, as under the terms of their agreement any person can have their premises wired and fitted up for the supply of electricity without any initial charge whatever, the Corporation or supply authority agreeing to pay to the Wiring Company so much (generally one penny per unit) on all electricity supplied through their wires and fittings. In some cases this penny is added to the price charged per unit, and is paid by the consumer, but this, which is perfectly fair and reasonable, is open to the objection that such consumers are apt to imagine that they have a grievance—that they are unfairly treated in having to pay more per unit than other persons. It is better to have one uniform price and charge all alike per unit; but to explain to those who apply to have their premises free wired that no rebate will be allowed them whatever their consumption, and that the rebate they would have received if the installation had been made at their cost goes to pay the company. This cannot be regarded other than fair by all concerned. Taking Taunton as an example, it is fair to the Corporation because the amount received from all our consumers is 5d. per unit. This is the average amount we receive under the rebate system, and also the nett amount we receive from those whose premises have been free wired. It is fair also to those who have installed the light at their own cost, as in the amount of the rebate they have some return for the capital expended. It does not press unfairly on those whose premises have been free wired, because if they find that their consumption is such that the rebate would be a good return on the cost of the installation, they can, if desirous of so doing, buy the company out by the payment of the cost price of the installation, plus 20 per cent., less 1½ per cent. per annum depreciation. If further proof be necessary to show the valuable help the Free Wiring Company is in stimulating the demand for an electricity supply, it will surely be seen in the following statement, showing the number of lamps installed by the company up to the end of 1899, under contract and free wiring:—

Lincoln	4,233	8 c.p. equiv.
Prescot	2,505	ditto
Worcester	1,745	ditto
Blackpool	6,410	ditto
Taunton	4,903	ditto
Shoreditch	3,236	ditto
South London Supply Corporation	3,319	ditto
Wallasey	11,910	ditto
Crystal Palace Electric Supply Co. (Ltd.) (since July, 1899) over	3,000	ditto

In Lincoln not a single application for current had been received by the Corporation before the company entered into a contract. They were, however, able by the time the plant was ready to provide such a number of lights as to render it necessary for the Council to take steps to increase the plant. At Taunton, during the first year of the contract, upwards of 3,000 lights had been installed. In Wallasey, at the end of 1898, over 70 per cent. of the consumers connected with the supply had been obtained by the company, and they were taking over 80 per cent. of the output. As, however, the company require to be paid the minimum sum of 1s. for every 8 c.p. lamp, care must be taken to see that their agents do not instal lamps of greater candle-power than is actually required.

Closely allied to the question of free wiring is that of prepayment, or slot meters, which finds favour with consumers in poor and weekly wage-earning districts, many of whom would find it a difficult matter to pay a quarterly account, but prefer to pay as they go. Further, by the use of slot meters there is no dispute about the amount of the bill, nor any bad debts. Often the supply creates the demand. This is so in connection with electric lighting; the demand is stimulated by the supply undertakers adopting a bold spirited policy in laying mains in likely districts, even though they do not succeed in getting such a number of promises to use the light as, in the opinion of the over-cautious, would justify the expenditure. It is frequently the case that persons who, when canvassed for this purpose, object to give a definite promise, are amongst the first to become consumers when the mains are laid, and it is only a question of joining them up. Some three years or so ago the Taunton Corporation were asked to lay mains in order to light up two private residences in opposite directions, one a mile and the other nearly two miles from the generating station, the owners agreeing to pay 5 per cent. on the outlay until such time as the revenue from these mains should reach a certain amount. Notwithstanding this agreement there was opposition to carry the mains so far, it was said, for one house, but the mains were laid, and the results have fully justified such a course, for with the exception of the principal business portions of the borough these two lengths of mains are the most remunerative. The application of electricity for power and heating purposes presents many opportunities for stimulating the demand, and in stations having a day load for lighting purposes such an addition is very profitable.

In conclusion, it may be stated that Taunton is not a large rich manufacturing town, but a small agricultural town, at a great distance from the coal fields. There are no large consumers connected with its mains, such as theatres, large hotels, and public rooms, but principally short-hour shopkeepers and middle-class residences; but working more or less on the lines indicated in this Paper. The loss of over £900 a year on the revenue account up to 1893 (when taken over by the Corporation) has been converted into a profit of over £2,000 a year, with every prospect of an increased and continued success.

II.—By H. Collings Bishop.

(Borough Electrical and Tramways Engineer, Wigan.)

The subject of this Paper is one which has, I think, received far too little attention from most central station engineers—the chief engineer of a central station cannot be fully conversant with the best means of inducing people to use electricity, unless he is also the leading spirit in the accountant's department. He should have at his finger ends the whole of the business side of the station as much as the engineering side, as without this he will have a difficulty in accomplishing his purpose, viz., to obtain a high load factor and an increased demand for current. To stimulate the demand for electricity means to increase the sales and to lower the costs, and there are many ways of doing this. Some of these methods of course are already in use, among which are some that are not as satisfactory as at first sight they appear. The following are some of the means which seem to promise well: (1) Low price, (2) sliding scale, giving long-hour consumers a lower rate, (3) free use of meters, (4) free connection of services, (5) a free wiring system, (6) a system of wiring on the instalment plan, (7) a specially low rate for current used for motive power, heating, or manufacturing purposes, (8) the hiring out of motors, arc lamps, heating, and cooking apparatus (including inspection and repairs), (9) to enable short-hour consumers, with a large number of lamps connected, to obtain the current they require at a lower rate than the maximum, and to reduce at the same time the load demanded from the station. Each of the above methods may be considered acceptable to the consumer, and I now propose to consider what would be the probable effect of them on the output of the station, and to show how the consumer would be benefited by their adoption. The first four speak for themselves and require no explanation, so we may proceed to the fifth, viz.:—

Free Wiring.—It is difficult to understand why this system should be thus named, as there is very little that is free about it. It may be of great benefit to one consumer and of no use to another, as the charges are made on the number of units used, with a minimum payment of 10 per cent. on the cost of the installation, with trade profit added. The consumer who is most benefited by the use of "free wiring" is the one who uses the smallest number of units, and therefore does not have to pay more than the 10 per cent. minimum charge for the use of the wiring and fittings.

Instalment Plan.—This should be very popular with all classes of consumers, and I would suggest the following prices as both profitable to the wiring syndicate and acceptable to the consumer. The consumer should be allowed to have any kind or class of fitting that he prefers, the price of the installation to be ascertained in the following way: The prime cost of the work plus 15 per cent for standing charges, plus 20 per cent. for trade profit, plus 2½ per cent. for inspection by the "undertakers." The total amount to be paid as follows: 10 per cent. on the completion of the work and the balance in 16 quarterly payments, plus 5 per cent. per annum on the portions remaining unpaid, the installation becoming the property of the consumer on payment of the last instalment.

It may be of interest to see how these two systems compare with each other, and with a cash payment. We will suppose these three instances apply to the same building. Current is assumed to be supplied at the following rates:—7d. per unit for the first hour's daily average use, and 2d. per unit for all used beyond that time.

Cash.—A. instals in his shop 15 lights, the cost works out as follows:

Prime cost	£11	5	0	
Standing charges	1	13	9	
Trade profit	2	5	0	
				£15 3 9

During a four years' use of the light the consumer will have paid the following amounts, including interest on his outlay: No. of units used 3,800, and the average demand 4 amperes at 230 volts.

Current at 7d. per unit	£39	3	5	
Current at 2d. per unit	20	9	6	
Interest on capital at 5 per cent.	3	0	8	
Renewal of lamps	2	0	0	
Depreciation 2½ per cent. per annum	1	10	4	
Capital cost of fitting up premises	15	3	9	
				£81 7 8

Free Wiring.—I have taken the charges to be as follows: ¾d. per unit extra for all current used at the 7d. rate, and ½d. per unit for all current used at the 2d. rate, with a minimum charge of 10 per cent. per annum on the capital cost, the consumer having the option of purchasing the installation at the end of four years on paying the

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capital outlay *less* 10 per cent. for depreciation. Taking the same case as in the last instance the cost will be as follows :—

Current at 7d. per unit			£39	3	5
Current at 2d. per unit			20	9	6
¾d. per unit on the 7d. rate			4	3	11
½d. per unit on the 2d. rate			5	2	4
Renewals of lamps			2	0	0
				£70	19 0

Now, let us assume that at the end of the four years this consumer decided to purchase the installation, the cost would then be as follows :—

Brought forward from last account			£70	19	2
Cost of installation	£15	3 9			
Less 10 per cent. depreciation	1	10 4			
			13	13	5
Interest on the amount paid extra per unit, the whole being averaged			1	2	6
				£85	15 1

Instalment Plan.—Taking the same case again, the cost will be as follows :—

Current at 7d. per unit	£39	3	5
Current at 2d. per unit	20	9	6
Renewals of lamps	2	0	0
2½ per cent. for supervision of "undertakers"	0	7	7
10 per cent. of capital paid on completion	1	10	4
16 quarterly payments of the remainder	13	13	5
Interest on unpaid portions at 5 per cent.	1	8	4
Interest on paid portions as accumulated	1	11	0
Depreciation at 2½ per cent. per annum	1	10	0
		£81	13 11

A comparison of the three systems shows the following result :—

Free wiring	£85	15	1
Instalment	81	13	5
Cash payment	81	7	8

In each case the installation is the property of the consumer at the end of the four years. This, I think, shows that the consumer is a distinct gainer by adopting the instalment plan. Who would pay cash when such a means is open to him of having his premises fitted up and inspected for such a small extra payment?

The above instances show that in the majority of cases the instalment plan of payment is by far the most beneficial to the consumer, although it does happen that in some cases when a consumer is a short-hour user and does not desire to purchase that the free wiring plan is the best for him. Although the helping of a consumer to lighten the first cost of fitting up is a good means of stimulating a demand for electricity, at the same time it is necessary that a low tariff should be adopted, and that such a tariff can be made profitable is easily proved by a glance at the annual returns of lighting stations. Street lighting is also a department that requires special inducements to ensure its adoption, and this end is most easily obtained by a low tariff—of, say, 2½d. per unit inclusive of all charges of maintenance.

Tramways.—This department is an important one, and one that every municipal electrical engineer should try and combine with a lighting system if possible. The bogey one so often hears of now—the putting forward of the benefits of having a separate supply station—can generally be traced to self-seeking on the part of a tramway committee, and perhaps of an official as well, who, forgetting that both departments belong to the same body, wish to be able to say that their department is separate from all others. Would they talk in the same way if it were a question of supplying a company with current for the running of their cars? If a separate station can generate current cheaply the combined station can do so equally well, for, although on paper it may be supplying at a lower rate than it is costing to produce, the benefit of the extra long-hour load is cheapening the whole cost of production, and therefore enabling an extra profit to be made on the lighting supply. This can be done without any extra cost to the tramway department. The acquisition of a 16-hour load is a valuable adjunct, and even this can be increased by utilising the track at night-time for running cars for removing the town's refuse that has been collected during the day, and thus save the corporation a large amount of carting costs.

Stationary Motors.—By offering current on a low sliding scale of from, say, 2d. to ¾d. per unit, coupled with a system of hiring motors, a very profitable demand should be obtained.

There is a class of consumer very difficult to obtain, as it comes under the maximum lighting rate, and which I have often heard engineers say they are better without—I refer to the large consumer with a short-hour demand, whose lighting is required only at the peak of the load. Why should not this lighting be turned into a long-hour demand with a small demand in kilowatts? I venture to give an instance of how this might be brought about—at any rate, in continuous stations—with the aid of a storage battery and a motor generator. For example, a mill or factory using, say, 1,000 16 c.p. lamps at 100 volts. I would instal a battery of about 1,000 ampere hours and a motor generator of about 6 kw. The capital cost of this with switch gear would cost, say, £630. Assuming the daily average demand to be 1½ hours, the current required per annum would be 27,375 units, which, at a charge of 7d. and 2d., would amount to £608. 6s. 8d. In place of supplying current direct at the above prices, suppose we do so on the following plan, using the battery and motor generator mentioned above. The cost per annum should then work out as follows :—

Interest on capital outlay at 5 per cent.	£31	10	0
Maintenance of battery at 6 per cent. per annum (taking the cost of battery at £500)	30	0	0
Depreciation on remaining portion of capital at 2½ per cent.	3	15	0
Proportion of labour looking after plant	30	0	0
Oil, water, waste, &c.	5	0	0
Units used by motor generator in keeping battery charged, assuming a 50 per cent. efficiency, 54,750 units at, say, 1d. per unit	228	2	0
Total	£328	7	0

It will be seen that a saving of £279. 19s. 8d. is made, and the central station obtains a large demand in current at a very small demand in kilowatts. What follows may perhaps seem irrelevant to the subject of this Paper, but I venture to give an idea of the profits that might be derived if—a big If—consumers could be brought to the same way of thinking as the engineer. I am taking my own town as an example, and I instance only existing cases and those promised. The capital cost will be very close to the figures given, all contracts having been let and an ample amount allowed for contingences—

Kilowatt capacity of the station	1,800		
Deducted for reserve	300		
Net amount available for use	1,500		
Capital cost per kilowatt	£60		
400,000 30-watt lamps connected to the mains, each using 20 units per annum, at the average price of 4½d. per unit —800,000 units	£15,000	0	0
120 arc lamps 500 watts each, burning 3,700 hours per annum, and using 222,000 units, at 2½d. per unit, inclusive of maintenance	2,312	0	0
300 kw. in motors, including six mills and factories for lighting purposes, and 70 kw. in motors in a cold storage running 24 hours per day. The average demand is taken at 10 hours and the average price per unit at 1¼d.—1,095,000 units	5,703	0	0
26 miles of tramways running 1,226,000 car miles per annum and using 1 unit per car mile at 1½d. per unit	7,665	0	0
Total	£30,680	0	0

The load factor works out at 25·44, and with so high a one no difficulty should be found in obtaining a total cost per unit of not more than 1·25d. per unit. This would give a total cost on the above output of £17,420. A profit of about 12 per cent. is made before setting aside interest and depreciation and about 7 per cent. after paying all charges. I have endeavoured to place all the figures on a safe basis: at the same time I can see no reason why the total costs should not be brought down to 1d. per unit. I trust this short Paper may be the means of obtaining many suggestions for increasing the demand for electricity, especially that class which will increase the load factor.

CORRESPONDENCE.

LONG-DISTANCE POWER TRANSMISSION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Prof. Perry's letter in your issue of June 15. Instead of saying, as before, that it is impossible in a transmission line to get an efficiency of less than 50 per cent., he now says that this is impossible to a competent engineer. If he will further limit this statement to transmission lines *without boosters* he will have uttered a truism which everyone accepts. But the statement is untrue if boosters be used.

He very frankly admits that, in my letter which you published on June 8, I had succeeded in detecting certain erroneous data which he had made use of when criticising Table II. of my Paper given to the Institution of Electrical Engineers. But his last letter accentuates a serious mistake, which in his previous letter had escaped my notice.

In the second line of my Table II. the following question is answered: *What weight of copper* (per horse-power delivered) *is required for the efficiency 12 per cent.* under certain specified conditions? There is only one answer to this question, and it is *half a ton*, as stated in Table II.

Prof. Perry tries to prove this table wrong by answering incompletely a different question, viz.—*What efficiency can you get with half a ton of copper* under the specified conditions? There are two correct answers to this question, both of which

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happen to be given in my Table II. One is 12 per cent. (given exactly in the second line of Table II.). The other answer is about 70 per cent. (given in Table II. by interpolation at the fourth line). Now, Prof. Perry publishes a table in which the former value is headed "According to Prof. Forbes," and an approximation to the latter value is headed "Correct figures," although both values are indicated in my table.—Yours, &c., GEORGE FORBES.

London, June 18.

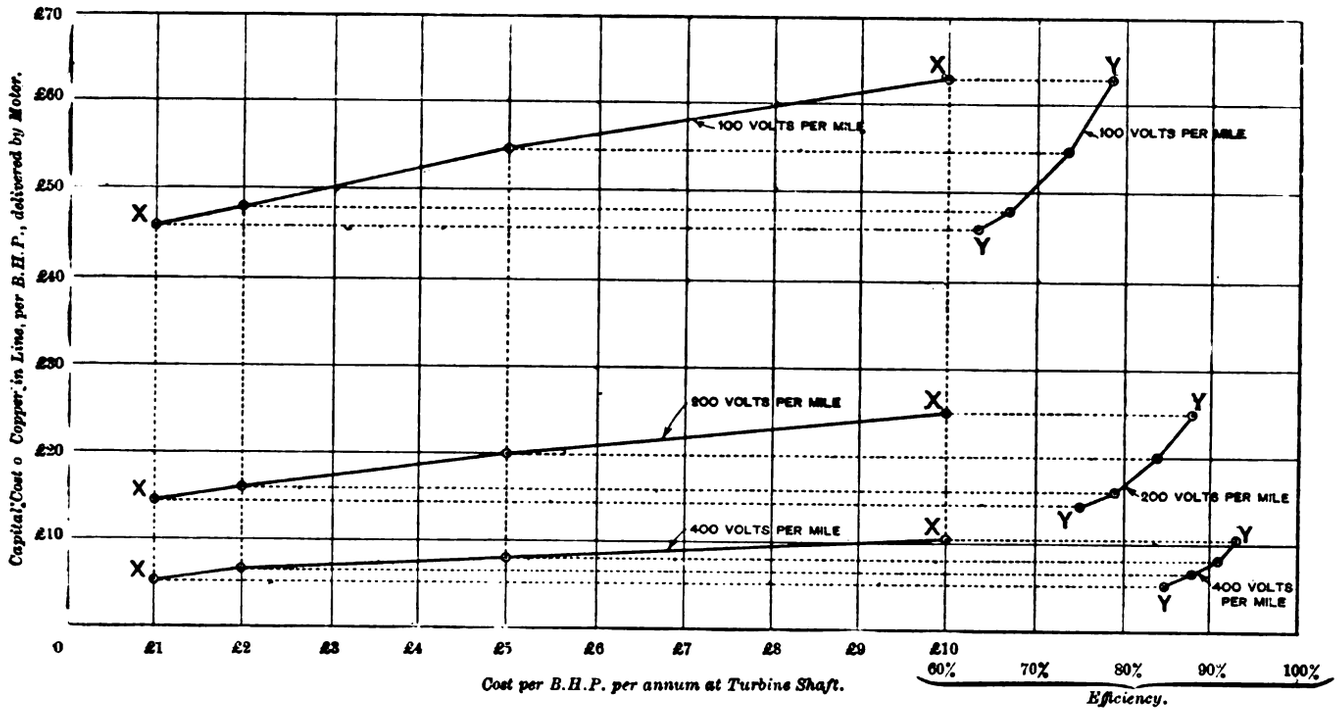
TO THE EDITOR OF THE ELECTRICIAN.

SIR: It would seem that Prof. Forbes' position in this matter is that, by the employment of boosters, we are able to waste as much power as we please in transmission, even to the extent of three or four times the power received at the motor end of the line. It is difficult to see that the booster serves any other function than to enable us to obtain nearly perfect regulation of the E.M.F. at the receiving end, no matter how great the loss in transmission be made. Why, then, should not the same principles which have hitherto guided us in deciding how much power to waste in the line, as against paying interest and depreciation on more copper, still guide us under the new conditions? No doubt Prof. Forbes only proposes to go below 50 per cent. efficiency when the cost of power is extremely small. The question is whether it is ever to be had, in any part of the world, so small as to warrant going down to an efficiency of less than 50 per cent.

Mr. Kapp has long since given us a means of working out in a convenient way—and one which takes account of all the factors concerned—a partial answer to this question. I refer to the investigation on page 377 of his book on the "Electric Transmission of Energy" (fourth edition). The convenient fact that the efficiency (η) and the total amount of copper in the line (t) are unaffected by the length of the line, provided the generating voltage be increased in proportion to the length, enable us to tabulate a few results, which will cover a large number of cases, by stating the generator voltage as so many volts per mile of transmission line. In the curves marked XX, attached herewith, the total capital cost of copper per B.H.P. delivered by the motor at the receiving end is plotted with the annual cost (p) of a B.H.P. as taken from the turbine, or steam engine, shaft. The curves are all on the same basis as regards interest and depreciation (q), which is taken at 10 per cent. on generator, motor, and line copper; also as regards the price of copper per ton (K), which is taken at £80 per ton (this value is now too low, the curves having been drawn some years ago, but the result is not seriously affected by the value taken for this item); also as regards the capital cost (g) of the generator, which is taken at £8 per E.H.P. The set of curves marked Y represents the result of plotting efficiency of transmission (η) with capital cost of line per H.P. delivered by motor.

It will be noticed that there are three curves in each case, viz., 100, 200 and 400 volts per mile. Also that 50 per cent. efficiency is not reached, even with water power costing only £1 per annum. The instance given by Prof. Forbes, where power is to be transmitted over 100 miles at 10,000 volts, comes, of course, on the first of these curves. The curves are obtained by ascertaining, in each case, the most economical current (see Kapp's formula) for a particular voltage. This current determines the back E.M.F. of motor; from this we get the efficiency of transmission, and from this, again, the section of copper in the line.—Yours, &c.,

Old Charlton, June 16. A. M. TAYLOR.



NOTE.—These curves show Capital Costs and Efficiencies for any possible length of line. To obtain Tons of Copper per B.H.P. of Motor divide ordinates by 80. q = 10 per cent. (interest and depreciation), g = £8 per E.H.P. (of generator).

CURRENT-RUSHES INTO TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Clinker's article on the above subject, appearing in this week's issue of your paper, there is absolutely no reference to, or acknowledgment of, the work of previous investigators in the same field. It is, no doubt, one of the easiest things in the world nowadays—when so much experimental work is being done everywhere—to overlook the work of others. It may, therefore, interest Mr. Clinker to know that the explanation of current-rushes advanced by him as "probable" appeared in the pages of *The Electrician* as far back as 1894 (Vol. XXXIII., pp. 229, *et seq.*). If Mr. Clinker cares to take the further trouble of referring to Vol. XLIII. of *The Electrical Review* (August 26th and September 2nd, 1898), he will find an account of some experiments closely resembling those described in his own article; he will also find references to the work of other investigators. It seems a pity that Mr. Clinker did not refer to his *Science Abstracts* before publishing his article; he might in that case have been spared the disappointment of finding that he has been forestalled by others.—Yours, &c.,

Liverpool, June 16. ALFRED HAY.

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LEGAL INTELLIGENCE.

Electric Construction Co. (Ltd.) v. Imperial Tramways Co. (Ltd.) and British Thomson-Houston Co. (Ltd.) (the 3rd parties.)

The hearing of this application was resumed on Monday.

At the conclusion of Mr. Fletcher Moulton's address, reported in our last issue,

Mr. BOUSFIELD said that apart from the question of the springs, the sleeving mentioned in the specification was of great importance. The whole object of the invention was the mode of attachment of the motor so that the up-and-down movement of the car should not harm it. To get that it was necessary to have one end sleeved on to the axle. Nobody could fail to see that the purpose of sleeving at one end was to allow freedom of motion at the other. The sleeves described in claim 1 meant sleeves to permit of that kind of motion.

The MASTER OF THE ROLLS: In his judgment Mr. Justice Cozens-Hardy had used these words: "This being the construction which I place upon the specification. It was faintly, if at all, argued that the patent could be supported"; but what I want to know is this, if we should be of opinion that the first claim does not include springs or their equivalent, but was independent of the mode of attachment, do you argue that the action proceeded in the Court below on the basis that the patent could not be supported?

Mr. BOUSFIELD said he could not accept that view.

The MASTER OF THE ROLLS: You still say that the patent can be supported although the first claim has nothing to do with springs.

Mr. BOUSFIELD said it was true the whole fight was conducted on the assumption that the first claim implied springs, but where they were met by an alternative which did not include springs, there it was clearly put that even in that case it was not anticipated. The fact that the learned judge used the words "faintly argued" positively showed that the alternative was put before him, and one judgment having gone against them they were now more anxious to make good before their lordships their contention as to that alternative.

Lord Justice RIGBY: Your own witnesses say that springs are essential, and that if claim 1 did not include springs the other four things are not within the invention.

Mr. CRIPPS: That is how we put our case.

Mr. BOUSFIELD: Then I am entitled to complain that my learned friend did not bring it home rather more closely to the witnesses. I do not, however, intend to argue that springs, or what would amount to an equivalent, are not essential to our invention.

The MASTER OF THE ROLLS: The difficulty seems to be that apart from Sprague there is nothing to show that it may not have been thought perfectly good to support the motor so that the relative positions of the armature and the field-magnets would not be changed, and the mechanical connection between the motor and the driving-axle would not be disturbed.

Mr. BOUSFIELD said the inventor had got a problem before him. He stated in the specification the nature of the problem, and then he explained how he was going to solve it.

The MASTER OF THE ROLLS: You have got to state what your specification means.

Mr. BOUSFIELD remarked that the specification was a plain statement of the object of the invention, and they must take the claims in connection with what was the real purpose of the invention. They must be read in conjunction with what had gone before in the specification. He admitted frankly if he had to argue this first claim on the supposition that it was a claim for a particular combination used in a manner inconsistent with the use which the patentee professed to make of it he could not hope to succeed, because it was not only anticipated by Sprague but by half a dozen other people, but if he took the claim as a combination to be used so as to effect the purpose of the patentee, and which was consistent with the description which went before it, then he felt that his difficulties if they did not vanish were at any rate very much lessened.

The Master of the Rolls asked Mr. Cripps to direct the attention of the Court to that part of the evidence which bore upon how the case was conducted in the Court below.

Mr. CRIPPS said that in the Court below, quite outside Sprague or any anticipation of any kind, the witnesses called by the plaintiffs themselves assented to the proposition that, apart from the springs, there was no invention at all. The learned judge, upon that, held that the first claim excluded the springs, and therefore, as he said, it was faintly if at all argued that the specification could be supported. Mr. Moulton, in the Court below, took his stand on claim 3, which included springs, and endeavoured to show that in the light of that claim springs could be read into claim 1.

The MASTER OF THE ROLLS: That was their main argument here.

Mr. Cripps then read those parts of the evidence directed to his argument, that if springs could not be read into claim 1 there was no invention.

Mr. Moulton shortly replied.

The MASTER OF THE ROLLS, in giving judgment, said that this was an appeal from the judgment of Mr. Justice Cozens-Hardy, who had decided, upon the construction he had put on the first claim, to certain letters patent, that the patent could not be supported. Speaking of himself, he (the Master of the Rolls) felt very considerable sympathy with the patentee, because this was a case not without precedent, in which the real substantial anticipation was a disclosure of the patentee's own invention in a description previously sent from the United States of America by the inventor and communicated to Great Britain. But if they came to the conclusion, as in his judgment they were driven to do, that the claim in the specification, so long as it stood, was too wide and was old, they had no alternative but to accept the position described by Mr. Justice Cozens-Hardy that the whole patent was invalid. The patent related to the means of connecting electric motors with the wheels which they were to drive. It was to be observed, and he thought it was a very important matter in the present case, that the Court had no statement made to it as to what the existing state of the knowledge was, which they had to bear in mind in construing the claim in the specification. All the Court had to guide it was the nature of the specification itself. Now the object of the invention was stated in the opening passage of the complete specification: "This invention relates to electric motors mounted upon railway cars or carriages for the purpose of propelling the same, and its object is to so arrange and support the motor that the relative positions of its armature and field-magnet will not be changed and the mechanical connections between the armature and the driving axle will not be disturbed by any movement of the car body or carriage body on its springs, while at the same time the driving-axle is relieved of dead weight. In accomplishing those objects the yoke or back piece of the field-magnet of the motor is hung from a cross-piece of the truck of the car or carriage by heavy springs; or from the car body itself in case of a street car or other vehicle having no truck." The next few paragraphs of the specification described certain proportionate parts of the invention. He passed now to observe that it had been contended on behalf of the appellants that the Court was to assume for the purpose of considering the specification that the whole, and if not the whole the real substantial merit of the invention rested on the fact that the motor was suspended by springs from the car, and that the Court was to assume both from the directions given by the patentee in his specification and from such reasoning as their lordships could bring to bear upon it themselves, that it would be utterly inconsistent with any application of the invention that the motor should be suspended by anything other than springs or their equivalent. Speaking for himself he did not think there was anything on the face of the specification which enabled anyone to form that conclusion. His lordship then referred to claim 1 of the specification, "The motor of an electric railway car or carriage having its field-magnet centred or sleeved upon a driving-axle, its armature supported directly upon the said field-magnet, and having a shaft separate from the driving-axle and gearing communicating motion from the armature shaftt to the driving-axle, substantially as hereinbefore described." That first claim enumerated what appeared to be the essence of the invention, excluding the springs in terms. It had no reference to a spring suspension. Then, it was said that the Court by reason of the words "substantially as hereinbefore described," must read into claim 1 the supporting springs. He thought that would be a construction the Court had no right to adopt. His lordship had read the whole of the proceedings in the Court below and looked through the whole of Mr. Moulton's speech, and from the way the cross-examination was conducted he could not see any substantial indication that the plaintiffs in the Court below attempted to justify the first claim, if it were assumed that the springs were not included in it. He thought, in the present case, on the face of the specification, that the Court must come to the conclusion that the patentee, whatever he wanted to do, did claim as against the public to include as within the ambit of his invention a claim to a motor in which the field-magnet was centred or sleeved upon a driving-axle, its armature supported directly upon the said field-magnet, and having a shaft separate from the driving-axle and gearing communicating motion from the armature shaft to the driving-axle, and this whether it was supported by springs or not. That being so, on the evidence given in the Court below, he came to the conclusion it was impossible to say that that particular combination excluding those springs was new. He thought himself it was clearly shown in the drawings of Sprague's invention, and so shown that any competent electrician could have understood it at once. Here no witness had said that those drawings would not have disclosed to a competent electrician the four essential features of the first claim. That was published in England before the date of the application for a patent, and that being so, it was not possible to support the first claim. For those reasons he thought that Mr. Justice Cozens-Hardy was right, and that the appeal should be dismissed.

Lords Justices Rigby and Collins gave judgment to the same effect, and the appeal was dismissed with costs.

National Telephone Co. v. Tunbridge Wells Corporation.

This case was heard in the Queen's Bench before Justices Grantham and Channell on Monday, and raised a question as to whether a stipendiary magistrate or a county court judge has, since the passing of the Telegraph Act, 1892, any jurisdiction to hear and determine an appeal from a refusal of the highway authority to allow a telegraph company to open up streets for the purpose of laying wires or tubes. By two deeds of 1881 and 1896, made between the Postmaster-General and the National Telephone Co., the company were authorised to work and use certain forms of telegraph for the purpose of transmitting telegrams within the borough of Tunbridge Wells. By a deed dated 1896, and made between the Corporation of Tunbridge Wells and the Telephone Company, the Corporation consented to the company exercising within the borough such powers as might from time to time and at any time be delegated by the Postmaster-General to the company, in pursuance of the provisions of sec. 3 of the Telegraph Act, 1892. This deed went on to say: "It is expressly agreed that the consent contained in the preceding clause is given upon the following conditions: (1) Except as regards the work mentioned in the schedule, the company shall not exercise any of the powers conferred on the Postmaster-General by the Telegraph Acts 1863 and 1878, in respect of which the consent of the Corporation is required under the said Acts, without obtaining the further consent in writing of the Corporation, to be from time to time given to the specific works for the time being proposed to be carried out under such powers, it being intended that the general consent contained in the preceding clause is not to operate to relieve the company from the obligations of obtaining

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the particular consent of the Corporation to such specific work as required by and provided for in the said Acts." Clause 10 of this agreement contained a reference of all disputes under its terms to two arbitrators and an umpire. The company wished to open a street and lay telephone wires and to execute works not mentioned in the schedule to the last-mentioned deed, and applied for the consent of the Corporation. The Corporation refused, and the company contended that under sec. 4 of the Telegraph Act, 1878, they had the right to refer the "difference" to the county court judge. The county court judge, while expressing the opinion that he had jurisdiction to hear and determine the difference, refrained from doing so until the hearing of this motion, which was for a prohibition, upon the ground that since the Telephone Act, 1892, sec. 5, the county court judge had no further jurisdiction in such cases.

Mr. JOSEPH WALTON, for the Corporation, having read the special case stated by the learned county court judge,

Mr. CRIPPS, Q.C., and Mr. J. CASSELL, for the National Company, submitted that the consent required by the deed of 1896 meant consent subject to appeal to the county court judge. They further contended that the county court judge was constituted an arbitrator, and that prohibition was not the appropriate remedy.

Mr. Justice GRANTHAM said there was no doubt what their judgment should be. The National Telephone Co. had not brought themselves within the Act of Parliament which gave general powers to carry on these works in the way in which it had been claimed by the National Telephone Co. There was not much doubt as to what really was the history of this legislation. In 1878 everything was in the hands of the Crown through the Postmaster-General. Then pressure was brought to bear upon them and they consented to delegate some of their powers, but the moment they did that and allowed these works to be carried out by a company, they very properly changed their *modus operandi*. During the time that it was a Crown monopoly and the Crown had a right to do this work it was considered just that the judicial authorities of the Crown should be invoked to determine any differences that arose between the Crown and the public authorities. The Postmaster-General consented to do this work in Tunbridge Wells. By the Act of Parliament it was provided that, supposing there was a difference between the 'Postmaster-General and the authorities at Tunbridge Wells, some tribunal must determine who was right. It being a question of the right of the Crown to do this, the Legislature decided to invoke the aid of the judicial authorities of the Crown—the county court judge or the stipendiary magistrate. Then came the Act of 1892, whereby these powers were delegated. The moment private individuals carried on this work the right which the Crown had to call in the aid of the judicial authorities ceased, and more power was given to the authorities in whose district the work was to be done. The urban authorities were given a power of veto. Their consent must be obtained to exercise, first, the powers to be delegated, and then there was a right to say in what way they would consent to these powers being exercised. The Tunbridge Wells authorities gave a general consent, but subject to the general terms of the agreement, that the consent was only to do the work thereby agreed upon and set out in the schedule, and before any other work was done they must obtain the further consent of the local authority. The parties to the agreement rightly understood what their rights and liabilities were. Under the Act of 1892 this agreement was expressly and properly drawn to give such rights as the Corporation intended to give in the first instance to the National Telephone Co. reserving to themselves the right which, by the Act of 1892, they had power to reserve. The National Company, were bound by the terms of the agreement, and had no right to say the county court judge was the proper tribunal to determine any difference which had arisen between the parties.

Mr. Justice CHANNEL concurred, and the application was allowed with costs.

Corporation of Huddersfield v. the National Telephone Co. (Ltd.).

This case came before Justices Grantham and Channell in the Queen's Bench on Wednesday on an application by plaintiffs for a writ of prohibition directed to the county court judge of Huddersfield prohibiting him from hearing an application made to him by the National Telephone Co. by way of appeal from the refusal of the plaintiffs to allow the company to open up streets for the purpose of laying wires or tubes.

After hearing Mr. Macmorran, Q.C., as to the nature of the appeal, Mr. Justice Grantham stated that having looked at the agreement on which the motion was based, it seemed on all fours with the case of the National Telephone Co. v. The Tunbridge Wells Corporation decided on Monday.

Their lordships, in the result, after hearing Mr. Cripps, Q.C., for the Corporation of Huddersfield, decided that as the case raised practically the same point as the other case, the prohibition would be granted with costs.

British Insulated Wire Co. v. Dublin United Tramways Co. and National Conduit and Cable Co. (of New York.)

In the Chancery Division, Dublin, on Tuesday, before the Vice-Chancellor, Mr. Blood, Q.C., applied on behalf of plaintiffs for liberty to deliver to defendants and each of them interrogatories, and that the defendants be ordered to make a full and satisfactory affidavit of documents, setting out amongst other documents, particularly invoices, bills of lading, consignment notes, receipts, &c., and documents relating to any portion of certain cables sold by the New York company to the tramway company in infringement of plaintiffs' patent. The action was heard in Nov., 1899, to restrain the infringement of certain patents which plaintiffs owned for the manufacture of cables for electric traction. On Sept. 2, 1896, plaintiffs' patent expired. The judgment of the Vice-Chancellor was that defendants admitted they had infringed plaintiffs' patent of 1884, and submitted to an inquiry for damages. The Court ordered an inquiry at Chambers as to what damages the plaintiffs had sustained, limiting it to any portion of the cable manufactured according to said patent received by the defendant tramway company prior to Sept. 2, 1898. Plaintiffs were unable to file their affidavit before the chief clerk without the information which they now sought to obtain.

Mr. S. RONAN, Q.C., for the tramway company, said the time had not yet arrived for defendants to file their affidavit, and it would be presumed that in their answer they would state how much they got. The New York company had an American patent which justified everything they did in America, and the plaintiffs had an English patent which only prevented acts in infringement in the United Kingdom. The tramway company had arranged with the American company to deliver a portion of the cable, but that it should not be delivered in this country until after Sept. 2, 1898, the date of the expiration of plaintiffs' patent. By mistake a small amount was delivered in this country prior to that date, and the tramway company immediately admitted liability for the amount. The real object of this motion was to extend the decree to everything put on board at New York prior to Sept. 2, which was contrary to his lordship's judgment.

The VICE-CHANCELLOR did not think he had gone the length of holding that the defendants were only liable for cables received in Dublin.

Mr. RONAN asked for an adjournment of the motion that he might serve notice to amend the decree.

The VICE-CHANCELLOR said it would be necessary to have this question decided. If the delivery on board ship at New York was a receipt by defendants, then they were liable for an infringement *quoad* those goods. It was not so much to amend the decree as to construe it.

The application was granted.

Stephens v. Mather & Platt (Ltd.).

An action was heard this week before Mr. Justice Lawrence in the Queen's Bench Division, being a claim by Mr. Hilliard Stephens for an account of all orders executed by Mather & Platt (Ltd.), in respect of the business of Dowson, Taylor & Co., engineers, of Manchester, in their district for 1899. The plaintiff claimed 2½ per cent. commission on the whole of the London turnover. The jury returned a verdict in his favour, and an account was therefore directed to be taken.

PARLIAMENTARY INTELLIGENCE.

MUNICIPAL TRADING.

The Lords and Commons Joint Committee on Municipal Trading held another sitting on Friday last, the Earl of Crewe presiding.

Mr. CHANDOS LEIGH, Q.C., counsel to the Speaker of the House of Commons, explained the nature of his duties in relation to private bills. In examining them he had to be careful that no bill involving general taxation, or which, in his judgment, should be introduced as a public bill, should be introduced into the House of Lords. As a rule, electric schemes were dealt with by the Board of Trade, but there had been some notable exceptions this year. An instance of opposition on second reading occurred in the case of the General Power Distributing Co.'s bill. That bill originated in the House of Lords, and was passed by the House, but so late in the session that it could not get through the Commons. It was thought very hard it should have to be begun *de novo* in the next session; the bill was suspended and taken up at the same point in the next session. In the result the House of Commons threw the bill out after it has passed the House of Lords. This session there was a group of seven electric distribution bills, which, after a long discussion, were referred to a special—not a hybrid—committee, with Sir James Kitson as chairman. Five of the bills had been heard, but the Committee did not intend to give a decision until they had heard the whole. The general principle in these bills was that where sufficient public advantage was shown power might be given for the supply of electric energy over an area embracing the districts of numerous local authorities. In some of these bills restrictive clauses would be inserted. Thus one provided that where local authorities already had power the company should not within the district of that authority supply electricity except to wholesale consumers; and another clause gave the local authority power to exclude the company from supplying if the authority were ready to take the supply in bulk and distribute it themselves. All unopposed bills were examined very closely, and a very careful report drawn up in regard to them. In the House of Lords the powers of the Chairman of Committees with regard to these bills were autocratic; if he liked he could cut a clause out, and the House of Commons Committee could not re-insert it. Witness read unopposed bills to discover novel clauses which might be objectionable in going further than the general law. If he saw any strong clauses in a bill he would direct attention to them. Thus in the Rochdale bill the Corporation took power not only to create ice stores but to make and sell ice. That was, to his mind, a clear case of municipal trading. That clause was unopposed; so witness went to the Chairman of the Committee dealing with the bill, and directed his attention to it in order that it might be dealt with by the Committee.

The CHAIRMAN: So far as you know has the power ever been given?—No; it is a totally novel power to me. Continuing, he said a most important matter was the power which corporations sought to raise money by bills and promissory notes. The ordinary way of raising money by a corporation was to issue stock.

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Lord ROTHSCHILD: Suppose they were unable to raise a loan, what would they do?—They would have to come to Parliament to be authorised to raise the loan unless they had got unexhausted borrowing powers. No doubt corporations, in some cases, had very large overdraughts from their bankers. The first case of allowing money to be raised by promissory note and bills, which was a more straightforward method, was that of the London County Council some years ago. The difference lay in the fact that the London County Council were subject to Government audit, while the old municipalities elected their own auditors. Consequently great care had to be exercised in this matter. He could not say whether the banks would be able or not to recover overdrafts allowed to municipalities.

Mr. HOBHOUSE: Are not these overdraughts shown on the municipal accounts?—They ought to be. That rather supports me as regards watching things very carefully.

A NOBLE LORD: You do not assert of your own knowledge that any corporations have borrowed in excess of their statutory powers by overdraft or otherwise?—I cannot say that. I know that there have been overdrafts to a considerable extent; there may have been unissued borrowing powers. He thought it would be better to allow these clauses relating to bills and promissory notes, provided the city or town had sufficient status both in population and finance to warrant it being done. On the question of allowing an individual trader *locus standi* to oppose a trading scheme of a corporation, he said, as a general rule, the *locus* was not allowed. This was a point on which some guidance was wanted for the Committee. The general principle acted on in one case at least was that where there was anything which affected the interest of the general travelling public, the 'bus companies concerned were allowed a *locus* to oppose.

The CHAIRMAN: It is quite clear you would not give a *locus* to any individual trader to say he was injured by municipal trading?—I do not think so. While recognising that no private company could have carried out water schemes such as those of Manchester, Birmingham, Liverpool, and the Derwent Valley he rather deprecated the practice of municipalities acquiring water and gas companies against their will and consent. This practice had enormously increased in the last few years. Municipalities which had never initiated or invented anything in reference to gas, tramways, or electric lighting, had yet, in a manner, forced the companies which undertook those matters to sell when their concerns became flourishing. He knew of no case in which a municipal authority had sought to acquire a gas undertaking except it had been in a sound position. He stated, from information obtained from private sources, that between 1878 and 1897, while the increase of population had been 21 per cent., the increase of rates had been 175 per cent., and of local indebtedness 220 per cent.

Mr. SYDNEY MORSE, chairman of the Municipal Trading Committee of the London Chamber of Commerce, said the subject of inquiry had been very fully discussed by the Committee of the Chamber, and upon their report a resolution was passed by the Chamber declaring that the scope and sphere of municipal enterprise in opposition to private enterprise ought to be defined. The Municipal Corporation Act of 1835 was intended to place corporations in the position of trustees, and to restrict their use of corporation funds to certain definite purposes. Local authorities endeavoured to keep down the rates, and it appeared to his Committee that they desired to carry on undertakings outside their areas in order to make a profit and so reduce the rates. In regard to the Tramway Act, he complained that the consent of the local authority being a condition precedent to any scheme, private enterprise in this direction was often hampered by the local authorities seeking to impose hard conditions on the promoters. The intention in giving power to the local authority to purchase at the end of 21 years, was that when the purchase had been effected the authority should lease the line and not work it. Applications in regard to electric light were generally made by provisional order. It was necessary to prove to the Board of Trade the consent of the local authority, and although the Board of Trade had power to dispense with that consent, until last year they had never used that power where the question was one simply of granting or not granting; they had used that power in regard to matters of detail. In the early days, say in 1889, when electric lighting was not so far advanced, it was not difficult to get consent; but as it became more of an assured success so it became more difficult to get consent, and now if one went to even a very small district very onerous terms were put upon the promoters. Where the corporation owned the gas works it was often argued before the Board of Trade that they had invested a large sum in gas which might be endangered if electric lighting was allowed. Thus the progress of electric lighting had been very seriously retarded. Further, the electrical industry had been placed in a very unkind condition as regarded other industries. Gas and water obtained a freehold, as it were; but electric lighting companies' undertakings had been limited as to consent, price, and terms of purchase, though it had been, he supposed, quite as important an industry and as difficult to introduce as any of the others. As showing how municipal trading was increasing, he said municipalities in the last two years had introduced bills in relation to railways, canals, tramways, harbours and tidal waters, for which they had asked for a total of 70 millions of money, whereas in the previous nine years the total figure was only 37 millions. With regard to tramways he said in many cases mechanical powers had been given to a company, but practical operations prevented by the refusal of the consent of the local authority; and nowadays consent was always refused on the ground that the local authorities were anxious to work the lines themselves. The tramways had certainly not had fair play. In introducing a new tramway capital had to be embarked, but it had to be kept intact and a living wage made because at the end of 21 years the promoters were certain not to get back their original capital. No money could be spent on improvements or extensions, and the promoters had to get on as best they could, as compared with the authority, which had a freehold and could look to the future to repay losses of the present moment. If powers were given, as had been proposed, to municipalities to work tramways outside their districts, they would be actual competitors with the companies.

On Tuesday Mr. S. MORSE, continuing his evidence, said the opinion of Municipal Trading Committee of the London Chamber of Commerce was that the action of municipalities in trading should be restricted to matters undertaken in the public interest, and not with a view to profit, and therefore matters in respect of which it was reasonable that a rate should be made. Water was a thing which it was to the interest of everyone to deal with in a proper, wholesome, and pure manner, and the Committee of the Chamber of Commerce thought it reasonable that a rate should be made for giving a pure supply of water. They were of opinion that if municipal trading were allowed it must have the effect of abolishing the private trader. Where trading concerns were in the hands of local authorities there was no incentive to progress, and no inducement to take advantage of new inventions. If the principle of trading by municipalities were once allowed it would be extremely difficult to limit the class of trading permitted. The distinction he drew between water and lighting was that it was essential from a sanitary point of view that every house should have a good supply of water, but it made no difference to one householder whether his neighbour had any light at all or used candles or lamps. He did not see why a man should be compelled to contribute towards the provision of light for his neighbour, though he did see why he should be compelled to contribute towards the provision of water, the general use of which was necessary in the public interest. The mere fact that local authorities had power to veto companies' tramway and electric lighting schemes had, he thought, injured trade in this country. To such an extent was this the case that we had to get a large quantity of our tramway and electrical plant from abroad.

Mr. S. B. PROVIS, permanent secretary to the Local Government Board, stated that during the past five years the Board had sanctioned loans for electric lighting purposes amounting to £5,726,000, of which £5,138,000 were to town councils and £588,000 to urban district councils. The whole of these loans were sanctioned under the general law, but during the same period £1,051,000 was borrowed under local acts.

The Committee then adjourned till to-day (Friday).

THE ELECTRIC POWER BILLS.

THE LANCASHIRE COMPANY'S BILL.

The Select Committee of the House of Commons on Electric Power Bills resumed its investigation on Monday, Sir J. Kitson presiding.

Mr. WILLIAMS addressed the Committee in support of the petition of Southport Corporation against the bill. He said the proposed area of supply included hundreds of square miles of agricultural land which would be absolutely useless for the company's purposes. The estimate put forward by the promoters respecting the load factor appeared to be extremely sanguine, and yet, if it proved to be wrong, the whole scheme would fall to pieces. Southport, as a pleasure resort, was not a suitable place in which to carry on industrial pursuits. The local authorities wanted none of the scheme, and had asked to be excluded from it. There was no probability that they would ever send a requisition to the company for the supply of electricity, and he thought it was clear that unnecessary powers of supply should not be given.

Mr. GRIFFITHS, Mayor of Southport, said the town was a purely residential one, its staple trade being building. The generating stations at Wigan and St. Helens would both be about 20 miles from Southport, and he could not conceive why the powers asked by the promoters in respect of Southport should be given, the district to the north, south and east of Southport for many miles being entirely agricultural. The Corporation of Southport generated electricity very cheaply, and even if the hopes of the company were realised as to the price of supply the Corporation would be able to beat them easily. Why the wishes of an important place like Southport should be set aside on the speculation of a combination of traders passed his understanding. The maximum prices of the Council for electricity supply were 7d., 5d., and 4d., but those were not the prices actually charged.

The CHAIRMAN: You are aware that under the bill you cannot have a supply without your own consent and except on your own invitation. If that be so, where are you injured?—We are injured as the whole wealthy district of Lancashire will be injured in having established in the wealthiest portion of it a protected company of combined traders who will have protected rights and with whom no one will be able to compete except under an Act of Parliament. Of course, if the company expend the large sum of money they propose to expend competition cannot take place. I have not a shadow of a doubt that in the course of two or three years there will be a great improvement in the manufacture and distribution of electricity, and if counties combined to work their electricity, as they sometimes combine for water supply, they could give greater public advantages than it is possible for this company to give. The improvement will, in my opinion, be so great that in two or three years the provisions of this bill will become obsolete.

Mr. C. D. TAITE, electrical engineer to the Southport Corporation, stated that the present load factor of that town was 11·3, but the Corporation were laying down an extensive system of tramways which were to be worked by electric traction, in addition to the existing tramways. This would increase the load factor and reduce the cost to the Corporation of generating electricity for themselves down to about 1·45d. per unit, or 20 per cent. less than the company proposed to charge. It would cost the company 0·4d. per unit for cables to transmit power to Southport. He was not aware that in Germany agriculturists were banding together in order to supply themselves with cheap electricity. He did not know that it would do any particular harm to Southport

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to grant the company the powers asked for, but the people of Southport objected to the company having powers which they would not exercise.

Mr. BALFOUR BROWNE, Q.C., in opposition to the bill, said he appeared for 13 boroughs in South Lancashire, including Manchester, Liverpool, Oldham, Bolton, Warrington, Wigan, Accrington, Burnley, Salford, and Rochdale. The local authorities in all these important places did not consider the bill would put within the reach of anybody in the district electricity at a cheap rate. The measure sinned in every way. It was a grab at a huge area of country, not for the purpose of supply, but merely to get a foothold there for some ulterior object. The great towns of South Lancashire supplied themselves with electricity, and could do so much more cheaply than the company could. It would do the district serious injury to give a company Parliamentary powers to lay its hand on it, and to object to any local authority, at present without electrical powers, from acquiring them. Too large an area did not tend to the reduction of price. This was shown by the company's own scheme, because they proposed to set up not one undertaking but four. As to the recommendations of the Joint Committee respecting wayleaves, it was not a recommendation that wayleaves should be created promiscuously over a wide area of 1,100 square miles. What the Joint Committee recommended was that power should be given in connection with a generating station outside an area of supply, which of course, presupposed an area of supply in the first instance. The local authority of every great town in this district protested against the company coming in, simply because they knew that there was no public advantage in the scheme. There was no excuse for allowing a company to come in and supply where the municipalities were doing their duty and supplying at very cheap rates. The Corporation protested against wayleaves being granted through the streets of all the towns, the thoroughfares being in many cases absolutely unsuited for laying another pipe or main. The 13 boroughs had already spent about £2,136,000 on electrical undertakings, and they were about to spend £2,100,000 more, so that they had spent or were spending more than the proposed total capital of the company. Liverpool already supplied electricity for traction purposes outside its own area, Manchester supplied Salford and Swinton, and Bolton also supplied for traction purposes outside its own boundaries. The Manchester district of supply had an area of 36 square miles, which was about the limit at which electricity could be advantageously and cheaply supplied. The Corporation was supplying both the outside and inside area at the same price, which, on an average, amounted to 3·33d. per unit, while for power it was 1½d. Liverpool was supplying for lighting at 3·93d., for street lighting at 2·29d., and for tramways at 0·91d. Manchester was doing as well and better than the company could, and, on the face of it, the scheme was wild, ridiculous and absurd.

Ald. LLOYD HIGGINBOTTOM, Chairman of the Electricity committee of the Corporation of Manchester, said he was a mechanical engineer by profession. He acted as chairman of a conference of representatives of boroughs held in reference to this bill, and had been deputed to give evidence on behalf of those boroughs. In the judgment of the boroughs the company ought not to be entrusted with the sweeping powers asked for in this bill. The boroughs felt that the company should not have wholesale powers to break up the streets of any borough in the district. He saw no such public advantage to be gained under the bill as would counterbalance its disadvantages. The cost of laying mains from the generating stations to the towns which the company wished to supply would be so enormous as to absorb the saving that would be effected by placing the generating stations near the collieries. It would be a great inconvenience to have fresh mains laid in the streets of a city like Manchester, where the Corporation already had great difficulty in laying any additional pipes.

Mr. WORSLEY-TAYLOR, Q.C., for the promoters, said that if the Corporation were not properly protected he would see that proper protection was afforded. He asked the witness what objection there was to the bill if the Corporation were properly protected?—The bill was so framed that it could not be altered to properly protect the Corporation, and he declined to reply to a hypothetical question.

On Tuesday, Mr. LLOYD HIGGINBOTTOM, in reply to further questions put by Mr. Worsley Taylor, said Manchester sold electricity at the lowest prices, and if it were possible to introduce Manchester prices all over the County of Lancashire it would be a good thing for the public. The proposed area of supply ought undoubtedly to have the right to get cheap electricity.

Mr. WORSLEY-TAYLOR: Should we have been right if we had come with a bill to take out the rich parts of the area without taking the obligation to supply the poor parts?—I say that you have chosen the rich parts, and have practically left out the poor parts. I say that you cannot supply the poor parts of the district in the north. Witness went on to say that he did not deny that the company would be able to generate power in their proposed generating stations as cheaply as Manchester could generate it, but he did deny that they would be able to distribute as cheaply. Transmission and demand would be the difficulties in the way of the company. In Manchester and district at the present time electric power was not supplied to any of the numerous cotton mills. The Manchester Corporation could supply it, but the millowners did not ask for it, as they could produce it more cheaply themselves.

Mr. A. BROMLEY HOLMES, electrical engineer to the Corporation of Liverpool, said the Corporation purchased their electrical undertaking in 1896 from a company for £400,000. Since the purchase the price charged to consumers had been greatly reduced. To ordinary consumers the present price was 4d. per unit for light; for public buildings it was 3d.; for street lighting, 2d.; for power, 2d. up to 3,000 units per quarter and 1d. beyond. The total capital expenditure of the Corporation on the electrical undertaking had been £769,000, while a further estimated capital expenditure of £380,000 was to be made in the present year. The profits were £9,000 in 1896, £16,000 in 1897, £8,000 in 1898, and £11,000 in 1899. He did not think that the calculations on which the promoters of the Lancashire Electric Power Bill based their scheme were sound. He saw no provision in the estimates for the cost of the construction of transforming stations in the area of supply or for the apparatus that would require to be fixed in these stations, and no provision for duplicating the mains. In his view the proposed load factor of 35 per cent. was imaginary, and could not be attained in practice. His experience was that the company would have to depend for customers on the small consumers of power. The promoters could not possibly give the Corporation proper protection because the Corporation wanted all the room in the streets for themselves. He did not know of any street in which the room would not be required by Liverpool for its own purposes. The largest consumers of power in Liverpool were the printing establishments. The largest motor was 50 H.P. At present they supplied 800 H.P. of electricity for power. If they were called upon to supply the docks with mechanical power it would amount to several thousand H.P. At present they had 50 or 60 customers for power. He was strongly of opinion that if powers were given to the company to lay mains the local authorities should have power of supervision over the laying of them and should have a voice in the construction of the mains, the material used, the covering, and so on. The Corporation of Liverpool was greatly opposed to the principle of the bill, and considered that there would be no advantage to compensate for the inconvenience which it would occasion to the public.

In cross-examination by Mr. Worsley-Taylor, Q.C., WITNESS said that the great harm of the bill lay in the fact that it would empower the company to tear up streets for its mains. Generally speaking, he thought it undesirable that power should be given to a company to supply areas close up to populous centres, which areas could be supplied by the local authorities themselves.

Dr. PANTON, a member of the Bolton Town Council, said the tramway lines of the town had, since the Council acquired them in 1897, been adapted to electric traction. In 1898 the Corporation obtained power to supply electricity in a large district outside the borough from the generating station, which was situated inside the borough. Those powers were at once put into operation. Last year 824,792 units were sold at an average rate of 1·83d. The objections of Bolton Corporation to the bill were based on the serious interference it would cause with the streets of the borough. It was difficult and dangerous even now for the Corporation to find places for their own mains.

Mr. C. H. WORDINGHAM, electrical engineer to the Manchester Corporation, expressed the opinion that no economy would be obtained by increasing the scale on which electrical energy was produced beyond, say, 20,000 H.P. or 30,000 H.P. The only saving would be in the carriage of coal, and that would be swamped by the cost of the mains to the area of supply. It was not practicable to carry electricity for a long distance in this country.

At the conclusion of Mr. Wordingham's evidence, Mr. PEMBER, Q.C., representing the Newcastle Electric Supply Co., stated that an arrangement had been made with the promoters of the Tyneside bill with regard to the Wallsend generating station site, which was scheduled in both bills. The two companies agreed to abide by the decision of the Committee as to who was to have that site. The Newcastle Supply Co.'s bill was to be treated as unopposed in the House of Commons, but in the event of this Committee deciding that the Wallsend site should go to the Tyneside Company that site would be struck out of the Newcastle Company's bill before it passed through the House of Lords.

On Wednesday Sir WILLIAM PREECE said that the electric lighting legislation of this country had met with universal approval. Electric lighting was here developing at a rate of progress greater than in any country in the world, and we were also paying less for it. Electricity was well developed in Lancashire. As to wayleaves, he was of opinion that the local authorities should have a voice in the matter.

Major P. CARDEW said he had considered with regard to the amount of power to be transmitted through mains the question of danger to the public, and of the interruption of supply caused by a breakdown of a main. He considered that a limit of 300 kw. as desirable, though in special cases of trunk mains the limit might be as much as 1,000. He then gave particulars as to the possibility of increasing the danger by multiplying the number of mains through the streets of large towns. He did not think they should refuse to allow the local authorities of a big town to say what route their mains should take on passing through that town. There would not, however, be any harm in leaving the matter to the Board of Trade, who would give ear to the case of both parties. He did not think it necessary to pass through Bolton or Liverpool, and it was not necessary to touch more than two small districts to the east of Manchester to be supplied from the generating station at Old Trafford.

By the CHAIRMAN: The local authority should have the power to lay the mains if they so wished, though the company could not afterwards be responsible for their condition. It might, however, be supposed that the local authority, being solicitous for the safety of their own streets, would take all the greater care. If a jealous local authority laid the mains badly there could easily be an appeal to the Board of Trade. Local authorities had a special knowledge of their own streets, especially with regard to subsoils, and the suitability of mains for such sub-soils. Local authorities should have the power of supervision, with an appeal to the Board of Trade.

Mr. A. H. AITKEN, town clerk of Accrington, said his borough with four other districts to the north and west between Accrington and Clitheroe—which the company proposed to supply—had obtained power to supply the area. The company would have to go through the whole of the Accrington main roads in order to get away up in a corner of Clitheroe. He admitted that the people of Accrington wanted cheap electricity, but stated that they had obtained a provisional order in 1891 and now, practically, had their works finished.

Mr. EVANS, town clerk of Salford, gave evidence against sanctioning the proposal of the company to go into their district.

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In connection with the Newcastle Electric Supply Bill, Mr. RICKARDS, Q.C., on Wednesday, informed the Electric Power Bills Committee that arrangements had been come to which made it unnecessary to trouble the Committee to go into the merits of the scheme covered by the bill.

Yesterday (Thursday) Mr. CHARLES HOPKINSON, C.E., was called in support of the petition of the large boroughs, and said that the electric supply which the company proposed to give would be useless for the textile trade, as the cost would be prohibitive. If there was a demand for the kind of power the company could supply it must come from the small industries, in regard to which the cost of a steam installation was very high, and for which the most economical power at present was gas. In his opinion the prospects of the bill were extremely vague. The only elements of economy the promoters could claim were aggregation of works, staff, &c., and the nearness of the coal field; the second consideration did not apply to the generating station at Old Trafford. It would be possible to supply the textile trade with electric power economically if the generating station were next door; it would be more difficult if the station were a mile off, and impossible if it were 10 miles off.

This concluded the case for the opposition.

Mr. WORSLEY TAYLOR addressed the Committee on behalf of the promoters. He had never before come in contact with a more remarkable collection of electrical Baalams than had been put forward as witnesses by the petitioners. The nett result of their evidence was that as soon as any one of them made a point another infallibly came and destroyed it. All the promoters of the bill asked was that they should be placed in a position to offer to supply electric power either to local authorities or to those who had been allowed to set up electrical undertakings with the consent of the local authorities—that they should have the option of giving a supply of cheap electricity with the consent of the local authorities. With regard to the price, he would point out that the schedule included in the bill would only last for seven years, and if at the end of that period it proved to be too high it would be cut down by the Board of Trade. The promoters had voluntarily put into the bill a clause providing that there should be no monopoly, and another giving the local authorities a voice on the question of cable route, with an appeal to the Board of Trade. The promoters had tried honestly and liberally to meet the views of those who they hoped would be their customers, and he appealed with confidence to the Committee to pass the preamble of the bill.

The Committee adjourned the further consideration of this bill.

THE SOUTH WALES BILL.

Mr. PEMBER, Q.C. (yesterday) followed on with the bill of the South Wales Electrical Power Distribution Co. He said it was promoted by a number of gentlemen who were very largely interested indeed in the industries of South Wales, and no financier or contractor had any part or hand in the matter whatever. The total number of factories or undertakings in which the promoters were interested had among them a capital of over £22,000,000. The Company proposed to supply with electricity an area of 1,034 square miles. There were only two local authorities in the whole of the district that were at present supplying electric power. There were only generating stations for some 32 square miles in the district, and only mains laid for 10 square miles. Only 900 odd persons were taking electricity out of a population of 1,000,000, and the average price at present charged was 4½d. per unit. It was obvious that the promoters, being connected with large industrial concerns, would be to a large extent their own customers, and, therefore, the bill stood in a very different position from any other which had been brought before the Committee. The bill proposed to incorporate a company with power to erect three electric generating stations, one at Neath, a second between Pontypridd and Caerphylly, and the third near Pontypool. The measure also provided for a system of mains to be laid partly underground, but partly across country, over which easements were to be obtained. The company was to have a capital of £1,000,000, divided into £750,000 ordinary shares and £250,000 debentures. The area of supply was probably as concentrated in its industrial activity as any in the kingdom its industries including iron works, foundries, tin-plate works, chemical works, and collieries. It was covered with a network of railways, and its shores were covered with ports, while there were some large docks. The manufactures of the district were not, however, in due proportion to the output of coal, though the coal was of the finest quality. The tin-plate industry had largely drifted away to America and other countries, one great factor in the superior position of the foreigner being his superior utilisation of electrical facilities. It was possible by using electric power to employ the essence of the coal instead of the coal itself. This meant a revolution in transport and a great saving. Under these circumstances the production of power became a new industry.

Mr. Pember had not concluded when the Committee adjourned till to-day (Friday).

NORTH METROPOLITAN ELECTRIC SUPPLY BILL.

On Tuesday the consideration of the proposals contained in this bill was resumed by the Committee of the House of Commons presided over by Mr. A. H. Brown.

Mr. WM. L. MADGEN, one of the promoters, said the extent of the district proposed to be served was approximately 18 square miles. On the east was the river Lea, navigable for barge traffic from London to Hertford; almost parallel with the Lea was the Great Eastern Railway, running to Hertford; the Great Northern Railway, running to Hertford via Hatfield, and other railways running through the district. He believed these facilities would attract a number of small manufacturing trades now carried on under unfavourable conditions in the east-end of London. In Germany electrical installations are being put down in some of the agricultural districts for the purpose of supplying farmers with current for agricultural purposes, and electrical ploughs are now being made in Germany for that purpose. I think the charge for electrical ploughing is from 8 marks to 10 marks per acre. Very little has been done in this country in the direction of the application of electricity to agricultural uses.

Mr. MOON: What do you say as to the distances from the proposed power station to the distributing centres?—The distances are quite practicable, and the serving of two or more distributing centres from the same trunk main is not only possible, but is very commonly done. At the present moment nearly the whole of the area, with the exception of Harrow, is absolutely barren of electrical supply; at Walthamstow, what might be termed a preliminary plant has been put in, and Hornsey, which obtained its electric lighting order two years ago, has actually invited tenders from companies willing to take over and work the order.

Do you think that the result of your obtaining the powers you seek would be that places like Harrow and Walthamstow would find it more economical to purchase electrical power from you than to go on utilising the plant they have put down?—It is, of course, quite optional for them either to continue manufacturing their own or to take a bulk supply from us or a partial supply from us.

Mr. CLAUDE BAGGALLAY Q.C. (for Edmonton District Council and other authorities): You think you would take people from existing districts where their work is to be found to new works?—No, manufacturers would come very readily, I believe.

I gather from yourself, Mr. Raworth and others, that the works are likely to be situated principally near the river Lea, so that if you have to supply remote districts in Hertfordshire or in West Middlesex the works near the Lea would have to bear the added cost of long length of main?—We propose to supply at a uniform price throughout the whole district.

But people near the Lea who want a cheap supply will have to pay something towards the cost of supplying at a uniform price the western and northern parts of the district?—No; you are quite wrong.

Lord ROBERT CECIL, Q.C.: Supposing the existing small Distribution Company establishes its generating station at Hertford, do you think they will abandon the site in the event of the bill passing?—No, they regard that as the pioneer station. They will immediately make arrangements for supplying electricity in bulk from the main generating station, and will take the smaller plant away. There is a ready market for such plant.

Mr. MOON: Supposing this bill passes, what will take place at Hertford?—The Distribution Company has certain statutory obligations, and they must commence to supply. In the event of the bill passing, the main will be immediately run along the Lea valley, through Hoddesdon and Ware, probably right into Hertford, and as soon as a bulk supply is available the generating plant at Hertford and Barnet will be shut down and taken elsewhere.

This concluded the case for the promoters.

Counsel for the opponents of the bill having addressed the Committee,

Mr. BARTLEY DENNIS asked that in the event of its being passed the Harrow Electric Light and Power Co. should be exempt from its operation.

On Wednesday the CHAIRMAN said: We find the preamble of the bill proved, but in view of the importance of the principles involved the Committee will postpone the consideration of the clauses until Thursday, June 28, in order that we may secure as much uniformity as possible with the other bills now before the Electric Power Bills Committee.

WAR OFFICE CONTRACTS.

In the proceedings, on Friday last, before the Select Committee of the House of Commons which is enquiring into certain allegations of fraud and irregularity in connection with War Office contracts during the 12 months to April last, the charges brought against the Walsall Electrical Co. were investigated. It is clear from the evidence already given before the Committee that these charges are of a nature which could be easily much exaggerated, as we know from Messrs. Stiff and Sons' letter to us (p. 233 of our issue for June 1). Mr. Jackson presided.

Mr. W. PEARSE, R.E. Inspecting Department, Woolwich, said that in January last a representative (Mr. F. Brown) of the Wallsall Co. called upon him at Woolwich Dockyard, respecting a number (8) of electrical testing instruments supplied by the company and rejected on inspection. Witness explained the defects, and showed Mr. Brown the record of tests of the instruments complained of, and also explained the department's requirements. Mr. Brown appeared to be pleased with what witness stated, and admitted the goods were rejected for sufficient reason. He then placed his hand in his pocket and asked if witness would accept a trifle for the trouble he had been put to. Witness declined. Mr. Brown then asked him for his private address, and this he also declined. Mr. Brown then went away, and witness reported the circumstances to the chief examiner, who advised him to report to the inspector, and he did so.

By Mr. SHEARMAN, counsel for the Walsall Co.: The eight small instruments were worth about 50s. a-piece.

Mr. FREDERICK BROWN, managing director of the Walsall Electrical Co, being a member of the Society of Friends, was allowed to affirm. He said he agreed with Mr. Pearse's account of what happened at the interview. When he offered Mr. Pearse a trifle for his trouble he did not know that he was the person responsible for testing the instruments. His object in asking for his private address was to send him two tickets for the theatre, as he was at the time contracting for a theatre and had some spare tickets. Mr. Pearse had been very civil and had given him all the information he required. He now realised that his action was open to misconception, but he had certainly no fraudulent intention. In reply to a statement by Mr. Major, director of Army contracts, that the work of the Walsall Co. had been generally unsatisfactory, he stated that the total value of the War Office acceptances between 1897 and 1899 was over £1,000, while the rejections represented

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a value of about £100. The date when his firm's name was struck off the War Office list was stated as Jan. 17, yet they actually sent in a tender on March 23 at War Office request. Until he saw the name of his firm in the newspapers as having been taken off the list he had no idea whatever that they had been so struck off. No notification of the fact had been made to them, since they had the right of appeal in such a case, and he thought this was a great hardship.

The CHAIRMAN: As a man of business, if anyone had subjected a confidential servant of yours to this process of "treating," would you not have deemed it extremely improper?—Looking at the matter as I do now I think probably I should. In this case, however, Mr. Pearse had returned the instruments to us, whereas we are supposed to fetch them. This was extra trouble, which I thought worth acknowledging. I think Mr. Pearse acted quite rightly in refusing, and I have no complaint to make of him.

LONDON COUNTY COUNCIL TRAMWAYS.

The Select Committee of the House of Commons, presided over by Mr. W. H. Holland, on Tuesday considered the London County Tramways (No. 1) Bill promoted by the London County Council authorising the construction of 11 extensions to the Council's existing tramways north of the Thames; and on the south side the doubling of the existing line of tramway along Nine Elms-lane and the erection of a generating station at Camberwell for working by electric traction the tramways from Westminster and Blackfriars Bridge to Kennington and from Westminster to Tooting. The bill was opposed by several local authorities, the omnibus owners in London, the North Metropolitan Tramways Co., the North London Railway Co., and owners and frontagers along the routes.

Mr. DU CANE, for the promoters, said the proposed new tramways or junction lines were confined to the northern side of the Thames, the widenings were both on the south and north, and the electrical equipment was on the south. In the county of London there were 115 miles of tramways, of which the Council owned 48 miles on the north and 24½ miles on the south of the river, or 72½ miles in all. The Council's northern tramways were worked under lease by the North Metropolitan Tramways Co., which paid a dead rent to the Council, with an additional payment should the profits increase beyond a certain amount. In the south 24½ miles were worked by the Council themselves. The Council sought by this bill and another that had already passed the House to equip generally their system of tramways for electric traction. Most of the extensions had been suggested to the Council by the authorities of the districts through which the lines would run, and, with two exceptions, were unopposed. Opposition came from the Holborn District Board of Works, who objected to the proposed line along Rosebery-avenue, against the Drayton Park extension, and the line at Evering-road, Stoke Newington, on the extreme east. The bill was also opposed by the London General Omnibus Co., who claimed to represent the omnibus interest of the county of London. The other bill promoted by the Council (No. 2) was one authorising the Council to adopt electric traction subject to the approval of the Board of Trade. In the present bill, however, there were no works included which did not involve new construction. The lines of tramways proposed would run through the districts of some 15 local bodies of whom only three were opposing.

Mr. J. W. BENN, L.C.C., said the Council had found the tramways of London in a state of confusion, and were endeavouring to bring the whole system into order. In three years they would own the whole of the tramways of the metropolis. The object of the bill was to couple up the lines by filling up breaks so that passengers might travel through from point to point. By the other bill before the House it was proposed to apply electric traction to all the lines in London. If the overhead trolley system were adopted the local authorities were to be first consulted and their consent obtained. It was proposed to apply electric traction to the extensions now asked for. Any system could be employed by the Council with the approval of the Board of Trade. With regard to the North Metropolitan Tramways Co., the Council contended that the clause in their lease covering reconstruction and extension was sufficient protection for that company. If there was any doubt, provision was made in the lease for arbitration. The omnibus opposition might be summed up in the fact that they feared competition with electric traction. If the Council's No. 2 bill passed, the provisions of this bill in regard to the electrical equipment of the Tooting line would be unnecessary. This bill had provided a generating station and mains to give effect to bill No. 2. Whatever happened to No. 2 bill the Council were very desirous to electrically equip the Tooting line. Under the powers taken over by the Council from the tramway companies, they could equip certain lines experimentally; but, as the cost was £15,000 per mile, including the generating station, it was impossible to do so, subject to pulling up the system should it not be approved by the local authority. The electric car, occupying the same area as the horse car, would carry 70 passengers against 46 by the horse-driven car. The substitution of electric for horse traction would, it was calculated, save in London some 9 miles of road space, the same number of passengers being carried.

Sir ALEX. BINNIE, chief engineer to the London County Council, said the cost of the extensions included in the bill with points and crossings would be £109,400. The electric equipment of the Westminster and Tooting line would cost £186,500, and that of the Blackfriars and Kennington tramway £57,600. The total cost of the proposals of the bill would be roughly £466,000, inclusive of site for the generating station (£90,000).

Yesterday (Thursday) Prof. A. B. W. KENNEDY said that last year the London County Council had asked him to report as to the use of electric traction in London. He had examined the tramways of Europe and the United States, and made himself thoroughly acquainted with all modes of electric traction. The general conclusion of his report was that an electrical system with underground conductors was perfectly feasible in London, and would not be extravagantly expensive. Any such system could be worked with economy and success, and he was in favour of an underground system as most suitable for the centre of the metropolis. In the outlying parts it might be preferable to adopt the cheaper overhead system. A veto was given by the bill to local authorities in regard to the use of the overhead system, and with respect to any other system they would have a right to particulars and to appear before the Board of Trade. After considering this report, the Council had instructed him to prepare plans, which he was now doing. The tramways would be so laid that neither the tram rails, nor the slot rails, nor any other part of the apparatus would interfere with the ordinary traffic, and to all outward appearance the conduit system would look exactly like the Brixton cable line, which had been working for years. There were practically two systems proposed to be used—the conduit system and the surface-contact system. The conduit system was at work on a large scale in America and in Europe. Under that system the two running rails were seen, with the slot rails in the centre with an open groove, underneath which there would be a continuous conduit carrying the two steel conductors, one being the negative and the other the positive. These would be carried on insulators entirely separate from each other. From the cars would drop down a very thin plough—a framework about 15in. long and ¼in. thick connecting with the conductors and picking up the current. There was complete insulation as in the case of electric light conductors. The surface contact had not been so extensively used as the conduit system. The principle of that system was that the electricity was collected by the car from metallic discs or contact studs placed between the rails. These discs were circular, about 8in. in diameter, with a contact surface about 3in. in diameter. The intention was to set each disc in bitumen blocks about 8in. by 15in., which would be sloped to meet the pavement of which they formed a part, and would be so constructed that in the highest part the discs would be only ⅛in. above the surrounding pavement. That ⅛in. would not present a sharp edge. There would be no danger whatever to the street traffic. The system had certain advantages in regard to cost and simplicity, and the Council thought they ought to have the right to adopt it if, on use, it was found advantageous without the local authorities having an absolute veto such as had been given in respect of the overhead system. With the surface contact system the current returned through the rails, so that there were no insulated returns, and the system was similar in that respect to the overhead system. There was a conductor running underneath the studs and connected to a moveable pipe of iron There was nothing else below ground. The tramcar carried certain electromagnetic appliances, which when they came over one of the studs lifted the piece of iron and brought it in contact with th stud through which the current was carried to the motors on the car. Directly the car passed the iron pipe dropped down and was no longer in contact. The actual contact was made by means of a skate which rubbed along the top of the studs. These studs were only alive when the skate was passing over them, which was when the car was passing. Some of the existing depots would be used as transforming stations, and he thought the site at Camberwell was a good one for the generating station, being close to the London Chatham and Dover Railway, upon which coal sidings would be constructed under the powers of the bill. The station would be large enough to meet the needs of South London for many years to come, even though the whole of the tramways were operated by electricity. The electric cars proposed to be used would carry 64 people, and the speed would be regulated by the Board of Trade. The initial difference of cost between the conduit and the surface-contact systems was about £2,000 per mile. The surface-contact system in use at Paris was a defective system, being worked in a complicated and inefficient manner, and was not suitable for use in London. So far as principle was concerned it was the same as that now proposed. He did not propose the Potter system, except that that system was a surface-contact system. From Westminster Bridge to Clapham Common, and from Blackfriars Bridge to Kennington the conduit system would be used, and from Clapham Common to Tooting the surface-contact system. From the conduit system there was no danger of electrolysis being caused, because the returns were insulated. With the surface-contact system there was the same risk as with the overhead system, the returns not being insulated. The Board of Trade regulations protected anyone from injury in that respect.

The Committee then adjourned till to-day (Friday).

CROYDON TRAMWAYS AND IMPROVEMENTS BILL.

On Tuesday the omnibus bill promoted by the Croydon Corporation, dealing, among other things, with tramways, came before the section of the Police and Sanitary Committee of the House of Commons of which Lord E. Fitzmaurice is chairman. In 1894 the Corporation obtained power to construct tramways within the borough, which they leased to the Croydon Tramways Co. The Corporation are about to take over these tramways, and seek power to wind up the company and to construct further tramways, to be worked electrically on the overhead trolley system. It is also proposed to take power to supply electric energy to adjacent local authorities. For the tramways borrowing powers of £170,000, and for the generating stations £35,000, are asked. One clause in the bill enables any department of the Government to represent to the Board of Trade that the use of their electrical powers injuriously affects any instruments or apparatus, whether electrical or not, used in any observatory or laboratory, and then the Board of Trade shall, after inspection or inquiry, have power to require the Corporation to use such reasonable and proper precautions, including insulated returns, as the Board of Trade may deem necessary, to prevent such injurious affection. The bill was opposed by

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two sets of petitioners—the frontagers on a part of the line and the Lambeth Water Co., who allege danger to their mains from electrolysis, and ask for a clause throwing the cost of any accidents through electrolytic action upon the Corporation.

After hearing evidence and counsel, the Committee decided against the petition of the frontagers and passed the portion of the preamble relating to the tramways.

The Committee then proceeded to deal with the opposition of the Lambeth Company.

Mr. STEPHEN SELLON (for the Corporation) said that such a provision had never been inserted in any Act of Parliament, although the Lambeth Company had unsuccessfully tried to get it inserted in another case this year. In 1893 a Joint Committee of both Houses considered, *inter alia*, this question of electrolytic action arising from electrical tramways, and their conclusion was that the only instances brought before them came from abroad, and were cases in which the tramways had not been properly constructed. Upon their report and recommendation the Board of Trade adopted a clause which was intended to secure the proper construction of electrical tramways and so to prevent the possibility of electrolytic action; and the Corporation had in this case adopted the Board of Trade standard clauses.

Mr. JAMES SWINBURNE (for the petitioners) said he had some apprehensions, even if the Board of Trade regulations were properly enforced, in the case of Croydon (where 2½ volts was the maximum pressure to be used and the area was limited), on account of the possibility of the extension of the system or of its being joined up with the County Council or some other large system in the South of London. He explained that electrolytic action was gradual, and resulted in eating away the pipes. Though the recording instruments, the use of which was insisted on by the Board of Trade, showed the difference in pressure and the amount of leakage at a station, they did not show that a portion of the leakage which left the line traversed the pipes and returned to the line.

Having heard counsel, the Committee deliberated in private, after which the CHAIRMAN, in giving their decision, said they did not see how they could grant the compensation clause asked for.

The tramway clauses were then gone through and adjusted in the usual way.

BOURNEMOUTH TRAMWAYS.

On Tuesday the Select Committee of the House of Commons, presided over by Mr. W. H. Holland, again considered the bill confirming the Tramways Provisional Order of the Bournemouth Corporation.

Mr. PEMBROKE STEPHENS, Q.C., for the Corporation, said that since their last meeting the promoters had had an opportunity to consider the position, and they found that certain points had been overlooked, and certainly some alterations would have to be made either by the Committee or in another place. Two things seemed to have been prominently in the minds of the Committee: one, the question of precedents, and the other the question of continuous working. By the action of the Corporation and the Committee tramways had been secured, and the Committee had imposed the terms that, if within two years the tramways were not constructed, other parties should be at liberty to make them. Now there came in the difficulty, which was not emphasised on the last occasion, that the two schemes were not absolutely alike. The Corporation scheme was for tramways generally throughout the whole of Bournemouth, and the scheme of the Christchurch Bill for tramways approaching Bournemouth, and with a considerable break in the middle, and if the Corporation tramways were not made in sympathy with that scheme continuous running would be impossible. The private tramway company had no continuous line to offer, and therefore the continuous line was a concession to the company, which they had no means of offering an equivalent for.

Mr. MOON, for the Christchurch Co., submitted that the Committee, having giving its decision, would not re-open the question of running powers at all.

Mr. PEMBKOKE STEPHENS: It had been put before the Committee with some confidence that there were precedents for compulsory running powers being given over corporation tramways. It was, however, a mistake to say that such powers had been given by Parliament. The Committee had therefore been unintentionally misled, and if the decision of the Committee rested on that statement it was based upon an error.

The CHAIRMAN: The Committee cannot see that any new point is now raised. The Committee decided on the evidence before it.

Mr. BALFOUR BROWNE, Q.C., for the Tramway Co., said his case had been opened on its merits. An agreement had been signed between the two agents, and the present application was bad in practice, and he protested against the matter being opened up again.

Mr. STEPHENS: If the decision of the Committee is irrevocable I shall be obliged to go to the other House and say that a thing had been done which was without precedent in giving these running powers over the Corporation tramways.

The CHAIRMAN: The Committee are advised that, as a matter of order, the bill is no longer before the Committee, so that, however disposed they might be, they have no power to re-open the matter.

Mr. BALFOUR BROWNE, Q.C., protested as strongly as he could against the action of the Corporation. The matter had been heard fully by the Committee, a decision come to, a careful agreement between parties prepared and signed by the Parliamentary agents and accepted by the Committee. The case for the running powers was not opened as one of precedent at all, and it was for Private Bill committees to make precedents. There had been no miscarriage, but if there had been it had been condoned by the agreement signed and settled.

Mr. STEPHENS said if the Committee did not feel themselves at liberty to hear the Corporation case, all he asked was that nothing should be done to hamper what was a great public case.

The CHAIRMAN: The Committee cannot see their way to re-open the matter. If anything new had occurred it can be stated in the other House. There is nothing to be added or taken away from the previous decision of the Committee.

TOTTENHAM DISTRICT COUNCIL BILL.

This bill came before a Select Committee of the House of Commons yesterday. Its objects include the proposed supply of electricity, for which borrowing powers are sought for £36,000.

Mr. R. C. GLEN explained the position of the electricity proposal, and pointed out that the only opponent was the Middlesex County Council, who would not have had a *locus standi* if the promoters had proceeded by way of provisional order. The County Council urged that they might in the future propose to run trams on the electric overhead trolley system, and the powers sought by the promoters if granted would prove detrimental to that undertaking.

The CHAIRMAN of the Tottenham District Council gave evidence of the great desire for a supply of electricity in the district, and said the estimate of Messrs. Preece and Cardew of the cost of the electric installation was £36,000.

Mr. EARLE (for the Middlesex County Council) said that although the actual duty of doing repairs and maintaining the main roads was retained or claimed by the District Council, the obligation to pay, in the name of a contribution, really the whole cost of repair and maintenance, was cast upon the County Council. So long as a private undertaker was carrying on the electric lighting work, the public were protected by the District Council, whose only interest is to protect the public, but here, although the District Council did not lose their public character, they came forward as traders, and their interest as traders might conflict to a considerable extent with their interest as a public authority. He therefore asked that the County Council should be put, in reference to main roads, in precisely the same position with regard to the scheme as the District Council would be if the work had been undertaken by a private company. There were many cases where this had been done.

The CHAIRMAN decided not to give the protection sought, and passed the preamble of the bill.

TWICKENHAM ELECTRIC LIGHTING PROVISIONAL ORDER BILL.

The right of the Middlesex County Council to be heard in opposition to the above measure was considered yesterday (Thursday) by the Court of Referees of the House of Commons, Mr. Parker Smith presiding. Mr. HARPER, for the County Council, in claiming a *locus standi*, held that his clients contributed towards the cost of the main roads which would have to be broken up under the powers of the bill, and that, therefore, they were entitled to be heard against the preamble of the measure. Mr. SHAW, on the other hand, contended that the management of roads was vested in the district council, and that it would be absurd to give two authorities the right to appear in opposition to the bill in respect of their ownership of main roads. The County County only paid a contribution towards the maintenance of the roads. Besides, this was an electric lighting order, and the eventual purchasers were the District Council and not the County Council. The *locus standi* was disallowed.

UNDERGROUND TELEGRAPH WIRES.

In the House of Commons, on Monday, Mr. HANBURY, in reply to Sir John Leng, said that the underground telegraph line from London to Birmingham met the demand for uninterrupted communication over that part of the country where destructive gales were most prevalent, but it was not at present found to be so generally useful as the overground line. The Postmaster-General could not at present contemplate its extension to the North.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Ashton.—The Council have decided to apply for borrowing powers for a considerable extension of the plant at the electricity works.

Asylum Lighting.—The Fifeshire County Council has decided to obtain a report from an electrical engineer as to the cost of lighting their asylum electrically.

Beverley.—Consideration by the Council of the report of Mr. A. H. Gibbings on electric lighting has been postponed until the decision of the Parliamentary Committee on the Electric Power bills has been given.

Bermondsey (London).—The Vestry have approved drawings prepared by their consulting engineers (Messrs. Kincaid, Waller & Manville), for the refuse destructor and electricity supply buildings, and tenders are shortly to be invited.

Birmingham.—The Public Works committee have approved of the adoption of central standards with cross arms for that portion of the Bristol-road tramway route between the Suffolk-street terminus and Bromsgrove-street, and side poles with brackets for the remainder of the route.

Burton-on-Trent.—The accounts of the Gas and Electricity works were presented at the Corporation meeting last week and approved. The chairman (Councillor Lowe) said he thought the

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Council would agree they had made substantial progress during the past year in their electric light undertaking, and the time was not far distant when that department would become a remunerative one. They had spent £1,825 in replacing the old rubber mains with British Insulated Wire Co.'s cables. The removal of the old mains had cost £2,359, and had been paid for out of the reserve fund of the gas works. The profit on the gas works had been increased from £6,105. 15s. in 1899, to £6,521. 7s. 3d. in 1900. Taking all things into consideration, the committee thought the gas and electric light undertakings had worked most satisfactorily. The report was agreed to. Afterwards Councillor Lowe moved that the price of gas be increased 5d. per 1,000ft. He said that either the price must be raised or they would fail to make any contribution to the rates, which would in consequence go up at the very least 6d. in the £. However much opposed to their interests, it was their duty to make the usual provisions in their accounts. The increase in their coal bill was £8,700, and the increase of 5d. per 1,000ft. would bring in about £6,250, leaving £2,500 to be met by the increased price of residuals. Councillor Hutchinson contended that the price was being raised much higher than was necessary, especially as the charge for electric current was to remain at its present figure. He considered the electric light consumer thus received an unfair preference over his neighbour who used gas. Eventually, however, the resolution was carried.

An application by the promoters of the Swadlincote and Woodville tramways for the Council's consent to the construction of tramways within the borough has been referred to a committee.

Cardiff.—The Tramways committee are about to invite tenders for about 1,000 tons of rails, fishplates, bolts, copper bonding, &c.

Carlisle.—The total receipts of the electricity department for the year ended March 25 amounted to £2,102. 11s., of which £1,592. 19s. 9d. was for current for private and £510 for public lighting. The expenses of generation were £1,169. 5s. 7d., distribution £90. 6s. 10d., public lamps £178. 11s. 10d., rents, rates and taxes, £32; management expenses £663. 8s. 6d., and insurance £30. 8s. 6d., a total of £2,164. 1s 2d. Interest came to £868. 18s. 6d. and sinking fund instalment to £1,189. 10s. 5d., leaving a net loss of £2,091. 1s. 5d.; 167,032 units of current were generated, 103,155 sold and 22,379 used on works. Private consumers took 85,922 units, and 44,233 units were used for public lighting. The total maximum supply demanded was 169 kw. The capital expenditure was £31,152. 5s. 2d., or £1,189. 5s. in excess of borrowing powers.

Chesterfield.—A canvass of ratepayers has resulted in offers to take electric current for the equivalent of 7,950 8 c.p. lamps. The canvass was made at the request of the Local Government Board.

Clacton.—At last week's meeting of the Council it was proposed to instruct the consulting engineer (Mr. W. H. Trentham) to prepare plans and specifications for an electric lighting scheme, but an amendment that the matter stand over for six months was carried.

Colne.—Application for sanction to borrow £40,000 for electric lighting has been decided upon. The Council already have one good customer, as current will be supplied to the Colne and Trawden light railway.

Coventry.—The accounts of the electricity department were presented an approved at the Corporation meeting on Tuesday. During the year ended March 31 the number of consumers increased from 135 to 236, and the revenue went up from £3,597 to £4,188. The profit had been £786, against £333 for the previous 15 months.

Crewe.—The completion of the 4,000th locomotive engine at the Crewe works of the London and North-Western Railway Co. was made the occasion of general rejoicings on Saturday, when Mr. F. W. Webb, chief mechanical engineer of the company, presided over a large gathering at the Mechanics' Institute, Crewe. A bronze medallion of the late Sir Joseph Whitworth, presented to the Institute by former Crewe students who have succeeded in securing Whitworth scholarships or exhibitions, was unveiled by Mr. Groves of the Patent Office. Mr. Webb, referring to the completion of the 4,000th engine, said although they had been hard pressed at the works to keep abreast of their business, they had not yet had to go across the Atlantic for any of their engines. He had informed the directors of his company that if any American locomotive were sent to Crewe for repairs they would have to get some one else to repair it, for he could not do so. He considered the locomotives turned out at the Crewe workshops equal to any in the world. It is not unlikely that if a similarly firm attitude had been assumed by other gentlemen in Mr. Webb's position, the importation of American locomotives into this country would have been on a much smaller scale. Mr. Webb was subsequently presented with the freedom of Crewe by the Town Council, and mentioned that when he first went to Crewe they had turned out their 250th engine and were employing 510 workmen, whereas in 1899 the employés numbered 7,428, and their engines had travelled 74,000,000 miles.

Dudley.—Until further notice electric light consumers are to have the option of being charged at a uniform rate of 5d. per unit or 6d. for two hours a day (between 5 p.m. and 7 p.m. in winter and 6 p.m. and 8 p.m. in summer) and 1½d. after. The chairman of the committee (Ald. G. H. Dunn) announced at the last meeting of the Council that the award of the Board of Trade as to the amount the British Electric Traction Co. had to pay the Corporation for electrical energy was very satisfactory. The new generating station could produce 700 kw., and there was room to lay down an engine two or three times the size of the present one, so that they would be able to meet any demand for electricity made upon the town in the future. In 1902 the Corporation would have to take over the tramways and re-lease them to the company for 21 years. If they could not agree as to conditions the Board of Trade would arbitrate. The Council have applied for sanction to borrow £10,000 for wiring consumers' premises in the district.

Dundee.—At the annual meeting of the Gas Corporation on Wednesday Treasurer Ritchie announced that the income of the electricity department for the year had been £10,755. 14s. 7d., and the surplus £628. 1s. 10d. The estimated income for the current year was £15,450. 1s. 10d., and the expenditure £14,535. The price of gas has been increased from 3s. 4d. to 3s. 10d.

Electric Driving.—In the report of the Ebbw Vale Steel, Iron and Coal Co. for the year ended March 31 it is stated the board have under consideration the remodelling of the blast furnace plant, and the extensive introduction of electric power.

Electric Launches on the Thames.—The subject of electrically-driven launches and other boats for the Thames traffic is one which is at the present moment receiving considerable attention from electrical engineers, the London County Council, and others. The Immisch Electric Launch Co. has just issued a pamphlet on this subject. These launches were introduced by Messrs. Immisch & Co. as far back as 1889, and the number of these vessels has continued to slowly but surely increase until now a considerable capital is invested in the development of this form of electrical progression. The pamphlet gives us much technical information as the public can absorb, and there is little difficulty in showing the advantages of electrical over other forms of mechanically-driven boats, from their handiness, the simplicity of the mechanism, easy working, perfect control, and the fact that the driving power is stored out of the way, leaving the whole of the room in the boats for the comfort and convenience of the passengers. The pamphlet gives particulars of up-stream and down-stream trips, the distances, the names of the up-river locks, and some interesting particulars of the chief places to be visited. A number of maps are given to aid the tourist adopting this method of visiting the charming upper reaches of the river. Last, but not least, a list of the launches available, their carrying capacity, and the charges made by the company for hiring and service. The time is surely at hand when this company will achieve a larger measure of success than it has yet attained.

Mr. W. Rowland Edwards of the Thames Valley Launch Co. writes us on the subject of electric launches and other vehicles as follows:—Motor cars can now be used comfortably between Oxford and London, the Thames Valley Co.'s charging stations being now available at the following places: Weybridge (river side), Maidenhead (Boulter's Lock), Hurley (at the lock), Pangbourne (adjoining Whitchurch Bridge), Shillingford Bridge, and by arrangement with the Oxford Electric Lighting Co. The Thames Valley Co. have a number of electrical boats available for hire and purchase.

Electric Lighting in the North Metropolitan Districts.—At the Tottenham Council last week the clerk reported that at the recent conference on the electric lighting question representatives from Friern Barnet, Edmonton, Finchley, Southgate, Wood Green, and Tottenham, agreed to ask the various authorities who had not yet done so to support the principle of co-operation in electricity supply. Edmonton, Southgate, and Tottenham had already passed resolutions to this effect.

Electric Lighting Plant for German Sea-going Vessels.—The German Bundesrath has decreed that apparatus and materials required for electric lighting on board sea-going vessels, including searchlights and their appurtenances, shall be admitted free of duty into the German Customs Union.

Electric Pumping.—At the meeting of Young's Paraffin Light and Mineral Oil Co. (Ltd.) last week, the chairman (Sir James King) said that among the items of special outlay for the current year was that for electric pumping plant at Newliston, which would accomplish the pumping much more efficiently than at present, and at greatly reduced cost.

"**Electric Shock.**"—*Inquest.*—An inquest was held last week on the body of an assistant night watchman named Golton, in the employ of the London Electric Supply Corporation, at the Deptford Works. It appeared that deceased suffered from a weak heart. His duties were to make certain rounds during the night and to enter in a log book certain particulars. It was no part of his duties to touch the machinery, except to do a little switching occasionally during the night. The evidence of Mr. Clement J. Bailey, superintending engineer at the works, went to show that deceased went to the switchboard to make an entry in the log book, which was kept near this spot. The voltage of the conductors near where deceased was

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found was 2,500. Evidence was given by members of the company's staff and by medical men that death was due to asphyxia and not to electric shock. Dr. A. J. Russell, of Deptford, stated that the post-mortem examination disclosed no marks or burns, except a small bruise on the nose where deceased had fallen. Death was due to asphyxia, the cause of which he had not been able to ascertain. The appearance of the body did not, however, exclude the possibility of death from electric shock. The valves of deceased's heart were diseased and the heart's action might have failed through a fall from faintness. Dr. Lewis Jones, of the electrical department, St. Bartholomew's Hospital, said he had never known of a case of death from electric shock where the voltage was 2,500 without a burn, which was usually a distinguishing mark of death by electricity. He was of opinion that deceased could not have come in contact with the conductor near which he was found without receiving a burn. Mr. G. W. Partridge, chief engineer to the Corporation, said the fuses found near deceased were not in use. The jury with one dissentient returned a verdict of death from asphyxia caused by electric shock. The dissenting juryman said he did not consider the evidence sufficient to justify the verdict.

Electric Tramways in London.—Some members of the London County Council recently had an interview with the President of the Local Government Board (Mr. Chaplin) and the President of the Board of Trade (Mr. Ritchie) on matters relating to the government of the metropolis, when a request was made that increased facilities might be provided, by legislation or otherwise, for the construction of electric tramways in districts where the Council had powers to build artisans' dwellings. The President of the Local Government Board had no difficulty in meeting the views of the deputation, and the President of the Board of Trade expressed the opinion that the wishes of the Council would best be attained by altering the Standing Order which rendered the consent of the local authority an essential preliminary to the use of thoroughfares.

Electricity in Mining.—On Wednesday the bottom of the shaft in No. 2 mine of Bridgewater Colliery, Walkden, belonging to the Bridgewater trustees, was lighted electrically for the first time. The electric light, which supersedes oil lamps at the bottom of the shaft, also extends nearly 200 yards in a tunnel leading to the workings.

Engineering Amalgamations.—Negotiations are practically completed for the amalgamation of Sir Christopher Furness, Westgarth & Co. (Ltd.), marine engine builders, Middlesbrough, with Messrs. T. Richardson & Sons, electrical and mechanical engineers, Hartlepool, and the newly-acquired Scotia Engine Works, Sunderland.

The firm and business of R. Napier & Sons, Govan (builders of a large number of vessels engaged in cable laying and repairing work) is to be absorbed in Messrs. Wm. Beardmore & Co., Parkhead, Glasgow. The latter firm is building considerable extensions to its establishment at Parkhead.

Engineering Trade Dispute.—It is announced that the A.S.E. officials have decided that their members shall cease to work overtime after 25th inst. "until some method of settling the wages question has been agreed upon." The engineering employers of the North-East Coast have declined to submit demands of the men for an increase of wages to arbitration.

French Submarine Cable Enterprise.—M. Ordinaire on Monday submitted to the French Chamber of Deputies (on behalf of the Colonial committee) a report on the bill before the Chamber for colonial submarine cables. *The Times* states that the report approves the proposed cable from Oran to Tangier, which would dispense with the use of the English or Spanish cables, but condemns the proposed extensions of that cable to Marseilles and Teneriffe, advocating a direct line from Brest to Saint Louis as less expensive and as being easily connected with a Central America and a Congo cable. The report advocates the connection of Madagascar with the Congo by submarine and inland telegraphs and with Tongking *via* Réunion. The report, without definitely pronouncing, is in favour of the laying and working of these cables by private companies, the State not possessing sufficient apparatus for constructing them and being unlikely to work them with success commercially.

Glasgow.—The Corporation on Wednesday agreed to increase the salaries of Mr. W. W. Lackie and Mr. J. C. A. Ward, assistant engineers of the electricity department, as mentioned in our last issue.

Greenock.—Additional plant, estimated to cost about £8,000, is to be erected at the electricity works in order to provide current for the projected electric tramway.

Halesworth (Suffolk).—The Colchester Brewing Co., who are putting down electric lighting plant, have offered to supply tradesmen in the district with current. The Council have, however, appointed a committee to consider and report upon the advisability of themselves applying for electric lighting powers.

Hampstead (London).—The profit on the working of the electricity department for the year ended March 25 amounted to £8,265. The Finance committee has transferred £5,061 out of the profits to the reserve fund, and £10,000 to be invested in London County 2½ per cent. consolidated stock, making the total amount invested £16,221, representing 10 per cent. of the capital expenditure. The sum of £3,205, the balance of the net profit for the year, is to be set aside to form the first instalment towards a depreciation fund for meters and plant.

Hanley.—The total receipts of the electricity department for the year ended March 31 were £8,809. 7s. 4d., and expenditure £7,631. 19s. 7d., leaving a balance of £1,177. 7s. 9d. Interest (£2,130. 18s. 5d.) and sinking fund (£1,315. 11s. 8d.) come to £3,416. 10s. 1d., leaving £2,269. 2s. 2d. to be provided out of the general district rate fund. 537,893 units of current were sold (123,070 for public and 414,823 for private lighting), and 14,199 units were used on the works. There are 65 arcs and 80 incandescent lamps, representing a total equivalent of 35,160 30-watt lamps connected for street lighting. The total maximum demand was 550 kw.

Hastings.—A report presented by the Lighting committee to the Council meeting on Friday, recommending that several additional thoroughfares be lighted electrically, and that the gas company be informed that the gas lamps would not be required after Dec. 25, was adopted, and a tender for lamp pillars accepted.

Heywood.—Last week the Town Council decided to apply for a loan of £15,000 for electricity supply.

Hotel Lighting.—The Coast Development Co. are putting down a complete electrical installation for lighting their new hotel and pier at Southwold. Edmundson's Electricity Corporation have obtained the contract, which is to be carried out to the specification of Mr. A. A. Campbell Swinton.

Hyde.—The Council have appointed six representatives of the Corporation to act on the joint committee (of 24 members) of the Councils of Hyde, Stalybridge, Dukinfield, and Mossley, for promoting a joint electric lighting and traction scheme for the districts. It has been resolved to make application, in conjunction with the Dukinfield Town Council, to the Light Railway Commissioners for an order authorising the Councils to undertake the construction and working, or to contract for the construction and working of light railways in Hyde and Dukinfield. Mr. Tinker, chairman of the Electricity committee, said it was important that they should pass the resolution unanimously, as if they failed to oppose successfully the application of the Oldham, Ashton, and Hyde Electric Tramway for an extension order it would be a very serious matter to the ratepayers of the borough. He was certain, and the Electricity committee agreed, that an electric lighting station would be much more profitable and much earlier remunerative if combined with an electric traction scheme. The resolution was carried unanimously.

Ipswich.—Prof. Kennedy's electric lighting scheme has been approved by the Council, and the Electric Lighting committee has been instructed to have the specifications prepared for inviting tenders. The scheme provides for 85 public arc lamps. The joint Electric Lighting and Parliamentary Bill committee recommended that it was desirable that all the electrical work relating both to tramways and lighting should be carried out simultaneously, and in order, if possible, to avoid interference with each street more than once, that specifications should be obtained for the whole of the work required for both. The committee also recommended that Prof. Kennedy should prepare the necessary specifications for both lighting and tramways as authorised in the Council's Parliamentary bill. The report was adopted.

King's Lynn.—An inquiry has been held into the application of the Council to borrow £10,000 for electric lighting extensions. Mr. J. W. Woolstencroft, town clerk, said there was an equivalent of 1,188 8 c.p. lamps connected in excess of the total capacity of the existing plant. Mr. J. Pilling, resident engineer, gave technical details, and said the proposed extensions would allow of 9,200 additional 8 c.p. lamps being connected. The new plant would consist of two steam dynamos, one of 200 kw. and one of 120 kw., with Lancashire boilers and Belliss engines. Mr. G. Humphreys Davies appeared in opposition, and asked that the proposed increased expenditure should be delayed for twelve months. He said the local gas company were willing to erect and maintain incandescent gaslights for street lighting at £3. 7s. 6d. per lamp per annum, and if this offer were accepted the existing electric lighting plant would be available for private consumers, for which it was quite adequate.

Lathom and Burscough.—The committee have received reports on electric and gas lighting, but no decision has been come to pending the result of the Lancashire Electric Power Bill now before Parliament. The cost of electric lighting plant has been put at £7,500 and the annual working expenses at £800. The Ormskirk Gas Co. offer to supply gas at 3s. 5d. per 1,000.

Leamington.—Mr. Horace Boot, of Tunbridge Wells, has been engaged by the Council, at a fee of 50 guineas and travelling expenses, to make a valuation of the undertaking of the Midland Electric Light and Power Co., whose application for a provisional order is unopposed.

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Light Railways.—An inquiry was held last week by the Earl of Jersey and Col. Boughey into the Warrington and Northwich light railway scheme. The eastern branch only was proceeded with, but, though the scheme was strongly supported by the local authorities interested, and by traders and residents along the route, it was dismissed because no compulsory powers had been obtained to acquire land. It is the intention of the engineer (Mr. R. H. Scotter) to amend this point, and again present the scheme. The western branch stands adjourned, as the time for lodging objections had not elapsed before the date of the inquiry.

An inquiry was held at Preston, on Friday, by the Light Railway Commissioners into the application of the Blackpool and Garstang Electric Light Railway Co. to construct a light (electric) railway from Blackpool to Garstang. For the promoters, Mr. Balfour Browne, Q.C., said the proposed railway would be divided into four sections. All the public authorities except Blackpool were in favour of the line. The estimated cost of the railway was £167,000, and of the electrical equipment under £75,000. After hearing local evidence, Mr. J. J. Myers, resident engineer of the line, gave evidence of the great tramway traffic on the various lines in Blackpool, and said that in 1898 the Corporation tramways carried 2,881,000 passengers, and last year 3,400,000. 2,500,000 people were carried by the Blackpool and Fleetwood Company, and about 1,000,000 by the St. Annes and Lytham trams. The necessity for a light railway was generally admitted. They would have one bridge over the proposed railway, one over the canal, and one under the public road. No. 1 railway would be 13 miles, No. 2 1 mile 5 fur., No. 3 1 fur., and No. 4 4 fur. The estimates of the cost were: No. 1, £131,816; No. 2, £23,900; No. 3, £3,647. 4s.; and No. 4, £16,147, in each case not including the electrical equipment. They expected to carry 600,000 people a year at 9d. a passenger, making £22,000, and estimated £11,250 from carriage of produce, making £33,700. Interest at 5 per cent. and cost of work would come to about £32,334, leaving £1,416 surplus profit. Mr. T. G. Lumb, C.E., also gave evidence. Afterwards evidence on behalf of Blackpool Corporation, who opposed, was taken, but eventually the Earl of Jersey said that the Commissioners believed a case had been made out, and that there was a demand in the district for a light railway, but they were not prepared to pass No. 2, but were prepared to sanction No. 1.

The Board of Trade have, after modification, confirmed the Bexhill and St. Leonards Light Railway Order (1900).

London, Walthamstow and Epping Forest Railway Act.—In the House of Commons, on Thursday last week, the President of the Board of Trade (Mr. Ritchie) said, in reply to Mr. S. Woods, that he had received from the agents for the promoters of this line, a statement of reasons for delay. On May 25 the House agreed to a resolution reported from the Standing Orders Committee that leave should be given for the introduction of a bill to abandon the undertaking. He was informed that the abandonment bill would accordingly be introduced forthwith.

Long Eaton.—The Council has adjourned the consideration of the proposal to establish electricity works in the district.

Melbourne (Australia).—The profit on the municipal electricity works from February, 1899, to February, 1900, amounted to nearly £5,000. Gross revenue totalled £29,849. 13s. 2d., and working expenses £17,818. 5s. 8d., leaving a gross profit of £12,031. 7s. 6d., an increase of £2,536. 14s. 1d. on the previous year. Interest on capital (4 per cent. on £112,402. 13s. 5d.) amounted to £4,496. 2s. 2d. and sinking fund to £3,372. 1s. 7d., leaving a net balance of £4,068. 2s. 3d. A statement appended by Mr. A. J. Arnot, city electrical engineer, shows that 834 electric street lamps are in use in the city, and that 1,688,626 units of current were sold.

Montrose.—The plans of the proposed electricity works of the Angus Electric Light Co. (Ltd.) have been passed by the burgh commissioners.

Morecambe.—The gross profit on the working of the electricity department for the year ended March 31 was £1,764, against £775 last year. The total capital expenditure is £39,700. Receipts from the sale of current amounted to £3,900, compared with £1,800 last year.

Municipal Telephony.—At the meeting of the Brighton Corporation yesterday (Thursday) the Telephone Committee presented a report in which they recommended the Corporation to apply for a licence to establish a municipal telephone system for the Brighton district. So far back as April 5, 1898, application was made to the Postmaster-General for a licence, but consideration of the matter was deferred pending the report of the Select Telephone Committee of the two Houses of Parliament. Since the issue of that report, licences to establish exchanges had been granted to the municipalities of Glasgow and Tunbridge Wells. On August 14 last, a letter from the Postmaster-General inquired whether, in view of the provisions of the Telegraph Act, 1899, the Brighton Council desired to renew their application for a licence, but to this communication no reply has yet been furnished. With a view to obtaining the best information on the subject of a municipal exchange, the committee had consulted Mr. A. R. Bennett.

In a lengthy report to the committee Mr. Bennett states that the existence of the independent borough of Hove complicated the working of the area by the Brighton Corporation, but telephonically considered, the two towns were practically one, and could only be worked separately at greatly increased cost and the sacrifice of efficiency. Mr. Bennett therefore treats them as one for engineering purposes. In order to obtain a licence for the area, the Brighton Corporation would have to produce to the Postmaster-General resolutions by the Hove Council and the Councils of the other local authorities within the area formally approving of the application. It was extremely difficult and even impossible to estimate the cost of constructing and working a telephone exchange in any area without an accurate knowledge of the number and location of the subscribers who had to be dealt with. The best that could be done was to assume a reasonable number and take it for granted that the location would not differ widely from that of subscribers to the existing telephone system. The present system of the National Telephone Co. comprised some 1,100 subscribers, and bearing in mind the tendency of telephone systems to expand under almost any conditions, and especially under the influence of reduced rates, he had prepared estimates for an exchange of 1,240 completed and 300 partially completed lines (corresponding in size to the existing system, and a second for an exchange of 2,080 completed and 600 partially completed lines for the guidance of the committee. He was of opinion that it was the larger of the two estimates which should be considered. With 2,000 subscribers Brighton would still be far behind many Continental cities in respect to the number of telephones to population, and would have fewer than the island of Guernsey, where there was one telephone line to every 60 inhabitants. As to capital expenditure, Mr. Bennett considered that, bearing especially in mind the increased cost of material, £18. 10s. per line would be sufficient provision for the cost of a first-class metallic-circuit telephone exchange system within the Brighton area, constructed in accordance with the specification annexed by the Post Office to licences to local authorities. If advantage were taken of the proximate opening of the streets for tramways to lay telephone conduits in the same trenches, a saving could be effected in this figure. The spare, partially completed lines would cost £8 each as a maximum. This worked out as follows:—1,200 line exchange: 1,200 subscribers and 40 public telephone lines complete at £18. 10s., £22,940; 300 partially completed lines at £8, £2,400; total, £25,340. 2,000 line exchange: 2,000 subscribers and 80 public telephone lines complete at £18. 10s., £38,480; 600 partially completed lines at £8, £4,800; total, £43,280. In the larger system the cost of the outside work would be somewhat reduced owing to the greater number of lines that could be put in position at the same time, but that of the inside work would be increased in about a corresponding degree, so that the cost per line would not be altered. The plan of construction would be, in the central districts, underground lines as far as circumstances would permit, with overhead lines in the more distant parts and suburbs. An average receipt per working line of about £5. 5s. per annum would be required to place the exchange on a remunerative basis at first. The Corporation was bound to offer subscribers the option of paying under the toll system, if desired, instead of an inclusive annual rental. Experience showed that the gross annual payments of toll subscribers did not, as a rule, amount to so much as £5. 5s. It was incumbent, therefore, in order to maintain the requisite average, to charge more for the inclusive service than would otherwise have been necessary. Mr. Bennett suggested the following tariffs as likely to result in an average receipt of not less than £5. 5s. per annuum. Should a considerable majority, as seemed not unlikely in such a busy town as Brighton, prefer unlimited service, that tariff could be reduced below £5. 10s. after a short experience. In Glasgow only 10 per cent. of the Corporation subscribers were taking the £3. 10s. and 1d. per call system. If that proportion held for Brighton the following tariffs would produce an average receipt of £5. 8s. 4d. per line per annum, allowing only one 1d. call per working day to each toll subscriber, which was more than was required to make the exchange pay its way. £5. 10s. for the unlimited rate might thereafter prove unnecessarily high:—Tariff No. 1: £5. 10s. per annum (payable in advance) to cover an unlimited number of calls. Tariff No. 2: £3. 10s. per annum (payable in advance) and a toll of 1d. per call (payable quarterly or half-yearly). 480 penny calls (about 1½d. per working day) would be required to overtake the unlimited rate, and so this tariff would be very appropriate for small users. The rates to cover installation, maintenance and Government royalty, and to apply over the whole of the Brighton area. The Swiss plan of a decreasing rental, say £5. 10s. for the first, £5. 7s. 6d. or the second, and £5. 5s. for the third and succeeding years, might be conceded to those willing to sign agreements for five years. On the 1,200-line exchange, he estimated the revenue at £6,787 per annum; and on the 2,000-line exchange at £11,469. After deducting working expenses (£6,441. 3s. 10d.) from the estimated revenue on the 1,200-line exchange, the net revenue was given at £315. 16s. 2d. The working expenses on the 2,000-line exchange were put at £10,269, and, deducting this from the estimated revenue, £1,200 was left as net revenue. Not only was provision made in these estimates for recovering the whole capital in 25 years, but for renewing the whole of the plant, so that at the termination of the licence the Corporation would be in possession of an efficient up-to-date system which would have cost them nothing. If this provision be deemed excessive, then the amount saved from the depreciation and renewal fund would be available towards a further reduction of rates. In the competition the National Telephone Co. would be at an enormous disadvantage in not possessing underground wayleaves, and would have to rely upon their old overhead single-wire system against the modern metallic circuit system of the Corporation. The company was much embarrassed in Brighton for want of wayleaves, and could not face the

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problem of converting their system to metallic circuit overhead. For the same reason the company would not be likely to reduce rates. They would not be able to find room overhead for the additional wires which such a proceeding would bring them. In numerous towns the company had accepted underground wayleave agreements which contained a clause binding the company to give the town granting the wayleave the benefit of any reductions in charges which might thereafter be made in any other town of corresponding size. The existence of the agreements constituted an important safeguard for corporations against unfair competition.

The committee thought the amount of certain items of expenditure was insufficient in view of local circumstances, but Mr. Bennett replied that on the fullest reconsideration he was convinced that his estimate was substantially correct, and required no amendment, except such as might be rendered desirable by the operation of local circumstances with which he was not familiar. The committee also considered a letter from the National Company requesting the Council to re-open the question of granting them permission to lay wires underground. Mr. W. E. L. Gaine, the general manager of the company, attended the committee meeting on May 22, but, after careful consideration of the suggestions made on behalf of the National Company, the committee came to the conclusion that the proposals submitted were not sufficiently advantageous to render it advisable that the Corporation should grant the company the right of laying wires under the streets. On the general question of the advisability of instituting a municipal telephone service in Brighton, the committee thought it desirable that such a scheme should be established, and that the Brighton telephone exchange area should include, not only Brighton and Hove, but the whole of the area between Rottingdean on the east and Shoreham on the west, and extending north as far as Burgess Hill. It was mentioned that the Act of Parliament did not make provision for the conduct of a telephone exchange jointly by two or more local authorities, and if it were desired to establish an exchange system under joint management a special Act of Parliament would be required. The committee accordingly recommended that application be made to the Postmaster-General for a licence to establish and carry on a system of public telephonic communication in the Brighton area for 25 years, the maximum rates of charge for exchange subscribers to be as follow: For unlimited service, £7; limited service, £3. 10s. and toll of 1d. per call, and that the Councils of the several districts included within the proposed exchange area be requested to give their consent to the application.

The Council yesterday adopted the Committee's report.

Newport (Mon.).—The accounts of the electricity department for the year ended March 31 were presented and discussed at the meeting of the Corporation last week. The chairman of the electricity committee (Councillor G. H. Llewellyn) stated that the gross profit amounted to £4,092, and provision had been made for all loans sanctioned, except the new loans. He hoped the small profit made (£403) was a beginning of better times. Several member supported a suggestion that the opportunity afforded by the gas company, who had raised their rates by 17 per cent., should be taken the greatest advantage of, and that at the earliest opportunity the price of electric current should be reduced from 6d. to 4d. per unit. The report of the Lighting and Tariff committee as to the erection of a power station and the electrical equipment of the Corporation-road tramways caused a rather animated discussion. The point at issue was as to whether the Electricity committee should act jointly with the Lighting committee. The report was adopted.

Personal.—Among the passengers by the Windsor train which was in the smash at Slough station of the Great Western Railway Co. on Saturday was Mr. R. G. Rawkins, secretary of the Notting Hill Electric Light Co. Mr. Rawkins lives at Slough, and the carriage in which he travelled was fully occupied by eight passengers. Hearing the cries of persons on the platform who saw a collision was inevitable, Mr. Rawkins and six of the other persons in the carriage jumped out on to the platform, leaving one passenger only in the carriage who was immediately afterwards killed, the carriage being completely splintered. We congratulate Mr. Rawkins upon his escape.

Portsmouth.—The accounts of the electricity department for the year ended March 31, now issued, are not quite so satisfactory as those of last year. This is attributed by Mr. E. Price, the superintendent of the station, to two causes—increased expenditure for coal and decrease in the current sold per lamp connected. During the year 426 new customers, representing the equivalent of 7,090 8 c.p. lamps, were connected, against 413 customers and 7,282 lamps in the previous year. 1,393,091 units of current were sold, including 972,051 for private lighting. The total receipts amounted to £23,991. 0s. 10d., and the income from private lighting alone was £18,177, against £14,696 last year. The capital expenditure has been increased to £161,056 from £140,776, and now represents £122 per kilowatt demanded against £124 last year.

Presentation.—Mr. J. J. England, who is entering the service of the British Electric Traction Co., was entertained on Friday last by the staff of the Cork Electric Tramway Co. at a farewell concert, and at the close was the recipient of a presentation.

Price of Gas in London.—Gas consumers for light, power, and domestic uses in the extensive area served by the Gas Light and Coke Co. north of the Thames received a severe shock this week in the form of an official intimation that "from the date of recording meter indices for the June quarter the price of gas is to be 3s. 5d. per 1,000 cubic ft.," vice 3s. deceased. The Gas Light and Coke Co. has an evil reputation for doing nothing by halves. This time they have been very thorough, as apart from the serious rise in the price of the commodity they have to sell, the day for taking the meter indices appears to have been brought forward. When will Parliament, or whatever public body should take the matter in hand, devote some little time and attention to the woes of the gas consumer within the area of the Gas Light and Coke Co. north of the Thames. We hear and see a good deal of competition in electricity supply. If the days of the gas fiend were not already numbered, the opprobrium now centreing upon everything connected with gas supply in the metropolis should prove the last nail in its coffin.

Royal Agricultural Show, York.—At the Royal Agricultural Society's Show at York, during the week, a cleverly constructed automatic electrical horse feeder has been exhibited, manufactured by Thomas Wood, Mills and Co., of Bristol. The hopper is filled with the allotted ration for the horse and an electrically operated clock is set at a fixed hour and as the alarm strikes the hopper is liberated and the ration of corn is shot into the manger. Another arrangement of this device is provided with a button, which can be pressed by any person in attendance on the stables, and a ration of food for the occupants of the stalls can be regularly and automatically provided.

St. Pancras (London).—The Electricity committee have considered the question of introducing "free" wiring for intending customers of the electricity department, but decided that the Vestry have no powers to embark in the business. Mr. Smith (chairman of the committee) hopes that, on the Vestry becoming a borough council in November, authority will be obtained to carry the system into effect.

Salford.—At a special meeting of the Council on Wednesday a report of the Selection committee in regard to the reconstruction of the Electric Light committee was discussed. The Mayor (Alderman Rudman) said that the Selection committee had done its work with care, and he asked members to assist the new committee in carrying out its duties during the next four months. He moved the election of the following members: Aldermen Holland, W. Robinson, and Shaw; Councillors Barrett, Bates, Broxap, Higson, Hodgson, Huddart, Leach, Mather, Muir, Stephens, Wilkinson, Worsley, and Yearnshaw. Only two of these members were on the old committee. The report was adopted and the members named duly appointed.

Sanding Tramway Tracks.—The action brought by the Dublin Corporation against the Dublin United Tramways Co. for the defendants to show cause why they should not be compelled to sand the tramway tracks under their control (which has been fully reported in *The Electrician*) came again before the Queen's Bench Division, Dublin, last week, and the magistrate's decision, ordering the company to sand the tracks, was upheld by a majority.

Shanklin.—An electric lighting scheme has been submitted by Edmundson's Electricity Corporation and will be considered by the Council in committee. The company offer to supply current to lamps of 30 c.p. each at £2. 10s. per lamp per annum, and if the contract is for seven years to fit the lamps free of charge. An alternative scheme was to erect 10 arc lamps of 750 c.p. each at £12 per annum each, and 149 incandescents at £2. 10s., making a total of £492. The present cost of lighting is £507 per annum.

Shoreditch (London).—Mr. H. E. Kershaw has severed his connection with the Lighting committee. Mr. N. Moss, chairman of the committee, has also resigned, and Mr. H. E. Winkler has been elected to the chairmanship. The Vestry has sanctioned an expenditure of £3,250 for laying ducts and cables from Reeve's-place sub-station to Great Cambridge street, and an outlay of £350 for a subway for mains between Coronet-street and Pitfield-street.

Silvertown and its Neighbourhood.—If there is one spot on the earth's surface which is well known to electrical men the world over, either from actual acquaintance or by repute, it is Silvertown and the near neighbourhood. Silvertown is named after the factories erected by Mr. Silver about 40 years ago, and which are now in the occupation of the successor to Mr. Silver's company, the India Rubber, Gutta Percha and Telegraph Works Co. (Ltd.). The district within easy reach of Silvertown is also the locale of the factories of Messrs. W. T. Henley's Works Co., and those of Messrs. Siemens Bros. & Co., the Telegraph Construction and Maintenance Co., Messrs. Johnson & Phillips, the Western Electric Co., and many other prominent manufacturing firms in the electrical industry. It will be news, however, to most that the district has an interesting history, that in the near neighbourhood is situated quite a large number of historical landmarks; but that this is so is shown by an instructive little work, just published, from the pen of Mr. Archer P. Crouch, who, by means

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of nearly 100 pages of text and a number of excellent illustrations, gives a complete history of the district in an attractive form. The publisher is Mr. Thomas Burleigh, 17, Cecil-court, Charing Cross-road, London, W.C., and the published price is only 1s. The book will well repay perusal. Several excellent photo illustrations of the c.s. "Silvertown" are given, as well as cable-laying incidents associated with this vessel and the c.s. "Buccaneer."

Southport.—Last week a proposal to light London, Chapel and Eastbank-streets by arc lamps was considered by the General Purposes committee. An amendment in favour of incandescent gas was moved by the chairman of the gas committee (Dr. Isherwood), and after an exciting debate the voting resulted in a tie. The mayor (Ald. Griffiths) gave a casting vote in favour of the amendment, but on a protest from the advocates of electric lighting he did not press the amendment as a substantive motion, and the matter will have to be thrashed out later. The delay is interfering with the work of the Tramways committee, who wish to push on with the preliminary work in connection with the conversion of the lines, but cannot order poles until they know whether or not the streets named are to be illuminated by electricity.

Telephone Junction Line Working.—A new rule of the Postmaster-General is to the effect that inattention at the National Telephone Co.'s exchanges, where it can be proved to be due to the fault of the company's operators and not to the existence of a fault on the wires, is in future to be treated as though it were inattention on the part of the company's subscribers, and trunk calls which fail from the former cause are to be charged for.

Tynemouth.—Mr. Charles Turnbull, borough electrical engineer, has issued a useful pamphlet entitled "Notes on Electricity, for Light and Power," which will be of service to those contemplating putting in electrical installations for lighting or other domestic purposes. Tynemouth Corporation has arranged for a system of "free" wiring, to be undertaken by the Northern Electrical Engineering Co. (Ltd.).

West Ham.—The Lighting and Tramways Committee have submitted a report for the past half-year, which states that the gross profit was £2,002. 8s. 10d., and the net profit £470. 4s. 11d., which they recommend should be transferred to the general district rate in part payment of £1,380, the total loss charged to that account. After the whole of that deficiency has been repaid steps are to be taken to create a reserve fund sufficient to meet the cost of renewals. The committee suggested that £172, cost of wiring artizans' dwellings, be charged against the housing scheme. The consulting engineer (Mr. John J. Steinitz) states that, in comparison with the average of five London municipal concerns, West Ham sold about half the number of units, and the total cost was only 0·09d. higher. That was a satisfactory result, especially when its was remembered that the coal account was exceedingly high, and was being compared with the coal account of the five stations before the immense increase in price took place. The average price obtained for current for private lighting in West Ham was 4·32d., compared with 4·77d., the average of the other five stations, and West Ham was selling current about a halfpenny a unit less than the average of the other local authorities who had electricity works in London. The return for public lighting showed a still greater difference, as West Ham obtains 1·9d. as against an average of 3·6d., or rather more than 1½d. less than the average. It was, said Mr. Steinitz, only their electrical engineer's (Mr. J. K. Bock) careful management that enabled such satisfactory results to be obtained.

Workhouse Lighting.—An increase of 7d. a thousand in the price of gas has induced the Penistone Guardians to appoint a committee to report upon the lighting arrangements. Probably electric lighting will be substituted.

The South Shields Guardians have received the sanction of the Local Government Board to adopt electric lighting at their workhouse. Tenders are being invited.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Extension of Time.—The date for tenders for the overhead equipment for about 16 miles of equivalent single track of tramways, for the Corporation of *Durban*, Natal, South Africa, has been extended. Tenders (in duplicate) to Messrs. Webster, Steel and Co., 5, East India-avenue, Leadenhall-street, London, E.C., by July 20, or to town clerk, Durban, by mail delivery, on or about Monday, Aug. 13.

Swansea Corporation require tenders for main switchboard and instruments and a battery of accumulators and accessories. Specification may be obtained at the Guildhall, Swansea, and can be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller & Manville), 29, St. George-street, Westminster. An advertisement gives further particulars, and tenders must be forwarded to Messrs. Kincaid, Waller & Manville before noon of July 5.

Salford Corporation require tenders for overhead equipment for tramways, exclusive of steel poles. An advertisement contains additional particulars, and specification may be obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh, & Sillar), 2, Queen Anne's-gate, London, S.W., and 78, King-street, Manchester. Tenders to town clerk (Mr. L. C. Evans), Town Hall, Salford, by 10 a.m. of July 16.

Limerick Corporation require tenders for the supply, delivery, and erection of electrical plant and apparatus, particulars of which are set out in an advertisement. Specification, &c., may be obtained at the office of the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., and tenders must be sent to the town clerk (Mr. Wm. N. Nolan) by July 14.

Edinburgh Corporation invite tenders for the supply of copper strip. An advertisement contains further particulars, and specification, &c., may be obtained at the offices of the resident electrical engineer (Mr. F. A. Newington), Dewar-place. Tenders to town clerk (Mr. Thomas Hunter, W.S.), City Chambers, by July 9.

Tunbridge Wells Corporation being about to establish a municipal telephonic system, invite tenders for instruments, apparatus, material, and accessories, particulars of which are set out in an advertisement. Copies of the specification can be obtained from the telephone engineer (Mr. A. R. Bennett), Castle Chambers, West Regent-street, Glasgow, and tenders have to be delivered to the offices of Mr. W. C. Crippe, town clerk, Town Hall, Tunbridge Wells, not later than Thursday, July 5.

Croydon Corporation invite tenders for the re-construction of the present tramway track and the construction of new tramways and paving of roads. Specification, &c., can be obtained at the offices of the town clerk, Town Hall, Croydon, after June 25, and all further particulars can be had from the engineer (Mr. E. W. Monkhouse), 14, Old Queen-street, Westminster, S.W. Tenders must be sent to Mr. E. Mawdsley, town clerk, Town Hall, Croydon, by 12 noon of July 10.

Blackpool Corporation invite tenders for trolley poles, cables, and trolley wire, boosters, and switchboards and a storage battery. Further particulars are given in an advertisement, and specifications may be obtained from the borough electrical and tramway engineer (Mr. Robert C. Quin). Tenders to chairman of Electric Lighting and Tramways committee by 10 a.m. July 23.

Aron Electricity Meter (*Ltd.*), 46, Upper Thames-street, London, E.C., require tenders for the supply and delivery of large and small metal cases. Further particulars are set out in an advertisement, and tenders must be delivered to the company by noon of July 2.

Warrington Corporation invite tenders for the installation of the electric light in the town hall, bank house, museum, school of art, drill hall and gymnasium. Specification can be obtained from Mr. W. H. Grimsdale, Bank House. See advertisement.

Tenders are required for an electric lighting installation (generating plant, wiring, &c.) for the Union workhouse, Hanton, *South Shields*. Tenders by 26th inst.

Glasgow Corporation invite tenders for work, in connection with alterations and foundations for machinery at sub-stations at Coplaw, Dalhousie, Partick and Kelvinhaugh. Tenders by 29th inst.

Leeds Tramways committee require tenders for ironwork in connection with the raising and extension of the Hunslet car sheds. Tenders by 25th inst.

Dudley Corporation invite tenders for condensers, pumps, cooling tower, &c. Tenders to town clerk (Mr. H. C. Brettell) before 30th inst.

Newcastle-upon-Tyne New Tramways committee require tenders for trolley wires and attachments. Tenders to town clerk (Mr. Hill Motum) by 25th inst.

Manchester Tramways committee invite tenders for the overhead equipment of three tramway routes. Tenders (addressed to chairman) by 30th inst.

London County Council require tenders for the supply (within three months of order) of about 70 arc lamp standards for lighting Victoria Embankment. Tenders to clerk (Mr. C. J. Stewart) by July 10.

Trimdon (Co. Durham) Parish Council invite tenders for public lighting by electricity or acetylene gas. Tenders by July 17.

Hackney (London) Electric Light committee require tenders for 220 arc lamp pillars. Tenders to clerk by July 11.

Tottenham Council invite tenders for fire alarm posts and instruments and about 11,000ft. of ¾in. gas barrel. Tenders to clerk by July 3.

Alford District Council require tenders for lighting from August 14, 1900, to May 14, 1901.

Harrow District Council require tenders for public lighting for one year. Tenders to engineer by 26th inst.

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French Post and Telegraph authorities invite tenders until July 5 for 12 tons of galvanised iron wire (1mm. diameter) and 135 tons ditto (4mm. diameter). Tenders to Le Sous Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Belgian State Railway authorities invite tenders for supply and erection of plant and apparatus for the electric lighting of the railway stations and workshops at Montigny, Couillet and Chatelineau. Tenders to La Bourse, Brussels.

The Municipal Authorities of *Cassano al Jonio* (Italy) invite tenders until July 21 for electric lighting for 25 years.

TENDERS RECEIVED AND ACCEPTED.

In our issue of June 1 we gave a list of the tenders accepted for the supply of electric lighting extension plant at Melbourne. In a report on the tenders prepared by the municipal electrical engineer (Mr. A. J. Arnot), and by the consulting engineer (Major P. Cardew, of Messrs. Preece and Cardew), the tender of the Allgemeine Elektricitäts Gesellschaft was recommended for acceptance. The Council, however, decided to accept the tenders indicated below :—

Contract No. 1.—(Boilers and Economisers).

		Time for delivery.
Babcock & Wilcox (*accepted*)	£6,604	20 weeks.
Davey, Paxman & Co.	13,102	55 „
Sterling Boiler Co.	8,310	30 „
Danks & Co.	6,500	—
Rowland & Co.	6,100	—

Contract No. 2.—(Engines, Dynamos, Equaliser, Booster, and Switchboards).

Thomas Parker (Ltd.) (*accepted*)	£22,367	12-14 months.
(Ditto)	23,081	12-14 „
(Ditto)	22,926	12 „
Allgemeine Elektricitäts Gesellschaft...	24,463	10 „
(Ditto)	22,363	11½ „
(Ditto)	17,574	10 „
(Ditto)	27,480	10 „
Johnson & Phillips	20,000	22 „
Australian General Electric Co.	20,276	9 „
(Ditto)	22,502	9 „
Siemens Bros. & Co.	22,090	15 „
Brush Co.	23,215	18 „
Mather & Platt	24,926	10½ „
(Ditto)	24,833	10½ „
(Ditto)	24,276	10½ „
(Ditto)	23,290	12½ „
Easton, Anderson & Goolden	27,419	19 „
Greenwood & Batley	24,953	17 „
British Thomson-Houston Co.	24,811	14½ „
(Ditto)	24,706	14½ „
Crompton & Co.	23,770	18 „
Electric Construction Co.	23,610	12 „

Contract No. 3.—(Cables and Joint Boxes).

British Insulated Wire Co. (*accepted*)...	£27,348	30 weeks.
Siemens Bros. & Co.	29,487	22 „
Callender's Co.	29,348	31 „
W. T. Glover & Co.	28,904	52 „
W. T. Henley's Telegraph Works Co....	25,526	35 „

Contract No. 4.—(Accumulators).

Tudor Accumulator Co. (*accepted*)	£3,529	20 weeks.
Chloride Electrical Storage Syndicate...	5,430	—
Gibson, Battle & Co. (Chloride Cells)...	4,561	—
Hart Accumulator Co.	4,520	—
Allgemeine Elektricitäts Gesellschaft...	3,910	16 „
Noyes Bros.	3,739	32 „

In the accepted tender for engines and dynamos, Thomas Parker, Ltd. specified for Belliss high-speed compound engines. The dynamos are for an output of 350 kw. at 460-520 volts. To the amount of the tender (£22,367) will have to be added customs duty, which will increase the total by £6,000. The Tudor accumulators will have a capacity of 1,000 ampere-hours and the B. I. W. cables will be paper insulated and lead covered.

The following tenders have been received by the Newington (London) Vestry for the supply and laying of insulated electric mains, conduits, junction boxes, &c., in the side streets :—

W. T. Henley's Telegraph Works Co....	£10,137 12 1	British Ins. Wire Co.	£9,026 5 6
Western Electric Co.	9,952 15 0	Callender's Co.	8,992 10 4
Siemens Bros & Co.	9,063 8 4	W. T. Glover & Co.	8,870 6 0
		St. Helens Cable Co.	8,464 0 0

The tenders have been referred to the consulting engineers (Messrs. Kincaid, Waller & Manville) for report, and the Vestry will be invited to accept a tender at their meeting on July 4.

The King's Lynn Town Council has accepted the following tenders :—

Laurence, Scott & Co., two steam dynamos and one small motor generator	£3,498 10
Yates & Thom., boiler, economiser, condenser, pump, &c.	2,375 0
Lewis, Bayliss & Co., extensions to switchboard	206 0
Callender's Company, feeder mains, joint boxes and dynamo cables	523 5

The following tenders, received by the Bermondsey (London) Vestry for the supply and laying of electric light cables, conduits, and junction boxes, have been referred to the Electric Lighting committee for consideration :—

British Ins. Wire Co.	£8,643 15 10	Siemens Bros. & Co.	£8,113 9 11
Western Electric Co.	8,219 0 0	St. Helens Cable Co.	8,109 16 8
Callender's Co.	8,212 7 1	W. T. Glover & Co.	8,018 4 8

As stated in our issue for June 8th, the Paddington (London) Vestry have accepted the tenders of Mr. A. C. Harnden for alterations and additional work in connection with the electric lighting arrangements at the public baths, for the total sum of £153. Eleven tenders were sent in ranging from £153 to £795 (!). One item in the tenders was for extras if steel tubing was used throughout the alterations in place of wood casing. The tenders for this work ranged from £2 to £250 (!) the lowest being from the Concentric & General Contract Co. and the highest from Messrs. J. R. Reedman & Co. The accepted tender for this portion amounted to £10.

St. Pancras (London) Vestry received eight tenders for the supply of coal to the generating stations, prices showing a considerable advance over those of existing contracts. It was decided to accept the tender of Messrs. Facer & Co, for Warwickshire coal, at £1. 2s. 1d. for the Stanhope-street station, and £1. 1s. for the King's-road station, and for Nottinghamshire coal at £1. 2s. 11d. and £1. 2s. 4d. The tender of Messrs. Rickett, Cockerell & Co. for Nixon's navigation steam coal, at £1. 9s. 10d. per ton, compared with £1. 1s. 9d. under expiring contract. The higher price, the chairman (Dr. Smith) stated, would increase the cost of generation by about ⅛d. per unit.

Glasgow Corporation on Tuesday accepted the following tenders for the supply of electricity meters : Messrs. Chamberlain & Hookham for 150 25-ampere, 55 50-ampere, and 75 100-ampere meters ; British Electric Meter Co. for 50 2½-ampere and 50 5-ampere meters ; and S. Z. de Ferranti (Ltd.) for 350 5-ampere, 400 10-ampere, 150 25-ampere, 55 50-ampere, 75 100-ampere, and 10 200 ampere meters.

Glasgow Tramways committee recommend the acceptance of the tender of Messrs. Thomson & Sons to erect the brickwork for the Pinkston power station at £61,000.

Only one tender has been received for the public lighting of Larne—that of the Larne Electric Light Works (Ltd.), which tendered for the evening lighting (Aug. 1 to April 30) at £482. 16s., and for the day lighting (from Oct. 15 to Feb. 15) at £43. 4s., total £526. The tender has been referred to the lighting committee for report.

Hampstead (London) Vestry have accepted the tender of Messrs. Troy & Co. for the electric lighting of the new buildings at the electricity works at £214. Five tenders were received, Messrs. Troy's being the lowest.

Hastings Corporation has accepted the tender of Messrs. McDowall, Steven & Co. for the supply and erection of 50 cast-iron lamp pillars for electric lighting at £2,205.

In September last the municipality of Porto Alegre (Brazil) invited tenders for a concession for the electric lighting of the town. We learn that no offers were received for the concession.

APPOINTMENTS VACANT AND FILLED.

Derby Technical Educational committee require lecturers and demonstrators in mechanical engineering, and in physics and electrical engineering for their municipal technical college. An advertisement gives further information, and applications must be sent to the principal by July 9.

Norwich Technical Instruction committee require an assistant lecturer and demonstrator in physics and electrical engineering. Applications to the principal (Mr. Wm. Gannon, M.A.) by July 6. See advertisement.

Eccles Corporation require a consulting electrical engineer in connection with the proposal to adapt the local tramways for electric traction to be worked by the Salford Corporation in conjunction with the Salford tramway system. An advertisement contains further particulars, and applications must be delivered to the town clerk (Mr. Wm. H. Hickson), Town Hall, Eccles, by 10 a.m. 29th inst.

The Vestry of St. John, Hampstead (London) require an assistant electrical engineer. Further particulars are given in an advertisement, and applications must be sent to the vestry clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, London, N.W., by July 2.

Sunderland Corporation require a chief engineering assistant, a junior assistant, and two thoroughly trained motor-men for their electric tramways. Applications to borough electrical and tramways engineer (Mr. John F. C. Snell) by 28th inst. See advertisement.

An outside superintendent is required for the Sheffield Corporation tramways department. Applications to the engineer and manager (Mr. A. L. C. Fell), Town Hall, Sheffield. See advertisement.

Reading Electric Supply Co. require a station assistant. Applications to the managing engineer (Mr. Arthur T. Cooper), electricity works, Vastern-road, Reading, by 26th inst. See advertisement.

The Council of the King's College, London, invite applications for the post of demonstrator in electrical engineering. Conditions

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of the appointment can be obtained of the Secretary, and applications must be in by 30th inst. See advertisement.

Messrs. Chamberlain and Hookham (Ltd.), Solar Works, Birmingham, have a vacancy for an assistant in their experimental department. See advertisement.

The post of senior demonstrator in electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session. Salary is £150, rising to £200. Applications to principal of college, Leonard-street, Finsbury, London, E.C., by June 29.

Birmingham Corporation require two lecturers for the electrical and engineering departments of the municipal technical school in September next. Applications to Mr. Geo. Mellor, Suffolk-street, by 30th inst.

Carlisle Corporation require a clerk and switchboard attendant for their electric lighting department. Further particulars are set out in advertisements, and applications must reach the city electrical engineer (Mr. Charles D. Burnet), James-street, Carlisle, by Monday the 25th inst.

A chief assistant electrician is wanted for cable works near London. ee advertisement.

An assistant superintendent is required in the Indian Government Telegraph Department. Applications to Secretary, Public Works Department, India Office, London, S.W., by June 30.

An engineering assistant for electric tramways is required by Ayr Corporation. Applications to town surveyor by 30th inst.

Mr. Arthur Ellis, of Bolton, has been appointed electric tramway engineer by the Cardiff Tramways committee. Mr. Ellis, who served his apprenticeship with Messrs. C. A. Parsons & Co., was, in 1892, appointed resident engineer to the Cambridge Electric Supply Co. In Oct., 1893, he rejoined the staff of Messrs. Parsons & Co., and in 1894 was appointed borough electrical engineer at Southport. In 1896 he was appointed to Bolton, in succession to Mr. J. H. Rider, now of Plymouth, and in 1899 became general manager of both the lighting and tramway departments of the borough.

Mr. A. B. Farrell has been appointed engineer-in-charge, and Mr. A. J. Beckett junior tester, at the Belfast Corporation electricity works.

Mr. H. Davidson, of the Leith Corporation electricity works, has been appointed shift engineer at the Blackburn Corporation electric light and tramway generating station.

Mr. A. W. Money, who has been for the past five years superintendent of the electricity department at the Earl's Court Exhibitions, has been appointed resident engineer of the Chiswick station (now in course of erection) of the Aberystwyth and Chiswick Electricity Supply Corporation.

Brighton Corporation has appointed Mr. Thomas B. Holliday electric tramway engineer at a salary of £600 per annum.

BUSINESS NOTICES.

Messrs. Evershed and Vignoles (Ltd.), of Woodfield Works, Harrow-road, London, W., have opened City offices at 110, Cannon-street, E.C, where they are represented by Mr. P. F. Brittain. All particulars regarding Evershed instruments, together with catalogues, prices, and estimates, can be obtained at the City office.

The British Electric Works Co. (Ltd.) have opened a Manchester branch at 37, Piccadilly, which will be under the charge of Mr. John Walton, for several years inspector of installations with the Manchester Corporation electricity supply department.

Messrs. F. H. Medhurst and A. Kitchin, consulting engineers, 13, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. Medhurst.

The telephone number of Mr. A. P. Lundberg, Pioneer Electrical Works, 477 to 487, Liverpool-road, London, N., is 154 King's Cross.

BANKRUPTCIES, LIQUIDATIONS, &c.

The discharge of John E. Evered, 12, Miller-street, Camden Town, N.W., has been suspended for four years from the conclusion of the public examination in July, 1899. Bankrupt failed in June, 1899, with liabilities £7,905, assets to be realised £10. 16s. 7d. He formerly acted as commercial agent, and subsequently factory superintendent to the Electrical Undertakings Co. (Ltd.).

Claims against the Lithanode Electric Storage Co. (Ltd.) (in liquidation), must be sent by July 19 to Mr. Stuttaford, 11, St. Helen's-place, London, E.C., solicitor to the joint liquidators (J. M. Richardson and H. F. Pollock).

Winding-up Petitions.—A petition was presented in the Manx Chancery Court, on Monday, by Mr. Robert Okell, a creditor, for the winding-up of the Isle of Man Tramways and Electric Power Co. (Ltd.), and for the appointment of Mr. W. H. Walker as liquidator. Several shareholders opposed, and the hearing of the petition was adjourned till yesterday (Thursday).

A petition for the winding up of the Westminster Automatic Telephone Syndicate, Ltd., will be heard in the High Court on 26th inst.

A petition for the winding up of the Gutta-Percha Corporation (Ltd.) will be heard in the High Court on 26th inst.

Plant for Sale.—The St. Helens Electric Supply and Tramways committee invite tenders for the purchase of plant at their Warrington-road works. Particulars of the plant, which is in first-class condition and can be inspected on application to the engineer (Mr. J. S. Highfield), Corporation electric power station, Cropper's hill, St Helens, are set out in an advertisment.

In our advertisement columns Messrs. Wheatley Kirk, Price and Co. announce the sale by auction, at the Grays Engineering Works, Grays, Essex, on Tuesday, Wednesday and Thursday, July 3, 4, and 5, at 10 for 11 a.m. prompt, the contents of the works, including a variety of tools, machinery, utensils, stores, &c. The whole may be viewed on Monday, July 2 and on the mornings of sale. Catalogues (6d. each) may be obtained on application at the works, of Messrs. Hatten and Asplin, solicitors, Bank Buildings, Grays, Essex, or of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester.

Exhibition.—The International Tramways and Light Railways Exhibition to be held at the Agricultural Hall, London, N., will open on Saturday, 23rd inst., and remain open to Wednesday, July 4, from 10 a.m. to 10 p.m. There are over 100 exhibits, including the latest appliances for the complete equipment of electric tramways.

Asbestos Goods.—Cresswell's Asbestos Co. (Ltd.) have ready a series of well-arranged catalogues of asbestos goods, manufactured at the company's works at Wellington Mills, Bradford, Yorks. A large variety of goods are listed.

Patent Amendment.—Mr. Robert Lundell, 527, W. 34th-street, New York, has applied for leave to amend specification of Letters Patent No. 7,978 (1899) for "Improvements in and relating to electric motors or dynamo electric machines." Particulars of the proposed amendment are given in the *Illustrated Official Journal* (Patents) of the 13th inst, and notices of opposition must be given within one month of that date.

"Invicta" Accumulators—Messrs. Ashmore, Benson, Pease & Co., of Stockton-on-Tees, and 181, Queen Victoria-street, London, E.C., have issued a price list of "Invicta" accumulators, which can be obtained by the trade on application. The company will shortly be in a position to supply "Invicta" traction accumulators, as used in a number of motor vehicle competitions with, it is stated, considerable success.

"Hart" Cells.—The Edison & Swan Co., who have already the sole agency for the "Hart" accumulator cells for Glasgow and Dublin, have made similar arrangements for Belfast and Cork.

Electricite & Hydraulique Plant.—This company, for which Messrs. Witting Bros. (Ltd.), 49, Cannon-street, London, E.C., are agents, have now ready an instructive brochure describing and illustrating the works and track of the Ixelles-Boendael (Belgium) line of tramways, constructed and equipped by the company in 1896-97.

Milling Machinery.—Messrs. Schischkar & Co., of Stafford-street, Birmingham, are introducing the "Milwaukee" milling machinery designed for the greatest possible range with the least possible overhang of parts. The column of the machine is cast in one piece, and the feed of the table is automatic in either direction through 28in, is thrown in or reversed by the same handle on the front of the machine, and can be tipped either automatically or by hand as easily under full cut as when running light. There are 12 changes of feed, varying from 0·006in. to 0·130in. per rev. of spindle. The net weight is 2,300lb.

Watches for our Naval Heroes.—Messrs. S. Smith & Sons, Ltd., 9, Strand, London, have recently executed an order for a large number of keyless watches for presentation to each of the officers and men of H.M.S. "Powerful," on the occasion of their being paid off after their return from an active participation in the hostilities in South Africa. The watches are full hunters, the cases of plain silver, close fitting so as to be damp proof. The front cover is engraved with the name of the recipient and his rating on board ship. The watch movement has a special escapement to withstand vibration and change of temperature, and instead of steel, gold hands have been used to obviate damage from damp. The presentation was made by the mayor of Portsmouth.

Westinghouse Plant.—A pamphlet describing combined tramway braking and heating apparatus manufactured by the Westinghouse Co. is just issued. The chief advantages claimed for this apparatus are: economy and certainty of operation, accessibility of all parts, simplicity of construction and operation, automatic control and the electrical heating of the cars without cost for current.

Manganese.—Buyers of manganese ore are notified by Messrs. Kittel and Co. (Ltd.), 5, Fenchurch-street, London, E.C., that owing to the increase in railway rates in the neighbourhood of the company's mines, the price of manganese ore has been raised.

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Insurance of Electrical Plant.—The Law Accident Insurance Society (Ltd.) have added a branch for the insurance of all descriptions of electrical plant against breakdown, including periodical inspection. The proposed insurance will include protection against legal liability for personal injuries or damage to property up to an agreed amount.

Agents Wanted.—Agents are wanted in the principal towns for the sale of "Stellite" electrical fittings. Applications to the secretary, British Electric Works, (Ltd.), Cheston-road, Aston, Birmigham.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 13 to June 19, with the ports of destination :—

Aden, £46. *Africa*—Alexandria, £116 ; Algoa Bay, £66 ; Cape Town, £144 ; Durban, £180 ; East London, £101 ; Port Said, £55. *Argentina*—Buenos Ayres, £2,121. *Australasia*—Adelaide, £25 ; Brisbane, £307 ; Sydney, £1,250 ; Townsville, £1,186 ; Wellington, £208. *Azores*, £129. *Belgium*—Antwerp, £22 ; Brussels, £31. *Canada*—Montreal, £70. *Ceylon*—Colombo, £830. *China*—Shanghai, £129 (telegraph material). *Denmark*—Copenhagen £137 (telegraph cable). *France*—Boulogne, £20 ; Paris, £100 ; Rouen, £70. *Germany*—Hamburg, £1,200 (telegraph material). *Holland*—Amsterdam, £63. *Hong Kong*, £540. *India*—Bombay, £306 ; Calcutta, £584 ; Madras, £18. *Japan*—Tokyo, £41 ; Yokohama, £941 ; Yokosuka, £578. *Malta*, £35. *Mauritius*, £146. *Portugal*—Lisbon, £27. *Russia*—Archangel, £103 ; St. Petersburg, £80 (telegraph material). *Straits Settlements*—Penang, £150 ; Singapore, £323 (including £66 telegraph material). *Sweden*—Stockholm, £482 (telegraph material). *West Indies*—Kingston, £32. Total £12,993, against £20,346 in the corresponding week last year (June 14 to 20).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

4,727. Taylor. Electric conductor conduits and turn-outs for tramway and railway propulsion.
4,931A. Wise (Crehore and Squier). Telegraphy. (Date claimed under Patents, Rule 19, March 6, 1899.)
6,812. Bacon. Magnetic power transmitting devices.
6,933. Casella. Step-by-step printing telegraph instruments.
6,993. Schloesser and Moeres. Switching contrivances for two electric incandescent lamps connected up together.
7,105. Orling and Brannerhjelm. Apparatus for controlling the reversing mechanism for rudders or the like by means of electrical waves. (Date applied for under International Convention, February 27, 1899.)
7,577. Ballance and Jefferson. Method and apparatus for operating contacts for electric traction.
7,761. Gardner. Telegraphic transmitting instruments.
7,863. Cazin. Electric incandescent lamps and their manufacture.
8,075. Carter. Electrical double pole-fused lamp post (or bracket) watertight switch to prevent fusing of main fuses.
8,223. Fraser and Elphinstone. Apparatus for testing electric primers, batteries, and cells.
8,505. Dudgeon. (von Kodolitsch) Portable electric rivetting machine.
8,672. Lewis. Electric motor carriages or vehicles.
8,975. Schloesser and Moeres. Safeguard against screw loosening on electric incandescent lamp shade holders.
9,272. Greville-Williams. Telegraphing graphic or other matter automatically without wires, and apparatus therefor.
9,367. Lehmann. Process for the production of accumulator plates.
9,691. Belfield. (Stillwell.) Electric circuit breakers.
10,246. Ericsson. Portable telephones.
10,336. Belfield. (Davis, Wright and Wurts.) Controllers for electric motors.
10,393. Campiche. Electro-mechanical impulse devices, applicable to clocks and for other purposes.
10,608. Morrison. Manufacture of conduits for electrical conductors and other purposes and apparatus therefor.
10,860. Andreas. Electric railways and tramways worked on a mixed power system.
11,189. Wise. (Actien Gesellschaft Elektricitätswerke vorm. O. L. Kummer & Co.) Dynamo electric machines.
11,227. Hall and Robertson. Ventilation of electro-motors, dynamos and the like.
11,418. Pomeroy. Electric arc lamps.
11,445. Davis. Electric circuit breakers. (Date applied for under International Convention, November 4, 1898.)
11,446. Scott. Systems of electrical distribution. (Date applied for under International Convention, November 4, 1898.)
11,456. Mills. (Bonnet, Paufique and Limière). Contact boxes for electric tramways and the like.
11,513. Bretschneider and Lauth. Self-acting mule with electrical driving gear.
11,657. Leitner. Apparatus for forming plates of secondary batteries.
11,780. Gent and Jevons. Mould for casting plates or grids for secondary batteries.
12,114. Scott. Electrically-driven fans.
12,478. Behrend. Electrical accumulators or secondary batteries.
12,787. Thompson. (Rolfe Electric Co.) Devices for breaking electric circuits and protecting the same from excessive currents.
12,956. Compagnie Electro-Métallurgique des Procédés Gin et Leleux. Electric furnaces. (Date applied for under International Convention, Jan. 27, 1899).
13,088. Mills (Bonnet, Paufique and Limière). Electric tramways or railways on a road-contact system.
13,991. Thompson. (Cantons) Monophase electric motors.
16,040. Smith and Corrie. Electric fuses and electric detonator fuses.
17,624. Mosca and Sivitz. Engine room order telegraphs and tell-tales.
21,355. Aron and Aron Electricity Meter (Ltd.). Apparatus for measuring multiphase electric currents.
22,028. Eycken, Leroy, and Moritz. Electrodes for electrolysers. (Date applied for under International Convention, May 23, 1899.)
23,663. Burke. Armature for alternating-current motors.
23,738. British Thomson-Houston Co. (Ltd.). (Steinmetz). Regulating electric alternators,
25,164. Schmidt. Electric igniting devices for lighting gas and like lamps.
25,451. British Thomson-Houston Co. (Ltd.). (Oxley.) Electric switches.
25,452. British Thomson-Houston Co. (Ltd.). (Ekstrom.) Means for cooling electric and other brakes.
25,453. British Thomson-Houston Co. (Ltd.). (Davis.) Alternating electric-current motor systems.
25,691. Feeny. (Allgemeine Electricitäts Gesellschaft.) Electro dynamo meters.
25,745. British Thomson-Houston Co. (Ltd.). (Steinmetz.) Method of regulating dynamo-electric machines.
25,748. British Thomson-Houston Co. (Ltd.). (Armstrong.) Electric railway systems worked with alternating currents.
25,752. British Thomson-Houston Co. (Ltd.). (Haskins.) Electric meters.

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683. Feeny. (Allgemeine Electricitäts Gesellschaft.) Alternating current meter for small non-inductive loads.
688. Myers. Sound transmitters and disseminators for phonographs.
813. Stanecki. Manufacture of electric accumulator plates.
1,560. Lambert. Record cylinders for phonographs and method of producing the same. (Date applied for under International Convention, August 14, 1899.)

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.).

The fourth ordinary general meeting of this company was held on Monday, Sir Charles Rivers Wilson, G.C.M.G., C.B., in the chair.

The SECRETARY (Mr. George Stevens) read the notice calling the meeting.

The CHAIRMAN said : Gentlemen, the period embraced by the report and accounts covers 15 months, from Jan. 1, 1899, to March 31, 1900. The working of these 15 months has been of a very satisfactory character. We must consider that the electric traction industry has now established a firm hold upon the country, and I think I may justly say that our company may be looked upon as the leading representative of that industry. The net profits for the 15 months, after paying all general expenses and interest on debentures, amount to £130,174, including the balance of £35,451 brought forward, but not premiums on new issues of shares and debentures, which amount to £160,529, which has been carried direct to reserve. The actual profit on the 15 months' operations, excluding balance brought forward, is, therefore, £94,723, comparing with £57,974 in the preceding 12 months. There is a surplus of £130,174 to deal with, and we recommend that this should be applied as set out in the report. The amount of £5,000 now put to reduction of goodwill leaves only £5,000 to be written off, which I hope we shall do next year. The addition of £20,000 to reserve brings this up to £20,655. A big business, such as that we are conducting, obviously requires some provision being made against contingencies of all kinds or unexpected reverses. It is very desirable that in a large industry like ours, which is not altogether free from uncertainties, ample provision should be made against losses of an abnormal kind. We hope, therefore, to establish a reserve out of profits, and this reserve will be specially available in case of necessity for the equalisation of dividends. I do not wish to be misunderstood on this point, and I hope the shareholders will not interpret my words to mean that the reserve which is built up from premiums on new capital cannot be so applied ; but I am expressing the views of the Board—and I hope the feelings of the shareholders—when I say that the portion of the reserve which is made up by premiums should be appropriated to making good losses of an exceptional character. If I can make myself understood in two words it is this—that we propose a double reserve—a reserve, first of all, that may be called a capital reserve for the purposes indicated, and, secondly, a smaller reserve derived from surplus profits, entirely to be applied to the equalisation of dividends. By a policy of that sort we shall tend very much to maintain and enhance the credit of the company.

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A SHAREHOLDER: You will ear-mark the premiums?

The CHAIRMAN: The premiums, as a matter of course, will go to reserve, and, as I have already said, will be used for very exceptional circumstances. Other items written off include £469 from furniture account, now standing at £2,345, and 10 per cent. will be written off this account annually in future. £23,051 has to be appropriated to the payment of the cumulative dividend on the preference shares in respect of these share for the 15 months. As to the dividend on the ordinary shares, the company was formed in October, 1896, and has, therefore, been in operation rather over three years. For the first year (to December, 1897) no dividend was paid. To December, 1898, 6 per cent. was paid, and £35,451 carried forward. We think, therefore, that if for the past 15 months we recommend the payment of a dividend at the rate of 8 per cent. per annum, and carry forward £43,783, we shall be meeting all reasonable expectations of the shareholders, and at the same time shall not do anything to weaken the financial stability of the company.

On capital account, during the 15 months we have issued 55,000 new shares, representing £550,000 of nominal capital, and also £250,000 of debenture stock. That makes altogether £800,000 of new capital. All this new capital has produced premiums of £160,529 net—after deducting all expenses and charges in connection with the issues. At the last general meeting the nominal capital of the company was increased from £600,000 to £1,200,000—and this carried with it the power to issue debenture stock up to the amount not exceeding one-half the subscribed capital. The present subscribed share capital is £950,000, leaving £250,000 unissued in 15,000 ordinary and 10,000 preference shares, and there is a balance of debenture stock which can be issued, the present issued amount being £350,000. The directors propose to allot the remainder of the share capital—the 15,000 ordinary and 10,000 preference shares—to the shareholders *pro ratâ* forthwith. We shall thus be able to satisfy the wish of the shareholders expressed at the last meeting to reserve this issue exclusively to them. The 15,000 ordinary shares will be allotted to the present holders of ordinary shares in the proportion of one new share for every three old shares, and the 10,000 preference shares in the ratio of one new preference share for every five old shares. The price of issue of the ordinary shares is £13, and the preference shares £11. The new ordinary shares will rank for dividend with the existing shares as from April 1 last, although the new shares will not be fully paid up for a few months. The preference shares will receive the preferential dividend of 6 per cent. on the amount paid up on August 15 next and from that date will rank equally as for dividend with the old shares. The bonus which the shareholders thus receive is about equal to the dividend which is about to be declared; it is really about double the dividend that you will receive. The magnitude of the company's operations will call—and at an early date—for further increases of capital, and therefore the directors recommend that the present opportunity should be taken to increase the nominal capital of the company by the creation of 80,000 new shares, half ordinary and half preference, making the total capital £2,000,000—£1,000,000 ordinary and £1,000,000 preference. There will, of course, be a corollary power to issue a proportionate amount of debenture stock.

On the question of contracts and undertakings, in the balance sheet made up to December, 1898, this item stood at £157,730; it now stands at £543,246, and represents the total expenditure on lands and buildings, permanent ways, electrical equipments, rolling stock, Parliamentary and other rights, general stores, surveys, negotiations and so forth (but not the shares and debentures in other companies). This company undertakes various operations and works on behalf of others—the promotion and surveys for new acts of Parliament and provisional orders and other powers. We do that work at a profit. Then, when powers have been obtained, we undertake on behalf of others the engineering work of reconstructing the permanent way and of installing electrical apparatus, and this also yields us a profit, and the amount expended on such works, still in progress, is £277,148. Another portion is in respect of works and undertakings which we ourselves own, lease or control. Of course, on this expenditure no profit is made until the works or undertakings are completed, and either paid for by others or operated by us for the sake of the revenue to be derived from such operations. This item represents £234,019, and includes a fairly large amount for general stores. We have for some time past recognised the need for purchasing materials in bulk and we have found it very advantageous. Latterly prices of materials have gone up enormously, but owing to the foresight of our staff we were able to make many of our purchases a long way in advance at a time when prices were much lower. We have found, and our various associated companies have found, very great convenience in having an available stock of materials to draw from, and the board have therefore decided to erect buildings for the convenient storage of tramway materials, to be afterwards retailed to our various undertakings all over the country. With this view, we have quite recently acquired a freehold site in the Midlands, conveniently situated in regard to railway facilities for the centralisation and distribution of materials. We believe that this will be a source of further economy and of profit in the future. The last item under the head of contracts and undertakings represents £32,077. This expenditure is made up of the cost of the negotiations and surveys, and legal, engineering, and other services in connection with the development and promotion of new schemes and powers, including the costs of such schemes as Barnsley, Birkdale, Blyth, Durham, Kingston, Morley, Peterborough, Sheerness, Jarrow, Spen Valley, Accrington, Cambridge, Leamington, Wellingborough, Windermere, and others. The amount may appear large, but the number of schemes it comprises is also very large, and I can speak with confidence when I say that the promotion of our schemes is carried out at the lowest cost consistent with the efficient way in which the work is done and, of course, all this work is done with a view to profit in the future.

The system of accounts which we have adopted since the beginning of the company, and which the auditors have approved, is that of allocating or charging every month the whole of our expenses to the various undertakings and schemes in regard to which the expenses have been incurred—that is, we have a separate account for every scheme, and the general expenses of the company are apportioned as near as it is practicable to each scheme, according to the cost of the time which the officers spend upon each scheme. It is a highly satisfactory and an extremely scientific method of accounts. At the end of the year all the schemes which possess vitality and constitute assets are included under the head of contracts and undertakings in the balance-sheet, and all the schemes which have proved unsuccessful or which represent losses are written off and charged to profit and loss account. The amount so written off this year is £15,185. The amount, therefore, which stands against contracts and undertakings represents valuable assets which are or will become sources of important profits; and as all items which, so far as we can judge, are not of this nature are eliminated and charged to profit and loss, I am warranted in saying that the amount standing against contracts and undertakings in the balance-sheet is not only thoroughly sound, but also a very moderate figure.

As to our investments, these stand at £950,280, and include upwards of £93,000 in Consols, National War loan at cost, and cash, exclusive of cash in hand. £60,023 represents loans and advances to associated companies and others. This amount stands to-day at about £23,000, and is perfectly good. Then there is £75,611 invested in mortgages and debenture stocks of associated and other companies. These are sound investments, and such as might almost be classed with trustees securities, though they yield a much larger return of interest. We have therefore altogether about £230,000 in valuable and realisable securities. Our reserve fund now amounts to £209,665, and the board consider it is best to leave a substantial portion of the reserve in the business of the company as we have done. The item of "shares of associated and other companies," stands at £721,180. This includes the nominal value of the shares held by this company in the original pioneer company, which is only a book entry, as we owe £25,000 to the pioneer company in respect of the purchase of that undertaking. The reasons for the continued existence of the pioneer company have nearly exhausted themselves, and there is every probability that that company will shortly be wound up. With regard to the remainder of the shares held by this company in other companies, and costing close upon £700,000, they represent a much larger nominal amount, as we have not paid par for all these shares. This £700,000 represent a nominal value of about £900,000. We think the principle of bringing these shares into account at cost is the only right one. We make a point of explaining that the profit of £123,000 on those shares stated in the accounts is subject to the shares which have been received in part payment realising par value; but after all, the total number of shares which have been received in part payment, and which have been taken at par value, is not large, and the fact must not be overlooked that many of the investments by us in shares of other companies are worth on the market very much more than the price we have paid for them. Our investment of about £100,000 in the ordinary shares of the Potteries Company appear in our books at about par, but the market price is even now much higher than the cost to us. The shares in the Oldham and Ashton Company stand in our books at about £10, and are worth in the market something between £15 and £16. The ordinary shares in the Kidderminster Company, all of which we hold, we should not dream of selling at par, which is the cost to us. The same applies to our interests in the Cork Company, in the Electrical Power Distribution Co., and other companies. Our investments comprise upwards of 60 undertakings, and £5,000 to £10,000 would amply cover any depreciation on any of these shares, without taking into account the considerable appreciation of many of them.

The proposed establishment of a superannuation fund for the company's growing staff was then referred to, and on the subject of the administration of the associated companies the chairman said: On appointing our officers and directors to act as administrators in these companies we do not allow them to take for their own use any fees or remuneration paid for their services. Whatever fees are received are paid into the treasury of this company. This principle has been strictly adhered to, and, for example, our managing director, who acts as chairman or director of something like 30 of these companies, does so without any additional remuneration by reason of holding those positions. The whole of these companies are controlled from here. The appendix to the report, you will see, enumerates 57 companies and undertakings—53 of these are tramway and light railway undertakings, but some of these will also probably undertake the supply of electric light and power. Then there are one omnibus company, one electric launch company, and one company which has recently been formed for the purpose of developing lands in the vicinity of our tramway undertakings; and there is also the Electrical Power Distribution Co., in which we have a large interest, and which undertakes the supply of power and light, more particularly in districts where we control tramway or light railway undertakings. Of the 53 tramways and light railway undertakings, 31 are actually in operation and are all working at a profit. Six undertakings are in course of construction, and 15 have only quite lately been sanctioned or are in various stages of being granted. The 31 undertakings in operation comprise 200 miles of lines, of which about 59½ are at present worked by steam, about 73½ are worked by horses, and about 62½ miles are worked by electricity, while about 19 miles are in course of being converted from steam or horse working to overhead electric traction; and a further 19½ miles of extensions connected with these 31 undertakings have been authorised. The six undertakings which are in course of being constructed measure just over 30 miles, and the 15 new undertakings which have been authorised, or which are in course of being authorised, measure about 104 miles, so that the company is interested in or controls altogether about 350 miles of tramways and light railways. Since the last annual meeting the Hartlepool tramways, the Potteries electric tramways and light railways, the Oldham, Ashton and Hyde electric tramways, the Dudley, Stourbridge and District tramways, and the tramways at Nelson, British Columbia,

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have been opened for working by electricity, and during the past week the Board of Trade inspection of the Swansea electric tramways has taken place, and these lines will be worked by electricity very shortly. We hope at a very early date also to open further lines of the Potteries Company and the Dudley and Stourbridge Company, some of the Dudley and Wolverhampton tramways, the Kinver light railways, and the Tynemouth tramways and light railways, and we are well under way with the construction of the Devonport tramways, the Gateshead tramways, the Merthyr tramways and electric lighting, the Middleton light railways, and the Poole light railways. I now move the adoption of the report and accounts, and the payment of the dividends recommended in the report.

The Right Hon. Lord RATHMORE seconded the resolution.

A SHAREHOLDER said they had heard with great satisfaction what the chairman had said with respect to the question of reserve, because he (the speaker) was perfectly certain that the only way in which a company like theirs could be carried on successfully was by having a very large reserve. For a great many years he had been a shareholder in a company admirably managed and of very high position—the Telegraph Construction and Maintenance Co.—the secret of whose success had been, he believed, entirely owing to the fact that the directors had always insisted on having a very large reserve. The superannuation fund for the staff would be regarded by the shareholders as extremely satisfactory. It was obvious that a company such as theirs must require an enormous amount of organisation and work on the part of the officials, and it was therefore very important that these officials should feel that their position was a permanent one. He was only surprised at the moderate amount which had been mentioned (£2,000) for the company's contribution to the fund. He resided at Brighton, and knew something about the Brighton and Shoreham tramways, worked by horses. He was convinced that these tramways could be made a source of very considerable revenue if they were worked by electricity.

The CHAIRMAN: I am well acquainted with the Brighton and Shoreham tramways, as to which I agree there are great possibilities; but the reason we leave this matter *in statu quo* is because we have the fullest expectation and desire to equip that line electrically. Unfortunately, however, we have not been able to come to terms with the local authorities.

A SHAREHOLDER said he did not know whether other shareholders agreed with him, but in view of the conditions of the Tramways Act, it seemed to him that it would be better if the directors could see their way to keep a larger proportion of the reserve out of the business.

The CHAIRMAN: It is absolutely impossible in a business like this that we can leave our money idle; all that we can do is to see that we are covered by the judicious investment of a very large amount of our assets in sound securities.

The motion was then unanimously adopted.

A resolution to establish the superannuation fund was also approved.

Sir C. Rivers Wilson and the Hon. Sir C. W. Fremantle, K.C.B., were re-elected directors, and the auditor having been reappointed, the meeting became extraordinary.

The proposed additions to the capital of the company were agreed to, and resolutions were passed approving the proposed Barnsley and District Light Railways (Extensions) Order, the proposed Durham and District Light Railways Order, the proposed Jarrow and South Shields Light Railways Order, the proposed Kingston, Surbiton and District Light Railways (Extension) Order, and the proposed Sheerness and District Light Railway Order.

A hearty vote of thanks to the chairman and directors was carried unanimously, and the proceedings terminated.

Bastian Meter Co. (Ltd.).

The second annual report of the directors of this company, made up to Feb. 28, states that there was a profit of £388. 13s. 3d., against a loss on the previous year of £2,227. 16s. 11d. During the first six months of the year under review the company was worked at a somewhat heavy loss, but nearly the whole of this was recouped out of the profits made on the second half-year's trading, when orders increased more than fourfold. The electrical installation at Holbein House has been let on lease at a satisfactory rental, and the company is thereby relieved of any further trouble or expense in connection with that department of the business. Expenditure on experiments has been very small, as compared with the amount previously expended; and this item is likely to continue to decrease. The prospects for the coming year appear to be most satisfactory. Markets are being opened up abroad, particularly on the Continent and in Australia. A licence to work the company's patents in Germany has been arranged on satisfactory terms, and agencies have been established for Belgium, Holland, Italy, and Western Australia. Although the Board of Trade certificate for the Bastian meter is not yet in the company's possession, the directors have obtained authority to state that the meter has been officially approved by the Board of Trade.

Electric and General Investment Co. (Ltd.).

The report of the directors for the year ended May 31 states that the gross profit on the transactions of the year was £19,796. 3s., and after deducting all general charges, and interim dividend paid on the ordinary shares, there remains a net balance of £14,711. 8s. 1d. Of this sum the directors propose to carry £711. 8s. 1d. to contingencies fund, leaving £14,000 available for distribution as follows: Dividend of 5s. per share on the ordinary shares for the year (of which 2s. per share was paid ad interim in December), £3,000, together with a bonus of 4s. per share (£4,000); dividend of £30 per share on the founders' shares (£3,000), together with a bonus of £40 per share (£4,000). (In each case subject to deduction of tax.) No distribution in respect of the founders' shares reserve fund or the ordinary shares reserve fund will be made.

HARROW ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual meeting of this company was held at Harrow on Thursday last. The directors' report states that the steady progress made by the company from its start has been continued during the past year. The equivalent of 2,985 8 c.p. lamps was connected, against 2,715 in the previous year; the number of customers was 92, and the units sold 113,551, compared with 58 and 79,419. The total receipts were £3,663. 5s 7d., against £2,786. 0s. 4d. Owing to increased demand a new 150 kw. steam dynamo and an electric pump have been ordered, the dynamo to be ready in September, and the pump has been already fixed. The boiler ordered in 1898 was erected during the year. Besides the reduction, since Lady Day, 1899, in price from 8d. to 7d. per unit for current supplied for lighting, the company have supplied current for arc lamps and heating and cooking purposes at 4d. per unit. The works cost for the year has been reduced to 2·4d. per unit sold. The total cost of extensions made during the year was £3,152. 13s. 10d. During the year 73 houses have been wired for consumers on the rental system, against 34 in 1898. The wiring business has increased so rapidly that the directors have decided to have their own wiring department in addition to employing Mr. Tate, who had been carrying out all the work previously. The new department was started at the beginning of 1900. The District Council have made application for a provisional order for Wealdstone on the terms of the company paying all expenses, and the Council transferring the order to them on the same terms as the original order, obtained in 1895 for the same district. The Board of Trade have now granted the order, and the confirmatory bill has been passed by the House of Lords. Prepayment meters have been supplied to consumers who desire them, and have been satisfactory, but they have not been largely taken up. Further capital being needed, the directors propose that the authorised capital be increased by £15,000, and that one-third of the increase be constituted 4½ per cent. preference shares. The sum available for dividend, after paying interest on debentures, mortgages, &c., was £1,296. 14s. 3d. £25 was written off leasehold property, £425 placed to depreciation of plant, 4½ per cent. paid on the Preference shares issued to end of year, and a dividend of 3½ per cent. was paid on the ordinary shares, absorbing £745. 5s. 5d., leaving £8. 14s. 5d. to be carried forward. The report was adopted.

MEXICO ELECTRIC TRAMWAYS (LTD.)—The general meeting was held on Wednesday. The chairman (Col. Sir C. Ewan-Smith) said the opening months of 1900 had been marked by some incidents bearing directly upon the fortunes of the company. At the close of last year the directors decided to send out the Hon. Chandos S. Stanhope to Mexico. Mr. Stanhope left England in November, 1899, with complete instructions, and his mission had been a perfect success. Shortly after Mr. Stanhope's arrival, the former board in Mexico was entirely reconstructed, but Mr. A. E. Worswick remained the chief resident engineer, Mr. Brandford, the former manager, resigned, and Mr. Clegg became manager of the company. Mr. Stanhope had negotiated an agreement with the municipality of Mexico, to remain in force for 10 years, under which the entire obligations of the Mexican Tramways Company are commuted for an annual fixed sum. Considerable progress had been made in the conversion of the entire system to electric working during 1899. On Jan. 15 the first section of the system completed for electric traction (from the city to Tacubaya) was formally opened. Since that date experience had shown them that the electric cars were earning for themselves an ever-increasing popularity. In every instance electric traction had been found to work satisfactorily. The conversion of the remaining portions of the system was being rapidly proceeded with, and the necessity that might afterwards present itself for further extensions, in order to meet the convenience of the public, was not being lost sight of.

WELSBACH INCANDESCENT GAS LIGHT CO. (LTD.)—At the annual meeting of this company, the chairman (Sir Henry C. Burdett, K.C.B.) referred to the arrangement with Dr. Auer and to the alteration of the statutes of the Austrian company providing for the establishment in one company of the gas and electricity undertaking. At the statutory meeting he stated that Dr. Auer had agreed to, and the statutes provided for, the acquisition and realisation of all inventions of Dr. Auer and the patents and licences for the same which had reference not only to electric lighting but to electric power transmission and the supply of current. That statement was a verbatim extract from the report of the Auer committee, which made the arrangement with Dr. Auer for the acquirement of the electric light. It had been urged, but in his view without justification, that this sentence might be read as meaning that Dr. Auer had sold all his inventions in the electric field of every kind, present and future, to the Austrian company, without knowledge as to their value or any further consideration for their acquisition. His words conveyed no such meaning, as to the power to acquire could only be exercised when the new inventions in the electric field were ready for commercial purposes, when alone it would be possible to fix the price at which they should be taken over by the Austrian company. It was, however, very important, in his judgment, to get Dr. Auer to consent to the insertion of this power for the acquisition, upon terms to be subsequently agreed on, of all his inventions in the electric field, because that implied that he would, in the first instance so offer them to the Austrian company. He had every reason to know that since Dr. Auer agreed to hand over his new electric light to the Vienna company he had continuously worked at the many problems which presented themselves. He had great pleasure in informing them that Dr. Auer had sent over Mr. Kuschenitz with his new electric lamp, which had been installed for the shareholders' inspection. They might further naturally desire to hear when the lamp would be available for use by the public. The last communication received from Dr. Auer on the subject intimated that the Osmium lamp would come into commercial working in the autumn. He hoped that the electric lamp would give every satisfaction, and that the shareholders would recognise that they had every reason to thank Dr. Auer for his close attention to the development of that lamp.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (June 14, 1900). Price of silver 27 1/16d. per oz. (June 21). Consols (2 3/4 per cent.) 100 3/8—100 7/8 for money, 100 13/16—100 15/16 for account; 2 1/2 per cent. 99 1/2—99 3/4 (June 21). Stock Exchange Settling Day: Consols, July 4; Stocks and Shares Continuation Days, June 26 and July 10; Ticket Days, June 27 and July 11; Pay Days, June 28 and July 12; Mining Share Carry-over Days, June 25 and July 9.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The coupons on this company's 4 per cent. mortgage debentures to bearer, due July 1, will be paid on and after 2nd prox., at Parr's Bank (Ltd.), Bartholomew-lane, London, E.C. The debenture register will be closed from 25th to 30th inst. inclusive.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—It has been resolved to increase the capital of this company from £20,000 to £50,000, in £5 shares. A confirmatory meeting will be held on July 2.

EASTERN EXTENSION, AUSTRALASIAN, AND CHINA TELEGRAPH CO. (LTD.)—The coupons on this company's 5 per cent. Australian Government subsidy debentures due July 2 will be paid at Messrs. Barclay & Co.'s Bank, 54, Lombard-street, London, E.C.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—Coupons due July 1 on this company's shares will be paid by Messrs. C. J. Hambro & Sons, 70, Old Broad-street, London, E.C.

NEW GERMAN COMPANY.—The German business of the well-known firm of Brown, Boveri & Co., Baden, Switzerland, has been formed into a joint stock company, with a capital of £300,000.

PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.)—The coupons on this company's 4 per cent. guaranteed debentures due 30th inst. will be paid at Parr's Bank (Ltd.), Bartholomew-lane, London, E.C.

REDUCTION OF CAPITAL.—Sanction has been given for the reduction of the capital of John Kirkcaldy, Ltd. (makers of feed water heaters, evaporators and surface condensers), from £50,000 to £30,000. The company was incorporated in 1886, and the vendor now agrees to surrender £1,000 £10 shares.

STOCK EXCHANGE NOTICE.—27th inst., has been appointed a special settling day in the further issue of 10,000 ordinary £5 fully-paid shares (Nos. 20,001 to 30,000) of *Callender's Cable and Construction Co. (Ltd.)* and the securities have been ordered to be quoted in the official list.

WESTERN TELEGRAPH CO. (LTD.)—Coupons on this company's second issue of 5 per cent. debentures, due 30th inst., will be paid at Parr's Bank (Ltd.), Bartholomew-lane, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways	June 16	4,450	+ 99	23	101,177	+ 5,965
Blackpool Corporation...	„ 14	1,238	+ 687	11	5,826	+ 1,071
Blackpool and Fleetwood	„ 16	989	+ 291	24	8,718	+ 9
Bolton Corporation	...	...	...	..	...	...
Bradford Corporation...	„ 17	577	+ 15	11	5,498	+ 1,202
Brisbane Trams	May 2	1,915	+ 429	5	9,032	+ 2,292
*Bristol Trams & Carriage	June 15	3,180	+ 14	24	68,638	+ 2,709
*Buenos Ayres & Belgrano	May 20	2,173	- 221	20	45,717	+ 4,984
City & South London Ry.	June 17	1,480	+ 581	24	30,734	+ 5,753
Dover Corporation	„ 16	214	+ 25	11	2,203	+ 230
Dublin United	„ 15	3,727	+ 106	24	79,613	+13,661
Dublin Southern Dist...	„ 15	1,005	- 184	24	19,591	
*Glasgow Corporation ..	„ 16	9,987	- 20	...	...	...
Hull Corporation	„ 16	1,303	...	50	38,671	...
*Liverpool Corporation..	„ 9	9,421	+1,638	23	164,707	+20,384
Liverpool Overhead Rly	„ 17	1,424	- 72	24	34,214	+ 923
*Sheffield Tramways	„ 17	2,281	+ 947	24	48,392	+15,270
*South Staffs. Trams....	„ 15	641	...	24	16,202	+ 1,032

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 13.	Price Wednesday, June 20.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending June 20. Highest	Lowest
			TELEGRAPHS.						
£110,000	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July	101	...
35,000	10	...	Amazon Telegraph	... ...	... ...	...	June and December	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£812,720	Stock	15/0	Anglo-American	61 64	60 63	5 17 0	Feb., May, Aug., Nov.	61½	...
£2,088,640	Stock	30/0	Do. Preferred	114 115	114 115	5 5 3	„ „	11[illegible]	114½
£2,088,640	Stock	27/0	Do. Deferred	13 13½	12⅞ 13⅛	10 3 9	„ „	13⅛	1 1⅛
$12,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 104	103 104	3 17 0	„ „	163½	102⅜
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	7⅛	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	6 1 2	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	11⅛	11½
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101 103	100 103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	150 155	4 10 4	Jan., Apr., July, Oct.	152	150
£1,836,888	Stock	2½%	Do. 2½ per Cent. Preference Stock	97 103	97 100	2 10 3	„ „	97½	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November	111¼	...
250,000	10	6/6	Eastern Extension	14½ 15⅝	14½ 15	4 13 4	Jan., Apr., July, Oct.	15	14⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 117	113 117	3 9 2	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.)	100 103	100 103	4 17 1	January and July	...	...
£36,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 18 5	February and August	...	...
£300,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	103⅛ 103⅞	103⅛ 103⅞	3 17 8	May and November	...	...
180,227	10	3/6	Globe Telegraph and Trust	11⅛ 11⅜	11⅛ 11⅜	4 9 4	Jan., Apr., July, Oct.	11⅛	11⅛
180,042	10	2/0	Do. 6 per Cent. Preference	15 15½	15 15½	3 17 5	„ „	15⅛	15⅛
150,000	10	15/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July	...	...
£96,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100 103	100 103	4 8 0	June and December	...	...
17,000	25	37/6	Indo-European	53 57	53 57	4 7 9	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7⅞ 8⅛	7⅞ 8⅛	4 14 1	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124 129	125 130	4 12 10	„ „	126	...
15,609	10	...	West African Telegraph	2⅛ 3⅛	2⅛ 2⅝	4 9 3	December and July	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
20,008	2½	...	West Coast of America	⅛ 1	⅛ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 13 7	January and July	...	...
89,321	10	1/0	West India and Panama	⅜ ⅝	⅜ ⅝	...	May and November	...	...
24,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	7	6⅝
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	102 105	...	3 17 4	June and December	...	...
207,920	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15	14½ 15	4 13 4	Mar., June, Oct., Dec.	15	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105 108	105 108	4 13 10	June and December	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,850	10/)	1½d.	Consolidated Telephone Con. and Manfg.	... ...	... ...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜ ½	⅜ ½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
470,000	5	3/0	National	4⅝ 5⅛	5 5⅛	5 14 3	February and August	5 1/16	5
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13 15	12 14	4 5 9	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5 5½	5 5½	4 15 3	„ „	5 1/16	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	98 101	3 10 3	June and December	100	99½
171,504	1	0/3	Oriental	1 1/16	1 1/16	4 14 1	April and October	...	...
88,000	5	2/6	United River Plate	4½ 5	4½ 5⅛	8 1 11	July	5	...
16,639	5	1/4	Do. 5% Cumulative Preference	4⅝ 5⅛	4⅝ 5⅛	4 15 3	June and December	5 1/16	...
£179,917	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, June 13.	Price Wednesday, June 20.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 20	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅝ ⅞	⅝ ⅞	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord. ...	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref. ...	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord. ...	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference ...	8½ 9½	8½ 9½	3 13 8	March and September	8⅝	8⅜
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid) ...	6½ 7½	6½ 7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp. ...	9 10	9 10	4 10 0	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference ...	5½ 6	5½ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary ... ...xd	6½ 7½	6½ 7½	4 0 0	March ...	7⅛	6⅞
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.) ...xd	103 112	107 110	4 1 8	June and December...	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) ...	100 110	100 110	4 10 11	April and October.....	...	...
70,579	10	8/0	City of London Electric Lighting Ord. ...	9 10	9⅛ 9½	4 4 3	February and August	9⅜	9⅛
40,000	10	6%	Do. 6 per Cent. Cumulative Pref. ...	12⅛ 13⅛	12⅛ 13⅛	4 8 11	January and July.....	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) ...	124 129	124 129	3 18 11	June and December ...	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary ...	9 10	9 10	4 0 0	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference ...	11½ 12½	11½ 12⅞	4 16 0	March and September	12⅜	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.) ...	110 113	110 113	4 1 1	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary ...	12½ 13⅜	12⅜ 13⅜	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference ...	7 7⅜	7 7⅜	4 0 0	January and July.....	...	...
110,000	3	...	London Electric Supply Ordinary ...	1 1⅛	1 1⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference ...	4 4⅜	4 4⅜	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures.. xd	100 102	98 100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord. ...	13⅜ 14⅜	13⅜ 14⅜	3 9 0	April and October.....	14⅜	11⅝
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage ...	113 116	113 116	3 18 11	June and December ...	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.) ...	97 99	97 99	3 11 6	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary ...	15½ 16½	16 17	4 2 4	March ...	16⅞	16⅛
10,000	5	5/0	Oxford Electric Ordinary ...	6 6½	6 6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric ...	⅜ ½	⅜ ½	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb....	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October.....	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures ...	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary ...	14½ 15½	14½ 15½	4 13 7	February and August	14⅞	14⅜
20,000	5	3/6	Do. 7 per Cent. Preference ...	8½ 9½	8½ 9½	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary ...	2 2½	2 2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures ...	85 95	85 95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3⅜ 4⅛	3⅜ 4⅛	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary ... x new	13 14	11 12	5 8 4	March and September	11⅛	11¼
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7¼d.	Aron Electricity Meter 6 per Cent. Cum. Pref. ...	⅝ ¾	⅝ ¾	8 0 0	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary ...	⅞ 1	⅞ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference ...	1⅛ 1⅛	1⅛ 1⅛	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures ...	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference ...	6 6½	6 6½	4 12 4	...	5⅛	...
100,000	5	1/6½	British Westinghouse 6% Preference ...	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,060	2	1/2⅝	Brush Electrical Engineering ...	1⅞ 2	1⅞ 2	4 0 0	September ...	1⅞	1⅛
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cum. ...	2 2¼	2 2¼	5 6 8	,,	2	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103 114	109 114	3 19 10	February and August	110¼	110
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.) ...	103 105	103 105	4 5 9	June and December ...	...	...
20,000	5	10/0	Callender's Cable Construction Ord. ...	13½ 14½	13½ 14½	5 3 5	,, ,,	14⅜	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference ...	5½ 6	5½ 6	4 3 4	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.) ...	112 116	112 116	3 18 5	November and May ...	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid) ... ... x l	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.) ...	99 102	99 102	4 8 3	...	...	...
60,000	1	0/8⅝	Chadburn's Ship Telegraph Ordinary ... ...xd	⅞ 1⅛	¾ 1	7 0 0	March	...	...
60,000	1	0/7⅛	Do. 6 per Cent. Cumulative Preference ...	⅞ 1⅛	¾ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098) ...	3½ 4	3½ 4	4 10 9	January and July.....	3⅞	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.) ...	100 103	100 103	4 19 0	,, ,,	...	...
60,000	1	0/7⅛	Davis and Timmins 6 per Cent. Cum. Pref. ...	⅞ 1⅛	¾ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid) ...	2 2⅛	2 2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid) ...	3½ 4⅛	3½ 4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock (red.) ...	93 95	93 95	4 4 3	June and December ...	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord.(fully pd.)...	4½ 5	4½ 5	6 0 0	Half-yearly ...	4⅝	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101 104	101 104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited) ...	2 2⅛	2 2⅛	5 6 8	January and July.....	2⅛	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference ...	2⅜ 3⅛	3 3⅛	4 0 0	July ...	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) ...	103 103	103 106	3 16 2	January and July.....	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary ...	13 14	13 14	6 15 9	February and August	...	...
30,000	5	1/6	Do. 4½ per Cent. Preference ...	5¼ 5⅝	5¼ 5⅝	3 18 3	,, ,,	5⅛	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock (red.) ...	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works ... ...xd	21 22	21 22	4 10 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) ...	100 103	103 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance ...	34 38	35 39	4 12 4	March and July ...	37½	35½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909 ...	102 105	102 105	3 16 2	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary ... xd & new	11½ 12½	10½ 11½	5 4 4	...	1⅜	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference ...	5½ 6	5½ 6	4 3 4	...	5⅝	...
30,000	5	7/0	Willans and Robinson Ordinary ...	11 12	11 12	5 0 0	April and October.....	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference ...	6½ 7½	6½ 7½	4 2 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures ...	104 106	104 106	4 0 2	May and November ..	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways ...	17½ 18½	17½ 18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures...	102 104	102 104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary ...	22½ 23½	22½ 23¼	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£3 paid) ...	8⅛ 8⅜	8⅜ 8⅝	...	...	8⅜	8⅜
£100,000	Stock	4%	Do. 4 per Cent. Debentures ...	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10¾	10½ 10¾	4 13 0	May and November ..	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15⅜ 16⅜	16 17	3 10 7	...	16⅜	16
15,000	10	...	Do. (Nos. 60,001 to 75,000)	15⅜ 16⅜	16 17	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000) ...	12 13	12½ 13½	4 8 11	February and August	13⅛	12⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures ...	124 127	124 127	3 18 9	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900) ...	120 123	120 123	...	...	...	...
40,000	5	2 8⅛	Buenos Ayres & Belgrano 6% "A" Cum. Pref. ...	5 5⅛	5 5⅛	5 14 4	...	...	...
27,500	5	...	Do. "B" ...	4 4⅛	4 4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures ... ...xd	103 106	101 104	4 16 2	...	103½	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. St'k Prov. Certs (£57½% to be p'd.)xd	37 40	37 40	...	...	...	...
206,297	10	3/0	Central London Ordinary ...	10 10½	10 10½	2 17 2	June and December ..	10½	1
£855,000	Stock	1½%	City and South London Railway Con. Ordinary ...	65 68	65 68	2 15 2	February and August	67	68
370,500	10	1/5⅞	Do. (Nos. 22,501 to 60,000)	6 7	6 7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) ...	140 145	140 145	3 9 0	,, ,,	...	...
£200,000	Stock	6%	Do. (1896)	132 137	132 137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture ...	123 123	123 123	3 2 6	May and November ..	...	...
20,000	10	8½%	†Imperial Tramways Ordinary ...	22½ 23½	22½ 23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference ...	14½ 15½	14½ 15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture ...	113 115	113 115	3 17 11	January and July.....	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord. ...	⅜ ⅝	½ ⅝	32 0 0	March and October ..	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	½ ⅝	½ ⅝	24 0 0	,, ,,	...	...
80,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref. ...	9⅜ 10	9⅜ 10⅛	4 17 8	May and November ..	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary ...	9⅜ 9⅝	9⅜ 9⅝	4 0 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference ...	13½ 13⅝	13½ 13⅝	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture ...	105 107	105 107	3 16 0	January and July.....	...	...
24,000	5	...	New General Traction Ordinary ...	3½ 3⅝	3½ 3⅝	...	...	...	...
80,000	5	6/0	Do. 6 per Cent. Cumulative Preference ...	4½ 5½	4½ 5½	5 14 3	May ...	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord. ...	16 18	...	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference ...	10½ 10¾	...	...	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary ...	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference ...	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£140,000	Stock	3%	Waterloo and City Ordinary ...	100 103	100 103	2 18 10	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,154. [No. 10, Vol. XLV.] FRIDAY, JUNE 29, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 20fr., or 10m.

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NOTES.

WE tender our sincere and hearty congratulations to Dr. OLIVER J. LODGE upon his nomination to the post of Principal of the recently-constituted University of Birmingham. The appointment is officially announced in the following terms, received by the Secretary of the Birmingham University from the Board of Education :—

HER MAJESTY, in pursuance of the provisions of the charter of the University of Birmingham, is pleased to appoint OLIVER J. LODGE, Esq., DSc., LL.D., F.R.S., Professor of Experimental Physics in the University College, Liverpool, to be Principal of the University of Birmingham.—A. W. FITZROY.

PROF. LODGE is so well known to our readers, both as a contributor to our columns and as a leader of the vanguard of physical science in this country, that it is superfluous to descant now upon the claims which his career makes upon this dignified post. The principal of a modern university needs to be a man who, on the one hand, is not too much wedded to the ancient tradition of university curricula, or, on the other hand, too restlessly anxious to uproot all these traditions and implant nothing but modern utilitarian methods. Such a requirement is abundantly fulfilled by the intellectual qualifications of Dr. LODGE, whose scientific researches constitute only the most salient feature of a mind abounding in diversified talents.

THE proceedings of the Select Committee on the Electric Power Bills, presided over by Sir JAMES KITSON, reached a critical stage yesterday afternoon, when an important announcement was made. At the conclusion of the evidence for the South Wales Electrical Power Distributing Company Bill, and after the Committee Room had been cleared for about five minutes and the public re-admitted, Sir JAMES KITSON stated that the preamble of the South Wales Bill was proved. He added that for convenience he might announce—though that business was not down for yesterday—that the preamble of the Durham and Lancashire Electric Power Bills had been proved to the satisfaction of the Committee, but that the preamble of the Tyneside Bill had not been proved. It was further announced that it is the intention of the Committee, so far as may be possible, to insert the same conditions in each of the bills carried forward.

IN our Contemporary Electrical Science notes this week a short account is given of another sensational discovery by P. LENARD, which forms a becoming sequel to his discovery in 1895 of the penetrative power and photographic action of cathode rays. That discovery was shortly afterwards crowned by the discovery of the Röntgen rays. The *tour de force* which LENARD accomplished in 1895 was to obtain cathode rays in the open air, outside the tube in which they were generated. He now obtains them in an "absolute vacuum"—or that which with our present resources stands for such—in which no electric discharge has hitherto been thought possible. The discharge of a negatively-charged electrode takes place instantly in such a vacuum, if the electrode in question is illuminated with ultra-violet light. The effect of the light is annulled by interposing a mica plate. A positively charged electrode retains its charge. That cathode rays are really in question is proved by the rectilinear propagation of the discharge and by its magnetic deflection. The only proof outstanding is the fluorescence of the walls of the tube, which has not yet been observed. The rays are the slowest yet discovered, their speed being only one-thirtieth of the velocity of light.

LENARD'S new discovery sheds a flood of light on a number of photo-electric phenomena which have hitherto been obscure. He does not seem to have made any experiments with polarised light, although such experiments are called for by ELSTER and GEITEL'S work. The precise mechanism by which a beam of light is enabled to ionise a charged metal

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not immersed in a gaseous medium will form a fascinating subject of research. Such an electrified body gives out cathode rays which at ordinary pressures will of course be absorbed by the surrounding air, and will in turn make that air conducting. This explains the influence of ultra-violet light in lowering the spark potential. Not only is the production of cathode rays now independent of the pressure of the gas; it is also independent of the potential of the cathode, so long as that is negative. This would appear to place at our disposal a new form of "current valve," simpler and more reliable than the aluminium cell. Like LENARD'S former discovery, the present one is not such as would appeal to the man in the street. But to the electrician its significance is of the greatest moment. The connection between light and electricity teems with vast possibilities, and at no previous time have these possibilities appeared nearer to their realisation.

A LETTER from Dr. SILVANUS P. THOMPSON in *The Times* of Tuesday last complains of the rise in prices of gas in London, and suggests as a remedy that municipalities or rival companies should undertake to supply houses and power users with non-illuminating gas in competition with the existing gas companies. The non-illuminating gas, he says, could not only be used for propelling gas engines and supplying gas stoves, but might also be used as a lighting agent, by means of incandescent mantles. We think the remedy is almost, if not quite, as bad as the disease. A weakness in gas companies is that they tacitly admit that a rise in the price of coal affects them so seriously that they must put up the price of gas. But if illuminating gas companies are really thus affected, the manufacturers of non-illuminating gas would be equally liable to raise their prices whenever coal might go up in price. It is the strength of electric light companies that the price of coal so little affects the producing cost of their commodity. We do not, of course, imply that the serious rise in the price of coal has not affected electric light companies at all, but those who are familiar with the analyses of electricity works accounts, published in our columns from week to week, will have no difficulty in understanding how small is the influence of a considerable variation in the price of coal upon the total cost, and therefore the selling price of electric power. Dr. SILVANUS THOMPSON'S heroic remedy is unnecessary. All who are dissatisfied with gas should use electricity.

IN an editorial note in our last issue we briefly referred to the superannuation scheme recently developed by the British Electric Traction Co. An interesting letter from Mr. E. GARCKE, in our correspondence columns this week, announces that the advantages of this scheme are not restricted to the staff of the associated undertakings of the British Electric Traction Co., as the directors of that company invite other electrical companies which may be so disposed to join the scheme. We are quite in agreement with Mr. GARCKE that there must be other electrical undertakings, whether tramway companies or only indirectly associated with tramway work, the officers and staffs of which would be glad to reap the advantages of this scheme. Mr. GARCKE states that the affairs of the Association will be managed by a representative committee on independent lines, with Mr. W. G. BOND as secretary.

THE Typewriting Telegraph Corporation (Ltd.), which has been registered with a share capital of £100,000, in £1 ordinary shares, has been formed to acquire the patents and develop the typewriting telegraph instrument invented by Mr. W. S. STELJES. An illustrated description appears in an article we publish this week. The present issue comprises 80,000 shares, of which 26,666 will be taken by the vendors in part payment of the purchase, the remaining 53,334 having been offered to the public for subscription. Among the directors are Sir JAMES FERGUSON, chairman, and Mr. C. E. SPAGNOLETTI, both well known in telegraphic circles. The business manager is Mr. W. T. GOOLDEN, a prominent electrical engineer, while the consulting engineers, Messrs. MORDEY and DAWBARN, are also well known to our readers. The invention with which this promotion is associated promises to satisfy a considerable want as an instrument for recording messages without the use of the Morse or any similar code. There should be an extensive market for a satisfactory instrument of this class, and Mr. STELJES certainly has brought to bear upon his invention a high degree of technical skill and experience. The promotion, which appears to be on eminently satisfactory lines, financially speaking, should prove a great success.

Electrical Engineers (R.E.) Volunteers at the Front.—It is reported that Serg. Wander has been taken prisoner at Vredefort.

Personal.—Mr. Shelford Bidwell, F.R.S., has been admitted to the degree of Doctor of Science in Cambridge University.

Erratum.—In the "Contemporary Electrical Science" note "Conductivity in a Vacuum Tube," last week, p. 318, read "resistances" for "conductivities" in the last line but two.

Röntgen Society.—The Annual General Meeting of this Society will be held at 20, Hanover-square on Thursday next, July 5, at 8 p.m. A presidential address will be read by Mr. Wilson Noble.

British Association.—At a public meeting held in Belfast recently it was decided to invite the British Association to visit Belfast in 1902. The last meeting in Belfast took place in 1874 under the presidency of Prof. Tyndall.

Azores–United States Cable.—Messrs. Siemens Bros. & Co.'s c.s. "Faraday" sails on Monday with the balance of the Commercial Cable Co.'s cable from Fayal (Azores) to Canso, (Nova Scotia). The cable is already laid 600 miles out from Canso.

Appointment Vacant.—The chair of physics at the University College, Liverpool, is vacant by the resignation of Dr. Oliver Lodge, who has been appointed Principal of the University of Birmingham. Applications to be made to the registrar by July 16.

Lift Accident on the City and South London Railway.—We learn that the lift accident at the London Bridge station of the City and South London Railway, which occurred at 6 o'clock yesterday morning, was not due to any defect in the electrical arrangements of the lift.

The New Physical Laboratory at Owens College.—The new and splendidly equipped physical laboratory recently built for the Owens College, Manchester, is to be opened by Lord Rayleigh this afternoon at 2.30 o'clock. The event is to be followed in the evening by a conversazione.

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Wireless Telegraphy.—It is stated that the Government is conducting experiments in wireless telegraphy between Swanage and St. Catherine's Lighthouse. Wireless telegraph stations are also, by the instruction of the chief signal service officer of the United States, to be established in the harbour of San Francisco, in Porto Rico and in the Philippines.

American Association for the Advancement of Science.—The annual meeting of this Association has been arranged to be held earlier than usual this year, viz, from the 25th to 29th inst. The change is partly to accommodate members intending to visit Paris and partly to avoid the excessive discomfort of sitting through long discussions in the dog days

Water Power Electric Traction in Newfoundland.—Power for the new electric tramways at St. John's, Newfoundland, is transmitted over a distance of 9 miles at 15,000 volts. 1,600 H.P. is generated at a waterfall under a head of 185ft. with turbines of the "Victor" type and Westinghouse generating machinery. The tramway is 7 miles long, and is equipped with 20 cars.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

Optical Treatment of Lupus.—Prof. Sinsen's method of treating skin disease by means of intense light rays projected on the patient has recently been introduced into the London Hospital, where it has been on trial for the last three weeks. The introduction of this method into this country is primarily due to H.R.H. the Princess of Wales, who took great interest in it during her visit to Copenhagen, where it has been practised for some time.

Employment of Electricity in Russian Coast Fortifications.—According to the *United Service Gazette*, all the electrical energy required for lighting purposes, firing guns, &c., in the Russian coast fortifications is provided by accumulators, which have to be taken to a dynamo outside the fort in order to be recharged. The cells at Cronstadt and Batoum are needing renewal, and the question is under discussion whether each fort should not now be supplied with its own generating plant.

Telegraphic Communication with China.—The Eastern and Great Northern Telegraph Companies notify that the British Government have agreed to allow all war vessels passing between Chefoo and Taku to carry telegrams. Messages for Taku and beyond can be accepted to go by this route at sender's risk. Communication between Shanghai and Chefoo is at present open by means of landlines belonging to the Chinese Telegraph Administration, but nothing is known of the state of communication beyond Taku. This is the first occasion on which any Government has sanctioned the conveyance of telegrams by warships.

Telegraphing Telephone Messages.—On Monday last, in the House of Commons, Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether postmasters had been instructed not to forward telegraphic messages over the wires of the National Telephone Co. Mr. Hanbury replied that the Post Office did not now deliver telegrams by telephone to subscribers of the National Telephone Co., with the exception that it has not withdrawn this privilege from any subscriber to whom it has been already granted. Apropos of this matter, we understand that the view of the National Telephone Co. is that this extraordinary new departure is illegal and a breach of the terms of their contract with the Post Office.

Institution of Mechanical Engineers.—The summer meeting of this Institution has been held at Westminster this week, commencing last Wednesday and concluding to-day. The proceedings commenced at 10:30 a.m. with a reception of members of the American Society of Mechanical Engineers. The reading and discussion of Papers followed, the first item being the adjourned discussion of Prof. H. S. Hele-Shaw's Paper on "Road Locomotion." Other Papers included one on "Recent Locomotive Practice in France," by M. E. Sauvage; one on "Polyphase Electric Traction," by Prof. C. A. Carus Wilson; and a Paper entitled "Observations on an Improved Glass Revealer for Studying Condensation in Steam-engine Cylinders and Rendering the Effects Visible," by Mr. Bryan Donkin. In the afternoon the members paid visits to the various electrical and other engineering works, and in the evening it celebrated its annual dinner at the Hotel Cecil. On Thursday the reading and discussion of Papers was continued during the morning, and in the afternoon visits were again paid to engineering works in and around London. To day the Institution will enjoy a number of excursions to various places of interest, including Messrs. Willans & Robinson's Works at Rugby. This evening at nine o'clock the Institution will hold its annual conversazione at its buildings at Storey's Gate.

The Paris Exhibition.—At about two o'clock on Monday afternoon the supply of electricity to the greater part of the Champ de Mars section of the Exhibition was interrupted by the bursting of a pipe conveying feed-water to one of the batteries of boilers which supply steam to the generating sets furnishing current for light and power. The machines affected were continuous-current machines, and in ordinary circumstances the effects of the accident would not have been felt at all, as three other large continuous-current units are supplied from another group of boilers. These sets are the only three English generating sets for supplying electric power to the Exhibition, but unfortunately they are also almost the only machines which are not yet in running order. Most of the continuous current circuits were, therefore, dead until the galleries closed at seven o'clock, but with the help of temporary make-shifts sufficient current could be obtained for lighting the grounds and restaurants in the evening, and also to supply the "Salle des Illusions" for a Press view between 4 o'clock and 5 o'clock. This "Salle des Illusions" is a hexagonal hall, the walls of which are covered with mirrors, and whose roof is a fine gilt dome. Hundreds of incandescent lamps of different colours are tastefully arranged on the dome in such a manner that they are not visible until lit, and beautiful effects are obtained by switching on different combinations of these lamps. The demonstration although somewhat belated was most successful, and it was repeated with equal success on Tuesday.

The Thames Ironworks.—A visit was made by about 90 of the members of the Society of Engineers on the 20th inst. to the Thames Ironworks at Blackwall. These works have a frontage on the river Thames and extend some distance up Bow Creek. They are the growth of more than half a century and now cover an area of some 30 acres on the Essex side and 3 acres on the Middlesex side of the creek. They are divided into four departments, of which the shipbuilding is the oldest and most important. The other departments are the civil engineering, the electrical engineering, and the dry docks. The electrical engineering department undertakes electric light and power installations, and has also carried out the electrical equipment of vessels built by the company. Here the visitors witnessed the production of general electrical machinery and apparatus, including dynamos, motors, electric fans, portable electrical drilling machines, searchlight projectors, switches and switchboards. In consequence of the transference of the marine engineering department to the newly acquired works at Greenwich, the present machine shops at the Orchard-yard will be devoted almost entirely to electrical manufactures, and the resources of the electrical engineering department will be greatly augmented. A central generating station has been established in the works for supplying current for the several departments. The installation consists of three locomotive and two gunboat boilers aggregating 600 I.H.P. There are nine sets of engines and dynamos aggregating 350 kw., three sets having been built by the Thames Ironworks. Distribution of current is effected on the three-wire system, the main cables to the distributing centres being of vulcanised india-rubber insulation laid in cast-iron pipes underground. The electric current generated is chiefly used for lighting purposes, but is also supplied to the motors employed in the works for driving machinery. The use of electricity for power purposes is in course of extension.

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THE CENTRAL LONDON RAILWAY.

(*Continued from page 280.*)

Opening Ceremony.—We suspend our description of this railway in order to give some account of the opening ceremony, which took place on Wednesday afternoon. The ceremony was performed by H.R.H. the Prince of Wales, in the presence of a number of distinguished guests and the chief officials of the associated companies. Among these were Sir Henry Oakley, chairman of the Central London Railway Co., and other members of the board, Sir Benjamin Baker and Mr. Basil Mott, the engineers of the line, the chairmen of a large number of railway companies, Sir M. Hicks-Beach, Chancellor of the Exchequer, Mr. Ritchie, President of the Board of Trade, Mr. Chaplin, President of the Local Government Board, Sir Courtenay Boyle, Permanent Secretary of the Board of Trade, Mr. F. J. S. Hopwood, Secretary to the Railway Department of the Board of Trade, Mr. F. Huddleston, chief engineer of the Electric Traction Co., by whom the construction and equipment of the line has been carried out, Mr. H. H. Holt, resident engineer in charge of the work on behalf of the same company, and a number of other well-known persons.

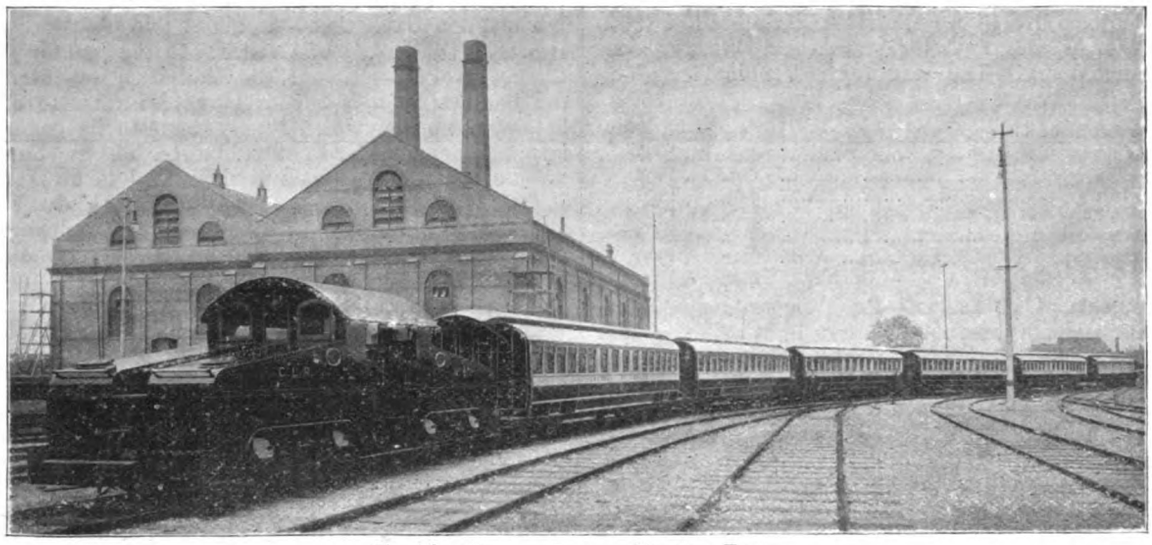

FIG. 12.—CENTRAL LONDON RAILWAY TRAIN.

The Prince of Wales, accompanied by Sir Francis Knollys and Captain Holford, arrived at the City terminus of the railway at 3.30 p.m., and descended to the line by one of the electric elevators. Prior to this a train-load of guests had been despatched to Shepherd's Bush. The Royal train performed the journey to Shepherd's Bush station, without stopping, in less than 19 minutes, and proceeded up the gradient to the depôt and power station, where it arrived in 22 minutes from the time of starting. The speed of the train was, therefore, about 15 miles an hour, but we understand that Lieut.-Col. Yorke and Mr. A. P. Trotter, who have inspected the line on behalf of the Board of Trade, consider that a much higher speed might be attained with perfect safety.

On reaching the power station, and after inspecting the generating machinery, His Royal Highness declared the line open in the following felicitous speech :—

My Lords and Gentlemen,—I have great pleasure in declaring the Central London Railway open. It has given me much pleasure to take part in to-day's proceedings. I wish to drink "Success to the undertaking," and I congratulate Sir Benjamin Baker, the eminent engineer, who has constructed this great railway. I have but little doubt that it will be an immense boon to London, and I am sure you will all join with me in wishing success to the company.

We understand that the opening of the line to the public will not take place until about the middle of next month, but the exact date has not yet been fixed. Although the line is practically completed and ready for traffic, there are one or two minor matters to be attended to, and, apart from this, the directors are particularly anxious not to open the line until the staff has been sufficiently drilled to allow of the railway handling a large body of traffic without risk of delays.

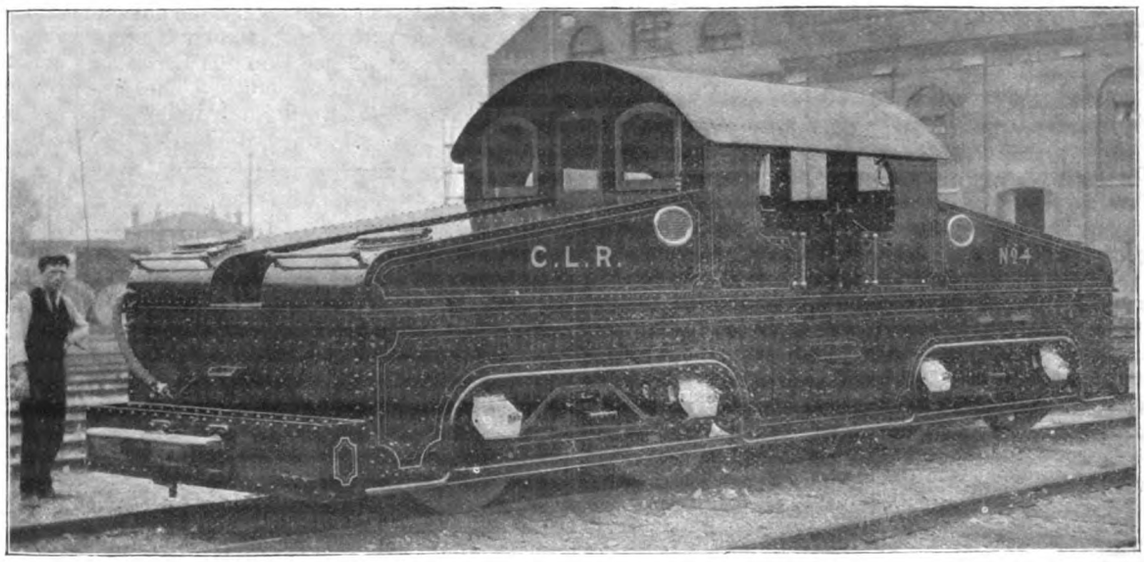

FIG. 13.—CENTRAL LONDON RAILWAY LOCOMOTIVE.

Our illustrations this week show the general construction of the trains, locomotives, stations and tunnel work of this the newest and best of London's underground railways.

(*To be continued.*)

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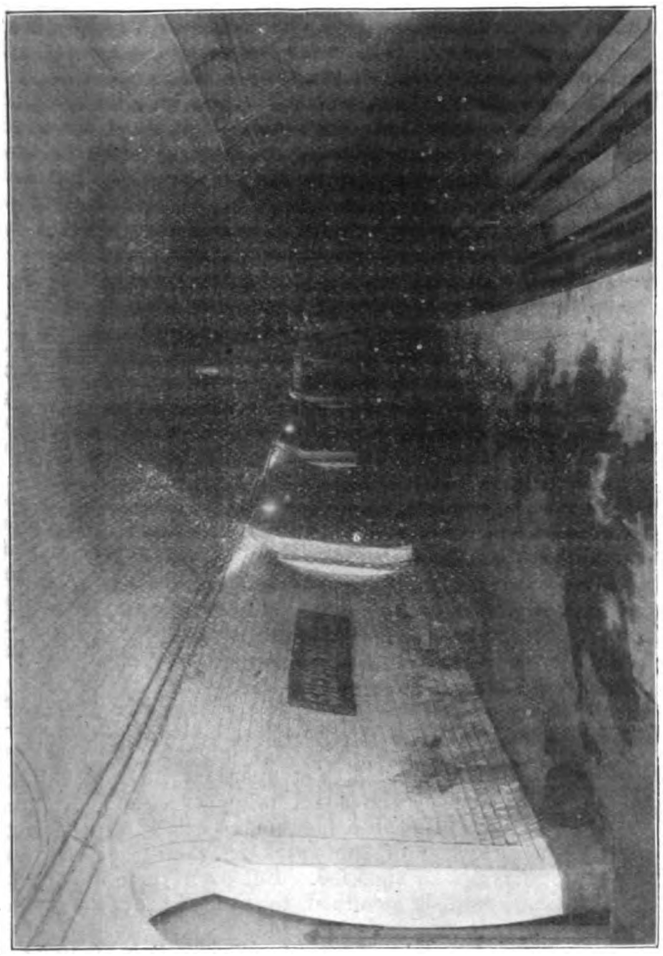

FIG. 15.—SHEPHERD'S BUSH PASSENGER STATION.

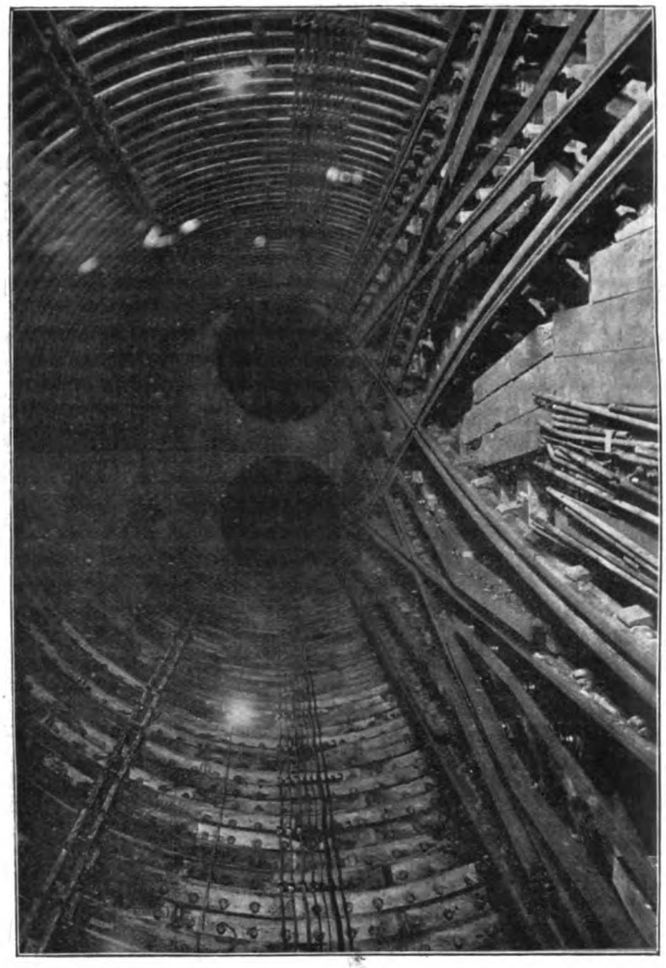

FIG. 17.—CROSS-OVER TUNNEL AT SHEPHERD'S BUSH STATION.

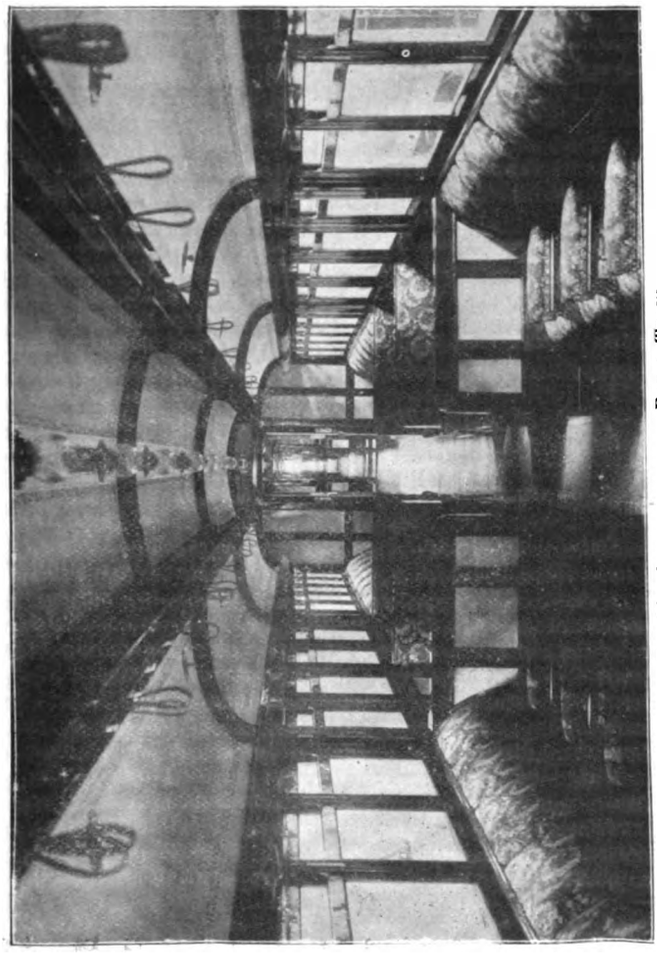

FIG. 14.—INTERIOR OF THE ROYAL TRAIN.

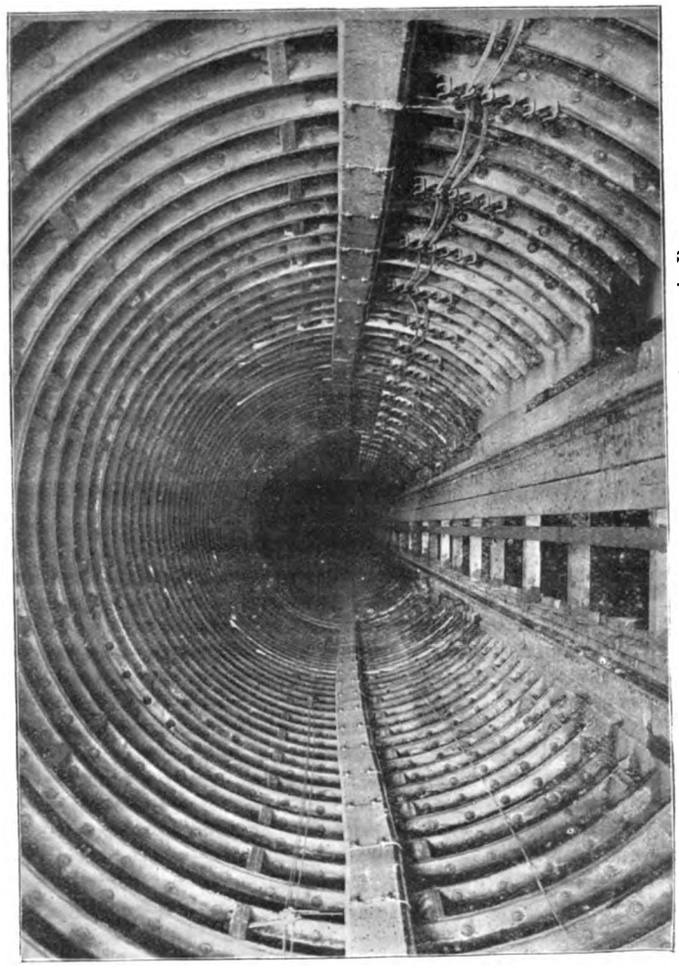

FIG. 16.—ENTRANCE TO THE TUNNEL AT SHEPHERD'S BUSH.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Duplex Wave Telegraphy.—A. Turpain has devised a system of superimposing a wave message upon an ordinary continuous-current telegram without interference, and so utilising the same wire for two simultaneous messages without going to the trouble of constructing dummy circuits. The wave message is sent by ordinary wire waves, but in order to prevent it rushing into the Morse electromagnet and destroying its insulation, the Morse receiver is enclosed in a metallic screen in contact with the magnet winding, and an electrolytic cell or an iron coil is also added to the receiving apparatus in order to force the waves into the line wire. The system can be applied either duplex or diplex fashion. It has been tested over a line of 350 metres of ordinary telegraph wire, and appears to have answered well. It was also applied to signalling over a guard-wire of the Bordeaux-les-Chartrons electric railway, and does not appear to have been affected by the proximity of strong currents of the latter. But, on the other hand, no guarantee is given that existing telephone circuits would not be influenced, as we know they are influenced, by other ingenious French devices.

[A. Turpain, *Comptes Rendus*, May 14, 1900.]

Production of Cathode Rays by Ultra-Violet Light.—P. Lenard announces an important development of the connection between electricity and light in the discovery that the discharge of electrified bodies by ultra-violet light is due to the production of cathode rays by the impact of the light. The hitherto accepted theory that the discharge was due to the mechanical disintegration of the electrode is rendered invalid by the fact that this would require the transfer of an amount of material such as could not fail to be detected by the spectroscope, and the spectroscope makes no such indication. The constant increase of the discharge with the exhaustion, as well as the strictly one-sided character of the discharge, suggested the probability of cathode rays being concerned in it. This was as good as proved by the following experiment: A vacuum tube was furnished with two electrodes, and exhausted until it failed to allow any discharge to pass. One of the electrodes was exposed to the ultra-violet light furnished by a spark-gap with zinc terminals. When the electrode was charged negatively it was instantly discharged by the ultra-violet light. A positive charge, on the other hand, was retained indefinitely. The potential is of no account, except that the discharge is not so complete at low potentials, probably on account of a lack of energy of the cathode rays. That the electric charge proceeds in the form of rays is shown by the fact that if it is made to traverse a perforated electrode, a charge is received on an electrode in a line with the hole, but not on a lateral one. The beam can, however, be brought to impinge upon the lateral electrode by magnetic deflection. The ratio e/m comes out as high as $11{\cdot}5 \times 10^{-6}$, and the velocity as low as $\frac{1}{30}$th of the velocity of light. The rays are not sufficiently intense to produce phosphorence of the walls of the tube. But it is now possible to produce these rays in an "absolute" vacuum, and with any given difference of potential.

[P. Lenard, *Ann. der Physick*, No. 6, 1900.]

Current Intensity in Vacuum Tubes.—H. A. Wilson has conducted some investigations into the potential gradient and the conductivity of the gas in a vacuum tube by means of an elegant contrivance which enables him to shift the two probes into any part of the discharge at will. The discharge passes through a Torricellian vacuum, and an open glass tube containing the two electrodes floats on the mercury, whose surface can be raised or lowered by means of an indiarubber tube with thistle funnel. The upper electrode is connected with the outside by means of a spiral of thin brass wire. The probes enter through the side of the barometer tube. They are fixed in one position, and the electrodes are raised and lowered. The author reproduces some interesting diagrams showing the distribution of the potential gradient. Being puzzled by its sudden decrease near the anode, he substituted mercury jets for the platinum probes, but obtained the same result. He therefore attributes the sudden drop of potential at the anode, which often amounts to 35 volts, to the great rate at which the positive ions are shot off there. He also studied the conductivity of the gas at various points by the same probes, and obtained curves which confirm those of Stark (see *The Electrician*, p. 818, where, however, the ordinates represent resistance and not conductivities), except that there is no such sudden drop of resistance near the anode as is found near the cathode. But then, of course, Stark's curve is an imaginary one.

[H. A. Wilson, *Phil. Mag.*, June, 1900.]

Alternate-Current Sparking.—The impossibility of producing an alternate-current arc between metals at ordinary pressures is an important practical safeguard for alternate-current switchboards and installations generally. The causes of this immunity are made clear by the researches of L. Kallir, who photographed the sparks produced by the breaking of the circuit at various phases on a rotating photographic plate. The duration and intensity of each spark depends upon a number of circumstances, such as the shape of the terminals in contact, the facility of evaporation of the material, the speed with which the terminals are separated, and the phase at which the interruption takes place. To arrive at definite data concerning the speed of interruption the author brought about the interruption by immersing a platinum point in mercury, and letting the mercury flow away at a definite rate. Even if the instantaneous speed of interruption could not be actually found in this manner, it could, at all events, be controlled. It was found that, whatever happens, the spark is confined to one semi-period, *i.e.*, there is no alternating spark. In ordinary air the spark never exceeds one semi-period in duration. But in a vacuum, especially with strong currents, the duration of the spark may well exceed an ordinary commercial semi-period. But even then the spark is intermittent, and is confined to the odd or the even semi-periods.

[L. Kallir, *Ann. der Physik*, No. 6, 1900.]

Radium Radiation at Low Temperatures.—O. Behrendsen has examined the influence of the lowest temperatures obtainable upon the activity of "radium." His specimen was not of the most effective kind, such as Giesel's recent preparations. It did not affect the fluorescent screen, but when the bottle containing the powder was placed in front of the eye accustomed to the dark, a dim luminosity was perceivable. About half a gramme of the preparation was placed in a test tube, and an electrode of platinum was mounted just above it. The electrode was charged by a dry pile and then connected with an electrometer. The rate of discharge was measured by counting the number of seconds required by the electrometer spot to pass certain points on the scale. Such measurements were made in the open air, in liquid air, and then again at the ordinary temperature. It was found that the extreme cold produced a retardation of the discharge to over twice its former rate. On restoring the tube to the ordinary temperature the activity was found to be considerably increased. This is exactly what Lumière observed in the case of phosphorescent bodies. The increase is transient, of course. Both the author and Giesel have noticed a considerable decrease in the activity of their polonium preparations of last year.

[O. Behrendsen, *Ann. der Physik*, No. 6, 1900.]

High Thermo-electric Forces.—Ever since Seebeck's discovery of thermo-electricity, or, as he called it, the "magnetic polarisation of metals and ores by difference of temperature," it has been known that many oxides and sulphides possess high thermo-electric powers, some of them far in excess of anything found among the metals. A. Abt has systematically examined a number of these ores, such as pyrites, pyrolicsite, pyrrhotite, and chalcopyrite, between the temperatures of 0deg. and 100deg. Taking the E.M.F. developed by a bismuth-antimony couple between these temperatures as a unit, that of a pyrite chalcopyrite couple is 10·8, and that of a pyrite-galena couple as much as 13·4.

[A. Abt, *Ann. der Physik*, No. 6, 1900.]

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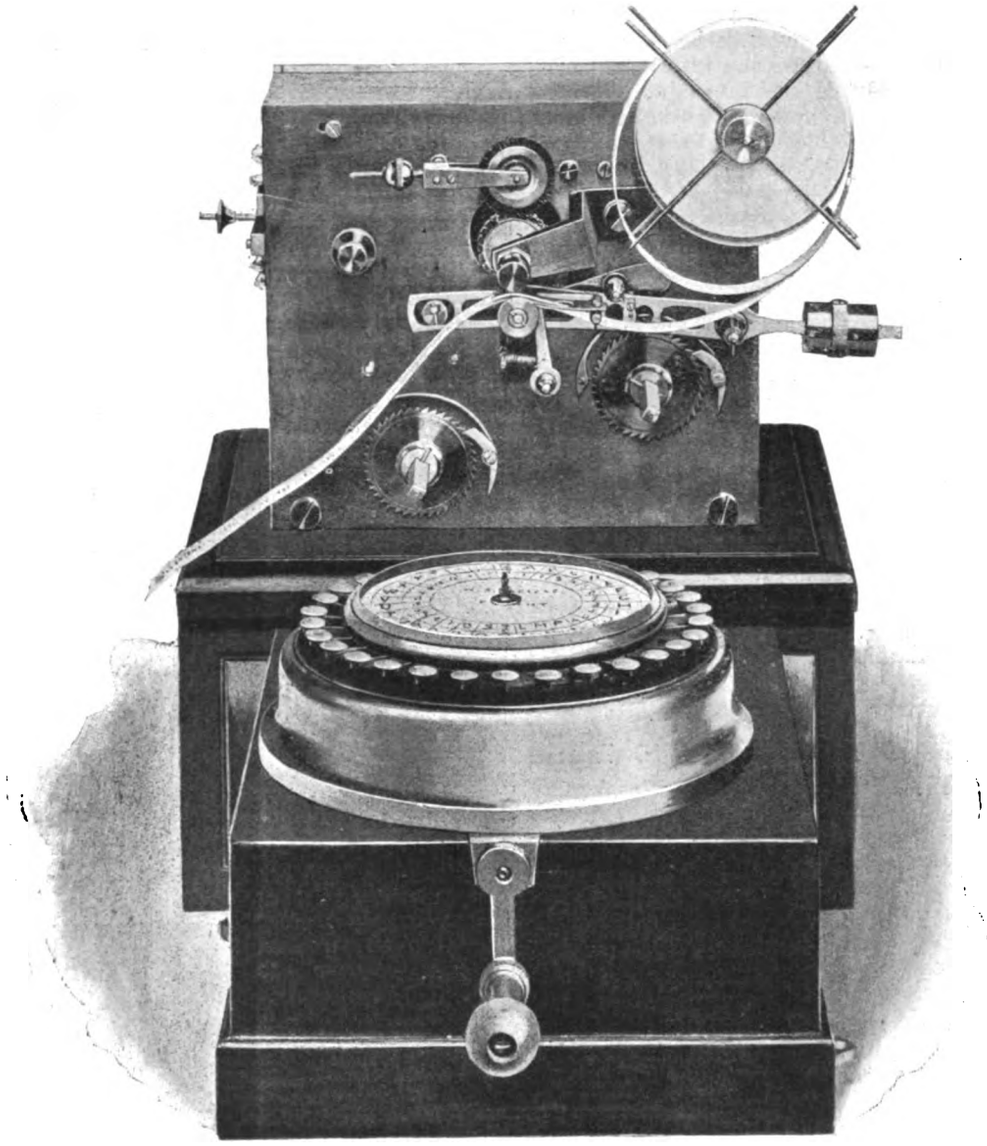
THE STELJES TYPEWRITING TELEGRAPH.

Two factors affect the design of type-printing telegraphs—two factors which appear to a great extent antagonistic, viz., speed and simplicity. On the one hand there is the ingenious Hughes instrument—valuable for public telegraph service—but the speed necessary for this is attained at the expense of complication, which not only makes the instrument costly but necessitates the employment of a skilled operator. From time to time we have described other type-printing telegraphic apparatus of more recent date, designed with a view to simplifying the work of transmitting to that of an ordinary typewriter, and necessitating practically no attention at the receiving end. In the latest addition to this class of instrument (to the description of which the present article is devoted) the mechanism and action are reduced to extreme simplicity compared with that of the Hughes instrument; but the speed of working is slow, viz., that of the Wheatstone A B C instrument, which is estimated by Preece and Sivewright to be 20 words a minute in the hands of very expert manipulators, but in ordinary practice to fall short of 10 words, and in the average not to exceed five words a minute.

The Steljes type-printer is, in fact, a modification of the A B C receiver, by means of which the letters, instead of being merely momentarily recorded by a pointer, are printed on a tape. An ordinary Wheatstone A B C transmitter is employed, of the pattern still in use by the British Post Office in many rural offices. It is only necessary here to refer briefly to the action of this well-known instrument—shown in the lower part of the illustration. On turning the handle in front, the armature of a simple magneto generator is revolved, and slowly alternating currents are sent to line, the pointer on the dial moving round from one letter to the next for each alternation. The key opposite to the desired letter is depressed, and the pointer is stopped on reaching the corresponding position while at the same time the current to line is cut off. In the Wheatstone pointer receiving instrument, the pointer moves in synchronism with the pointer of the transmitter, by means of the alternating currents; in the Steljes instrument a type wheel takes the place of the pointer. The escapement driving the type wheel is moved by a pair of electromagnets similar to those of a magneto bell, the power being obtained by a weight (or if greater portability is required by a spring, as in the illustration). The type wheel is double, the rim of one disc containing 30 letters, and the other numerals, &c.



PORTABLE PATTERN OF STELJES TYPEWRITING TELEGRAPH.

A simple mechanism is employed to move the type wheel against the paper tape at the moment the current stops. In addition to the escapement magnets and armature there is a very light aluminium armature attracted by a non-polarised magnet, which is traversed by the alternating line current. The reversals of the current are sufficiently sharp to keep this armature attracted until the current stops. At this moment, which is, of course, the one at which the type wheel is in the position for printing the desired letter, the

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armature drops and permits a cam at the end of a train of wheels (driven independently of the other escapement train by a weight or spring) to make a complete revolution. The cam, as it turns, lifts the arm holding the roller over which the paper passes, presses it momentarily against the type wheel and releases it again. On the downward movement of this arm, a click fixed in the frame engages in a ratchet, and this turns the printing roller one space forward, leaving the paper ready for the next letter.

For setting all the instruments to zero there is an arm placed friction-tight on one of the wheels in the type-wheel train, which is knocked down each time the printing lever is worked, so that if the type wheels are allowed to go two or more revolutions without printing, all the instruments will be brought to zero.

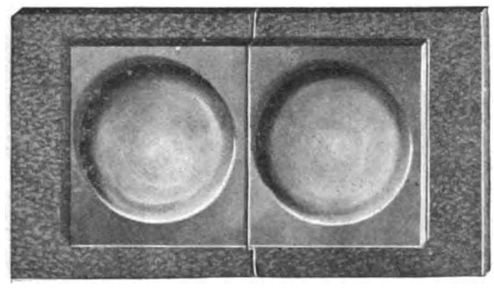
The arrangement for moving the type wheel parallel to its shaft for printing either letters or numerals is as follows: At right angles to the type wheel, and rotating with it, is a blade with a nose, and the type wheel is kept up against this blade by a light spring. When the zero key is depressed the printing lever comes in contact with this blade, and presses upwards, and the type wheel prints on the letter band. If the key opposite the zero key (between the letters N and O) is depressed, however, the blade is pushed up, and moves the type wheel forward parallel to its spindle, so that the numerals, instead of the letters, come in position above the paper.

The instrument has, we understand, undergone a trial of several months at the Post Office (in whose service Mr. Steljes formerly was), and has been used successfully on several underground circuits in different parts of London—the longest being from Hampton to Westminster through three intermediate stations. It has also been tested on a 200lb. copper overhead telephone circuit between London and Manchester, with an additional resistance of 2,000 ohms in series. The Belgian Government has also tried it with good results, we are informed, on some of their lines which are employed for simultaneous telegraphy and telephony. Steljes instruments, although not adopted by the Post Office for general telegraphic service have been put in by them on several private lines. They are also included in the official exhibit of the British Post Office at the Paris Exhibition.

THE INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

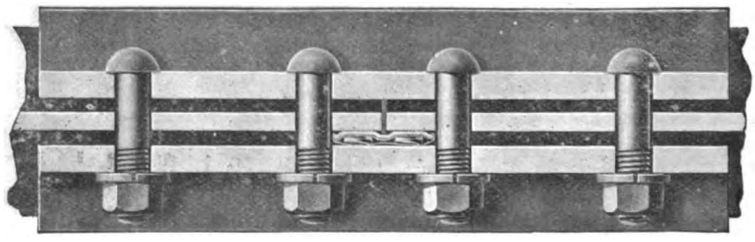
The International Tramways and Light Railways Exhibition was opened on Friday last week with a luncheon. The proceedings were commenced by a speech from the chairman, Mr. Dickinson, chairman of the London County Council, who dealt at considerable length with the economic aspects of the tramways question, more especially the problems of private versus municipal enterprise. As was, perhaps, to be expected, he expressed his adhesion to the principle that such means of transit ought to be owned by the municipalities. Mr. Dickinson maintained that the growth of the huge cities of the present day was due to these means of communication. When pointing out that effective means of locomotion are a *sine quâ non* of modern town life, and that of all modern cities of the first rank London was the most backward as regards the possession of rapid and convenient means of locomotion, the chairman was on less debatable ground. The fact that Mr. Dickinson selected one individual firm of electric tramway undertakers for special commendation by name, gave rise subsequently to a certain amount of adverse criticism on the part of those present. Mr. Dickinson was followed by Alderman Clegg and by Mr. Concanon, who devoted an amusing speech to the glorification of private enterprise and, as a director of the Dublin United Tramways Company, gave expression to legitimate patriotic pride in the success, both technical and commercial, of that undertaking. Mr. Concanon was followed by Alderman Jones, of the Dublin Corporation, who explained the admirable profit-sharing arrangement made between the Dublin Corporation and the tramways company. Then followed Sir W. H. Preece with what appeared to be the most popular speech of the occasion. Sir William explained that being an old hand at entertainments of this description, he had taken the precaution of sending his speech to the Press in advance. He therefore requested the audience to take his speech as read, moved the toast with which his name was coupled, and sat down amid prolonged applause. Several other speakers followed, amongst whom were Prof. Bryce and Prof. Perry, who gave an interesting comparison of the cost per horse-power hour of man, horse, and electricity, and the enormous reduction possible in the latter under a regular load factor.

The exhibition itself manifested plentiful evidence of unreadiness; everywhere stalls are still being fitted up, and exhibits are lying about in more or less confusion. The stalls of certain firms are, however, tolerably complete.



PLASTIC BOND.

Among these may be enumerated Messrs. R. W. Blackwell & Co., the Helios Company, Messrs. Witting Bros., and the Westinghouse Company. Messrs. Blackwell & Co.'s exhibit is indeed most admirable and complete. Practically every class of appliance connected with the electrical equipment and propulsion of tramcars is represented, and a number of interesting novelties are on view. Conspicuous among these are the contributions of the firm towards a solution of the perennial rail-bonding difficulty. Two forms of "plastic rail bond" are shown, the principal agent in both being the Edison-Brown plastic alloy. This composition, which is rather copiously displayed on the stall, is an alloy the exact composition of which is not disclosed. It is just hard enough not to run, but can be easily moulded by the fingers. Two methods of using the composition are employed. In the one two spots on each side of the division between the rails are freed from rust and silvered by rubbing



SECTION THROUGH PLASTIC BOND.

with the Edison-Brown hard alloy. Two corresponding spots on the fish-plate are similarly prepared, and between the prepared spots on rail and fish-plate a lump of the plastic amalgam is introduced and retained in position by a suitably perforated sheet of cork, and the fish-plate screwed up. In this case the fish-plate carries the current. There is also exhibited another form of the plastic bond which does not, however, differ in principle from the above. In this case the current is not carried by the fish-plate, but by a plate of rolled copper, which is provided with two bosses of plastic alloy, which are designed to make contact with the amalgamated spots on the web of the rail. These are mounted on a sheet of cork which exactly fits the web of the rail, and has two springs extending through holes in the cork, by means of

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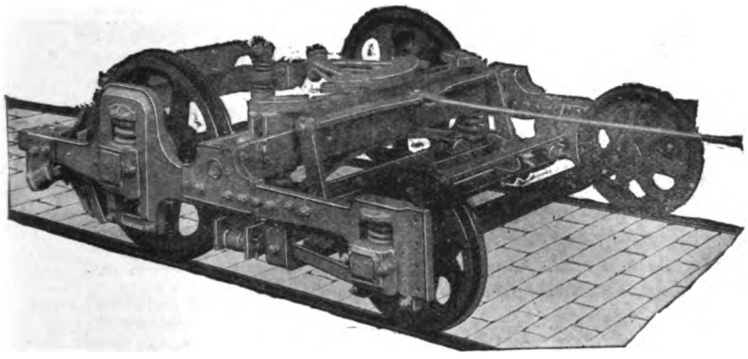
which the fish-plate is enabled to press the copper and amalgam firmly against the rails. The cork keeps out moisture and damp. It is claimed for this bond that its resistance is less than that of the same length of solid rail. An interesting exhibit is the apparatus for testing the bonds. A large welding dynamo is driven by a motor, and the current from it runs through a bonded rail. A Weston voltmeter of enormously magnified scale—its whole scale reads $\frac{3}{100}$ths of a volt—enables the drop in voltage to be measured. By this means the fact that the bond has considerably less resistance than the same length of unbonded rail is demonstrated.

Messrs. Blackwell's so-called "swing-bolster maximum traction truck" is specially designed for lines with sharp curves. These trucks are what may be termed double-bogeyed, *i.e.*, there is a bogey in front and a bogey behind, with the four large driving wheels in the middle. The car is mounted on two "bolsters," which are in reality slides arranged on either side of the driving wheels. The slides allow a certain amount of side movement, and on rounding a curve the car swings over towards the centre of curvature, so putting extra weight on the bogeys and counteracting any tendency to jump the rails.

An ingenious form of what is in reality a relay brake for use on tramcars is exhibited. In a lighter and slightly modified form it would probably prove a very useful addition to motor cars. An ordinary form of brake is applied by a chain wound up on a drum. The drum is rotated by a friction clutch which engages with one of the running wheels, and can be put on very gradually or with great rapidity. The



Maximum Traction Truck.

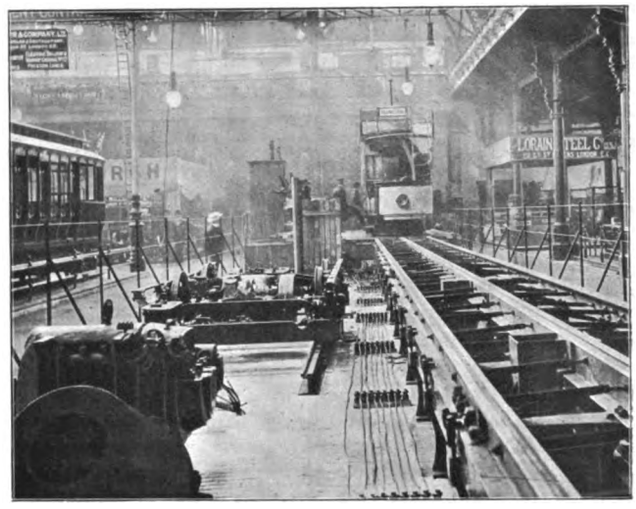
momentum of the car thus supplies the force with which the brake is applied, the action of the friction clutch being therefore that of a relay. As the *vis viva* of the car is being used up to apply the brake at the same time as the brake is stopping the car, the arresting power of the brake is very great. A fully-loaded tram-car can, it is said, be stopped on an emergency from a speed of 10 miles per hour in two yards.

Another system of dealing with the brake problem is provided by the Christensen air brake. It savours perhaps rather too much of the railway train air-brake system. There is a motor—that represents the donkey engine—and it compresses air into a receiver. When the necessary pressure is reached a relay contact cuts off the motor. When the pressure sinks below a certain point the contact mechanism puts in the motor which continues pumping as before till the normal pressure is re-established.

A feature of the Blackwell exhibit is the admirably constructed equable pressure trolley-poles. In the ordinary trolley-pole controlled by springs the upward effort increases as the pole is depressed. In these it is, within working limits, constant. This is effected by a special method of construction. A wire secured to the pole passes over a cam of varying eccentricity to a spring. As the pole is depressed the tension of the spring tending to restore it to its original position increases; the eccentricity of the cam, however, over which the wire passes diminishes, and the product of the two being constant, the force raising the pole remains the same. The pressure of the trolley against the trolley wire therefore remains within wide limits practically constant.

An interesting detail of line construction is supplied by the manganese steel crossings. The crossings have, of course, to carry double the traffic of the rails forming the ordinary track. If of the same material they would consequently wear out long before the rest. The rail ends abutting on the crossing after being planed and fitted are united, not by rivets or by bolts and nuts, but by having run round them and through holes in them a molten mass of metal. This metal in cooling draws together the different pieces of steel making a compact unit of the whole. Into this fits the manganese steel crossing, which is bolted down in position. If in spite of its extra hardness, it finally does get worn down, it may be removed and a fresh one substituted.

The Westinghouse Company exhibit a complete tramway installation in operation. A high-speed three-cylinder 120 H.P. gas engine, with electric ignition, is coupled direct to a multipolar 500-volt generator. This supplies current to a length of tramline on the underground conduit system, running the length of the hall. On this a highly-finished and well-appointed tramcar runs up and down, carrying passengers. The same company exhibit the Newell electromagnetic brake. In this apparatus an electromagnetic clutch is arranged on each side of the car, just clearing the rails. When the brake is applied the motors are disconnected from the line, and then



Westinghouse Tramway Exhibit.

run as dynamos in virtue of the momentum of the car. The current which they thereby supply is utilised to energise the electromagnetic clutch, which then clutches the rails and simultaneously applies the brakes. A feature of the Westinghouse exhibit is the pneumatic car control. A couple of dummy cars are shown in which it is applied. Each of these is provided with a motor equipment and a series parallel controller on the platform. These controllers are operated by compressed-air mechanism, which is in turn controlled by what may be called a pneumatic switchboard. The operation of the mechanism is such that whatever position the controller in one of the cars may be brought into, the other is at once brought into precisely the same position. The system is, in fact, a multiple unit system, and resembles, to a certain extent, the system introduced by Sprague, with this difference, that the controllers, which in Sprague's system are operated electrically, are in this case worked by compressed air.

The Helios Company, of Cologne, so well known on the Continent for their alternating and polyphase installations, have recently started an English branch. They were under some misunderstanding regarding the importance of the present exhibition, and their stand in consequence hardly does them justice. Their principal exhibit is a very good form of maximum current cut-out. The maximum current energises an electromagnet which, attracting an armature, throws out the main switch. The current is thereby shunted through a high-resistance carbon switch, which is subsequently broken, thereby diminishing sparking. This, of course, is not new. The novel feature is that, as long as the short circuit or other

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cause of abnormal current exists, the switch cannot be closed. This is effected as follows: On attempting to close the switch the carbon contacts are first made. This energises the electro-magnet, which attracts its armature, producing a lock of such a kind that the main switch cannot be closed. The Helios Company also show a form of resistance very suited for tramway use. In this, flat wires or ribbons are coiled up with asbestos paper spirally, the whole resembling in appearance coils of magnesium wire as supplied to the trade. Being arranged in vertical planes these resistances have an excellent cooling surface.

Messrs. Witting Bros., representing Electricité et Hydraulique, of Charleroi and Jeumont, show some car constructions and slung motors of an ordinary type. Their principal electrical speciality, however, has no reference to tramway practice. It is an alternating-current motor of special construction, for which it is claimed that it will start with only twice the normal current. The field has an extra winding, which is thrown out of phase with the ordinary winding by being connected through a self-induction coil. The armature resembles a three-phase rotor, with the windings connected through a resistance. When the motor has got up speed the extra winding of the field or stator is cut out, and the armature coils are short circuited. Messrs. Witting also exhibit a rather interesting lightning arrester. The trolley line is connected through a carbon resistance to a vertical iron rod running inside the upper of two serrated carbon blocks, forming the spark-gap—the lower carbon block being earthed. As the line current tends to keep up any arc formed across the spark-gap, a solenoid is connected in series with it. This is, of course, impervious to lightning, but when energised by the line current following the arc, lifts the iron rod and breaks the circuit.

Accumulators are represented by the Electrical Power Storage and Chloride Companies. The latter exhibit a type of cell supplied by them for the Bradford Corporation trams. The Electrical Power Storage Company show types of their batteries with the "K" type of positive. At this stand is also a small 500-volt battery for use on tramways, on what may be called the Dresden system, namely, a system of running from trolley wire outside the town, with accumulators charging at constant voltage and then running through the towns from the cells.

MUNICIPAL ELECTRICAL ASSOCIATION.

(*Continued from page 325.*)

Thursday, June 21st.

The Association met in the same building as on the previous day. The chief event of the morning's proceedings was a debate on electric motors, principally on the relative merits of single-phase, polyphase and continuous-current motors. A Paper was first read by Mr. T. P. Wilmshurst, of Derby, on "Power Supplied by Single-Phase Motors." This was followed by a Paper by Mr. C. A. L. Prussman, of Doncaster, on "Maintenance of Motors on Hire from an Electricity Works." Mr. Wilmshurst's Paper commenced with a general discussion of the advantages of alternate-current working and passed in review the various objections which are raised by opposing sides in regard to alternate currents versus continuous current. In the latter part of the Paper he discussed the results already obtained with alternate-current single-phase motors and described what has been accomplished in this direction at Derby, where there is a single-phase supply at a frequency of 40 ∽. The debate was opened by Mr. Ferranti, who plunged into the fray as the undoubted champion of the single-phase motor, as opposed on the one hand to the continuous-current and on the other hand to the polyphase motor. The single-phase motor was the coming thing and the only drawback to its use at present was the absence of a satisfactory condenser by which to split up the single phase supplied into the two phases requisite for starting the motor. Mr. Ferranti knew of a condenser which had been working satisfactorily for 4½ years and which would shortly be on the market. Mr. Fedden, of Sheffield, was inclined to view the whole subject as a "fairy tale" and could scarcely believe that the advocates of single-phase motors for serious work were not romancing. Mr. Chamen, of Glasgow, congratulated himself and all continuous-current men on being free from the troubles of alternate-current supply. In an interesting speech Mr. Langlon-Davies mentioned several merits and demerits of the single-phase motor. He particularly emphasised the importance of wave form in regard to the satisfactoriness of alternate-current motor working. The most objectionable wave form was the double-peaked wave. Mr. Quin gave some account of alternating-current work at Blackpool, and said that, owing to the number of different types of alternators there, the wave form was not constant for more than a few seconds at a time. Mr. Esson entirely disagreed with Mr. Ferranti with regard to the merits of the single-phase motor. He advised all alternate-current station engineers to have their alternators wound for polyphase working, an operation which simply consisted, he said, in putting additional coils into the empty holes provided in the stampings of the alternator armatures. The cost of this addition would only be 5 per cent. on the cost of the machine. He doubted whether there was a good condenser on the market, and whether anyone could supply such. At the close of this discussion Mr. R. C. Quin, of Blackpool, read a Paper on "Combined Management of Tramways and Lighting Departments." The Paper advocated the combination, under one chief electrical engineer, of all the technical work and management of municipal electric tramways and supply. A number of municipal electrical engineers supported the author of the Paper, and this view was also adopted by not a few chairmen of committees who spoke. Baillie Willock, of Glasgow, gave an interesting account of the circumstances which led to the separation of the tramways and lighting departments at Glasgow. The proceedings terminated with a discussion on a Paper by Mr. H. L. P. Boot, of Tunbridge Wells, on "The Reduction of Light Load Losses in Alternate Supply Works." Owing to the lateness of the hour, however, this Paper was but little discussed. In the afternoon the Association enjoyed the garden party given by the mayor of Huddersfield at Beaumont Park; and in the evening it celebrated its annual dinner at the Town Hall.

Friday, June 22nd.

Before commencing the business of the day the Association travelled to Leeds and assembled at the Albert Hall, where a number of Papers were read. The first discussion was on a couple of Papers on "The Distribution of Electricity in Scattered Areas," by Mr. L. Andrews, of Hastings, and Mr. G. Wilkinson, of Harrogate. It would, however, be useless to attempt to give an abstract of this discussion until our readers have had an opportunity of seeing the Papers, and we therefore refer them to the abstract of the discussion which we shall publish shortly with the Papers. Mr. C. H. Wordingham's Paper on "Maintaining Certain Portions of Electrical Distribution Systems at Earth Potential" gave rise to a short but useful discussion, partly on the earthing of the middle wire of three-wire electricity supply systems and partly on the earthing of the return conductor of tramway systems. The general opinion seemed to be in favour of earthing the middle wire and the return of high-pressure feeders in electricity supply systems. With regard to the return conductor for tramways, the dangers of electrolysis, in the view of most speakers, would be obviated by carefully bonding the neighbouring gas and water pipes to the return conductor. The next Paper was by Mr. A. E. Le Rossignol, of Newcastle-on-Tyne, and gave his impressions of the present American tramway practice. Mr. Le Rossignol has recently visited the United States with a view to studying, principally, the trolley system. He does not appear to be favourably disposed towards the slotted-conduit system, regarding its heavy expense as too serious a drawback. In the discussion several speakers gave accounts of their travels over electric tramways in the United States, and the relative advantages of the trolley and rival systems were briefly referred to. One important point emphasised was the great part played by the trolley system in

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solving the housing problem for the working classes. Rapid transit and low fares enable a considerable proportion of the town population to live several miles from the centre of the town, this tending greatly to increase the healthfulness of town life. The concluding Paper on "The Protection of Telegraph and Telephone Wires," in connection with overhead traction, was read by Mr. R. C. Quin, of Blackpool. Mr. Quin advocated placing telegraph and telephone wires underground, as the best solution of this difficulty; but inasmuch as the Postmaster-General has refused to adopt this view, Mr. Quin has drawn up a number of recommendations with regard to guard wires. These, if carried out, would prevent accidents from the breakage of wires crossing live trolley wires. In a short discussion which ensued, it was suggested by one speaker that the guard wires should be provided with a switch so that they might be disconnected from earth when men were engaged in repairing the line. Mr. Quin, however, pointed out that this switch was superfluous, as, though it might protect the men from injury due to contact with guard wires, it would not protect them from injury through touching the brackets and poles. These brackets, of course, could not be switched off from earth. In the afternoon the Association visited the various electricity works in Leeds, including the tramway power station, trolley lines and municipal electricity works.

Saturday, June 23rd.

The business meeting of the Association was held at the Technical College, Huddersfield. The report of the Council showed that good progress had been made by the Association during the past year, and many subjects of interest to electrical engineers had been brought before the Council for their consideration. It was resolved that the Convention of 1901 be held in Glasgow, and the following is a list of the Council for next year:—

President.
W. A. CHAMEN, Glasgow.

Vice-Presidents.
F. A. Newington, Edinburgh; H. Dickinson, Leeds.

Past Presidents.
C. H. Wordingham, Manchester; H. Faraday Proctor, Bristol; A. B. Mountain, Huddersfield.

Council.

L. Andrews, Hastings.	Bailie Maclay, Glasgow.
A. S. Barnard, Hull.	R. C. Quin, Blackpool.
Ald. F. Calvert, Huddersfield.	J. F. C. Snell, Sunderland.
J. E. Edgcome, Kingston-on-Thames.	Councillor J. P. Smith, Barrow.
A. Ellis, Bolton.	T. P. Wilmshurst, Derby.

Hon. Solicitor.—Ald. G. Pearson, Bristol.

Hon. Treasurer.—J. H. Rider, Corporation Electricity Works, Plymouth.

Hon. Sec.—E. T. Ruthven Murray, 21, Acton-lane, Harlesden, N.W.

The following gentlemen were appointed to control the benevolent fund:—

C. H. Wordingham, Manchester.	H. Faraday Proctor, Bristol.
S. E. Fedden, Sheffield.	C. D. Taite, Southport.

The president announced that this fund now amounted to a sum approaching £50, and he solicited further subscriptions. Hearty votes of thanks were accorded to the Huddersfield Corporation, Bradford Corporation, the Lord Mayor of Leeds and Leeds Corporation, the president and members of the Technical College, Huddersfield, and the president and members of the Borough Club and Huddersfield Club for their kindness and hospitality during the convention. Bailie J. Willock proposed and Mr. W. A. Chamen seconded a hearty vote of thanks to the president (Mr. A. B. Mountain) for the way in which he had presided over the meetings, and for the work he had done for the Association during the past year.

After the business meeting a number of members and friends visited the Harrogate electricity works upon the invitation of Messrs. J. & H. McLaren, of Leeds. The members were taken from the railway station to the electricity works in conveyances, and after the inspection had been made they returned to the Crown Hotel, where Messrs. McLaren had provided light refreshments. After the usual toasts and votes of thanks to Messrs. McLaren and the Harrogate Corporation, the Montpelier Garden and Baths were visited, which concluded a very instructive and enjoyable convention.

MEANS FOR STIMULATING THE DEMAND FOR ELECTRICAL ENERGY.

The following is an abstract of the discussion on the two Papers on this subject read at the convention of the Municipal Electrical Association at Huddersfield, last week, by Ald. W. Potter, of Taunton, and Mr. H. C. Bishop, of Wigan. These Papers were reprinted in our issue last week, page 830:—

Mr. H. FARADAY PROCTOR (Bristol) felt that "How to Stimulate the Rapid Extension of Buildings and Plant" would have been a more suitable subject for Bristol. Many suggestions have been made for making the electric light more popular, and he had been surprised that more attention had not been paid to stimulating the demand. He believed that the 3½-watt lamp was commonly used, but it was far from being the most economical. Where 5d. was charged, the 2-watt lamp would be nearer the mark. In the case of very small installations he thought one of the means for reducing the cost of connecting these should be to supply from a house-to-house system, by cutting the main in one place for three or four houses, and running an insulated wire inside the houses. He thought it was a mistake to lay down the mains in those streets only where the best shops were, as the best class of consumer was to be found in the poorer districts, where the hours of lighting were usually longer. He thought the so-called "free-wiring" was on a wrong basis from the point of view of the suppliers of electricity, since the long-hour consumer was the man who was least encouraged; the most fair principle seemed to be a simple hire with option to purchase. If a man was tenant on a short lease he did not want to buy out the installation at any time. With regard to public street lighting he thought it was better to charge a fixed sum for the current used, and in addition to this a certain sum for attendance. He considered the use of a battery for the 1½-hour consumer was a good scheme, but he thought 6 per cent. was too low for the permanent maintenance of a battery. Further, in working out Mr. Bishop's figures, he found that the motor generator would have to run "30" hours per day to charge the battery; this meant, of course, that the battery allowed for was not large enough.

Mr. T. P. WILMSHURST (Derby) said they all agreed with Mr. Potter that low cost was an important factor in stimulating the demand. The question of the cost of the installation was one which introduced a good deal of contentious matter. Although undoubtedly it is necessary to assist a certain class of consumer, the discussion would principally arise upon how that should be done. He did not agree with the system of the Free Wiring Company, which adds a certain amount to the bill of the consumer for current; and he still less agreed with the system which Ald. Potter said they had in use at Taunton. He considered it was better to have a uniform price and charge all alike. The two systems mentioned were antagonistic in principle to the demand indicator. As an illustration, in a town where the initial price is high, say 7d. or 8d. per unit, and the secondary price is low, under Mr. Potter's system a long-hour consumer who might get his current at an average of 3d. or 3½d. per unit would have to pay 7d. It may certainly work well in Taunton where the price is 6d. and 3½d., but even then he would not be surprised in the case of long-hour consumers if they did not pay more than 1d. extra. It was good policy to lay mains in likely districts. He was surprised that Ald. Potter had not mentioned the question of street lighting because this went hand and glove with the question of extending the mains. Wherever mains were laid they should, if possible, extend the street lighting. The advantages of this were two-fold; it was an outward sign that the electricity mains passed the door. Further, the Electric Lighting committee would then be assured of one good consumer, and it made it worth while to extend the mains into the district. In Derby they had permission from the Highways committee wherever they laid mains to convert the gas lamps to electric lamps under the sole condition that the cost for lighting should not exceed that previously paid for gas. He was very strongly in favour of hiring out motors. In Derby they were doing this, and in a very short time they had succeeded in getting on to the mains about 250 H.P. in motors.

Mr. F. A. NEWINGTON (Edinburgh) said that in Edinburgh they did not require the demand to be stimulated as they were connecting up lamps quicker than they conveniently could. He was strongly in favour of hiring out motors and in Edinburgh they were just considering this subject. There was one matter which he thought would be very useful, if it could be obtained, and that was a two-rate meter, so that they might charge a low rate during the daytime and a higher rate at night.

Mr. G. H. NISBETT (Prescot) thought corporations should be more ready to adopt the methods which have been adopted at Taunton as the results obtained there spoke well for the system of free wiring. He pleaded guilty to having circulated the words "Free Wiring," which were undoubtedly misleading; perhaps it would be better to call it "Free-of-initial-expense-Wiring," then the customers would understand it better. The advantage of the so-called system of free wiring lay in the fact that the tenant really pays a rent for it, and no tenant who was paying rent for a house desired to instal the wiring at his own cost when it would become the property of the landlord.

Ald. RICHARDS (Bedford) said he thought they should not charge an extra price for street lighting, but should give the ratepayers an advantage in this respect and charge a low figure, as this was the only electric lighting which some of them were permitted to enjoy. At Bedford they had reduced their price from 6d. to 5d. per unit, which had been the means of stimulating the demand very considerably.

Ald. BRUCE (Sunderland) thought that if the wiring had to be done by any other than private enterprise it should be done by the Corpo-

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ration themselves. He considered the best way for free wiring was not to charge so much per unit for the hire, but to charge a certain percentage upon the capital outlay on the wiring. He said they would have to deal with customers in two different ways: They would have to give them an opportunity to use the maximum demand system, and also encourage them in some way to put the lamps into all the rooms of a house.

Councillor BRIANT (Brighton) spoke of the advantages of the maximum demand system for encouraging consumers to use their lights a long number of hours. At Brighton they were charging an initial price of 7d. per unit and 1d. afterwards to encourage a long hour demand. He thought they should charge the same for street lighting as for private lighting upon this system which they did at Brighton, and as a result they were able to give three times the amount of light for the same expenditure. It would be interesting to know where and to what extent electrical energy had been adopted for heating purposes.

Mr. J. E. EDGCOME (Kingston-on-Thames) said that at Kingston-on-Thames they had promoted a bill in Parliament for powers to borrow £10,000 to carry out wiring work, and this had been passed without any trouble. When they obtained these powers it rested with the Committee to decide in what way they should use them. Should they hand the work over to the Free Wiring Company, or should the Corporation do the work themselves? It was very difficult in a small town like Kingston to keep the necessary staff continually going on this work, so they had decided to ask for information from other towns as to what they had done in this respect. From the replies he had received he was struck with the large number of towns which were doing nothing at all.

Mr. W. A. CHAMEN (Glasgow) asked the question whether it was necessary for corporations to do this work at all—*i.e.*, wiring work. He thought it would be much better if done by a company from whom the consumer could hire the wiring, motors, &c., just as one hired a bicycle, piano, &c. Nothing had been done, however, in this respect at Glasgow, as the demand had grown more rapidly than they had been able to meet. He thought, however, in small towns some system of free wiring was necessary. With reference to the method of charging for electrical energy, Mr. Newington had mentioned a two-rate meter, which seemed to be the nearest perfection because the maximum demand indicator does not give the time when the maximum demand occurs. He asked if the matter, however, could not be simplified by charging an all-round price to domestic consumers, and by this class he meant all those premises in which persons slept at night. For motive power purposes the charge in Glasgow was 1½d. per unit to those using the supply 5 hours per day.

Ald. POTTER, in reply, said that he agreed that the introduction of the Free Wiring Company into a town stimulated the demand, as the company canvassed the district thoroughly and made the installation work grow. With reference to street lighting, the policy adopted at Taunton was wherever they laid the electric supply mains to turn out the gas lights and put on incandescent electric lamps, using as far as possible the old lamp posts. He did not advocate a high rate of charge for street lighting, and his contention also was that they should not charge the ratepayers less for the street lighting than it actually cost. They had introduced slot meters at Taunton, and he was assured by their engineer that they were a great success. For heating purposes they had about 15 radiators on the mains and these also gave great satisfaction.

Mr. H. C. BISHOP, in reply, said that as the time was limited he would make his reply in the *Proceedings* of the Association.

ELECTRIC ROAD LOCOMOTION.*

Introductory.—There can be no doubt that with the rapid means for communication of ideas by telegraph and telephone, and of passengers and goods by means of the railway, the general want is felt of a more speedy means of transport by road. The great improvements which are needed in our road traffic have been set forth by Major R. E. B. Crompton, R.E., at present in South Africa, and one of our old members, in a Paper read by him before the Automobile Club, in which he clearly shows the vast and beneficial changes that the general introduction of the motor vehicle would effect in the relief and expedition of traffic in our cities, and especially in the metropolis.

Nor must the hygienic considerations be overlooked. This subject has been ably dealt with by Mr. Shrapnell Smith, Honorary Secretary of the Liverpool Self-Propelled Traffic Association (to whom the author is indebted for valuable assistance in many points dealt with in this Paper, and particularly in connection with the final section). In his Paper, read before the Congress of the Sanitary Institute at Birmingham in 1898, he points out that with motor vehicles, not only will our streets be less offensive, especially in summer weather, but exposed food stuffs will less frequently afford a *nidus* for organisms conveyed by disseminated particles from the roads; further, that the disintegrating effect of the horses' hoofs, which accounts for most of the dust of summer and the pasty slime of winter, will be to a great extent obviated. The sanitary advantages of the motor vehicle have also been recognised and strongly urged by many medical officers of health and surveyors to municipal and urban councils. This shows, then, what forces are at work urging us, both for light and heavy traffic, in the direction of utilising more efficiently and with mechanical power the 100,000 miles of road which we possess in this country.

* Extract from a Paper on "Road Locomotion." Read by Prof. H. S. Hele-Shaw, F.R.S., before the Institution of Mechanical Engineers.

Electricity.—The whole problem of the use of electricity in motor vehicles is determined by the life and capacity of the battery, and the merits of any accumulator should really be judged to a great extent by the condition of its batteries after six months' daily use in a motor vehicle. The fact is that the sudden heavy discharges, so often taking place with a motor vehicle, expand the grids and release paste, which is washed out by the movement of the surrounding acid, and these detached particles cause internal short-circuiting by remaining in suspension between the plates. If a cell is short of "acid room," excessive heating expands the grids to such an extent that they never contract sufficiently to make good their connection with the remaining paste. Moreover, splashes of acid are the cause of much more loss than is usually suspected. Again, the practice of grouping cells in parallel is open to the serious objection that if a cell on one side becomes dead or is reversed, those on the other expend energy in re-establishing equilibrium. English, French, and American tests prove that after six months' running, even under the most careful supervision, practically all secondary cells must have the positive plates re-pasted or renewed at a cost not below one-fifth of the original outlay, while in many cases as commonly used they are practically worthless at the end of this period or even sooner. So long as a range of 40 miles per charge, at speeds not exceeding 10 miles per hour, meets the requirements of an automobilist, electricity, at a cost of not more than 2d. per B.T.U., is at least on a par with steam or oil even for heavy traffic. Where these limits are exceeded, electricity is inadmissible. Distances greater than 40 miles, and speeds greater than 10 miles an hour, involve prohibitive dead-weight and excessive discharge rates.

It is a pity that no electrical motor vehicles for heavy traffic have yet been brought to the practical stage, as this is to be regretted for several reasons. The ease with which each of the four wheels of a lorry can be driven is of particular importance in respect of available propulsive effort, whilst the motors and batteries can readily be disposed so as to leave the entire platform free for merchandise. The weight of accumulators is not included in the legal tare of three tons, and the slower rates of speed demanded in this class of traffic should permit of a low ratio of battery weight to total moving weight. Experience has shown that, with a total moving weight of one ton, one-third each being batteries, vehicle and load, the effective distance is about 43 miles at a speed of 8 miles per hour, and only about 24 miles at a speed of 15 miles per hour on average roads.

It must be borne in mind that the cells deteriorate sadly when used for high speeds; nevertheless, results have been attained on a motor vehicle by electricity which surpass anything by any other kind of motive power. An account of these results has been given by the Marquis de Chasseloup-Laubat in the *North American Review* for September, 1899, which it is interesting to quote. "On Jan. 27, 1899, Jenatzy, mounting a carriage not specially constructed for great speed, left the starting point (a straight, level road near Paris), and covered 2 kilometres (1¼ miles) in 1min. 41⅕sec.; the first kilometre (⅝ths mile) with a standing start in 57sec.—that is, at the rate of 63·166 kilometres an hour (39·2 miles), and the second kilometre with a running start in 44⅘sec., that is, at the rate of 80·357 kilometres (50 miles) an hour. On March 4, 1899, Count de Chasseloup-Laubat, on a Jantard carriage, not specially built for this style of test, but with certain most important modifications, such as running the front and rear of the carriage into sharp points, so as to offer least resistance to air, covered the same course of 2 kilometres (1¼ miles) in 1min. 27⅗sec., the first kilometre with a standing start in 48⅗sec., or at the rate of 75 kilometres (46⅝ miles) an hour, and the second kilometre with a running start in 38⅘sec., or at the rate of 92·783 kilometres (57⅝ miles) an hour. Finally, on April 29, 1899, Jenatzy, riding a carriage specially built to break all records, and which has the shape of a large cigar mounted on four small wheels, made the 2 kilometres (1¼ miles) in 1min. 21⅕sec., the first kilometre with a standing start in 47⅘sec., and the second kilometre with a running start in 34sec., or 105·852 kilometres (65⅘ miles) an hour. The extraordinary nature of these results lies not so much in the fact of a high speed of 65 miles an hour by a motor vehicle, but in the fact that starting from rest the average speed for the first kilometre was 46¼ miles an hour. It is safe to say that no locomotive has ever achieved this result, that is, a distance of a mile covered from rest in less than 80sec., and those who witnessed the trials say that the start of the electrical carriages under these conditions left the same kind of impression on the observers as the start of a rocket. There is little doubt that these results could be beaten if the consequent expense were to be faced, but, according to report, the batteries were themselves practically destroyed in the run, and at any rate the contesting vehicles were not only towed out to the scene of the trial, but towed home again afterwards, and the trial, though interesting as showing the possibilities and use of electricity, must not at all be taken as giving results which could be of use for practical purposes."

Gearing or Transmission.—The ordinary modes of transmitting power, viz., by friction gearing, toothed-wheels, belts and chains, have been specially adapted and employed for transmitting the power

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from the motor to the driving wheels of a motor vehicle. The requirements for this particular purpose are in many respects of a special character, and the author had collected material for a special section of the Paper devoted to this subject. It has become evident, however, that it would be impossible to treat the question in a satisfactory manner within the limits of this Paper, and the subject well deserves a special Paper before the Institution. Take for instance the transmission of power by chain-gearing. This mode of transmission, from being in a very crude state a few years ago, has received so much attention that chain-gearing is as efficient, if not more so, than any other mode of transmitting power; whereas the wearing of the links of the chain, which as it occurs gives so much trouble and annoyance, has been met by the special provision of large bearing surfaces which are hardened, so that the mechanism of the chain-gear may be said now to compare favourably with the other working parts of the engine, such as cross-head pins and main bearings. The efficient lubrication of the chain is a matter of the greatest importance and difficulty. The grease chiefly requires to be *inside* the joints, and Major R. E. Crompton showed the author a most ingenious way of effecting this which he has most successfully employed with bicycle chains. He places the chain in a bath of melted grease, in which graphite is mixed. The air being expelled from the joints of the chain by the heat, the mixture naturally finds it way between the pins and rollers, and forms a complete internal solid lubricant, when the whole is allowed to cool together.

The Renold chain, which is largely used in heavy motor traffic, is a beautiful invention which meets in a most ingenious manner the change of alteration of pitch due to wear, and the latest improvements in this chain are also designed to obviate as far as possible the wear upon the pin itself, and reduce it to a minimum.

Again, one special feature of the oil engine is the necessity for change of speed gearing of some form or other, and this has led to a large number of arrangements of speed gearing which of themselves are worthy of detailed consideration. Besides the arrangements for changing the speed ratio by means of combination of toothed wheels are inventions such as the expanding and contracting pulley of Mr. Lucas, the arrangement for altering the throw of an eccentric through which the power is transmitted, such as in the invention of Mr. Newton, and last, but not least, the most ingenious hydraulic variable speed gear of Mr. Hall. These inventions are all in actual operation with apparent success, but unless actually examined they could not really be understood, except by means of drawings with detailed descriptions. It is obvious therefore that this part of the subject must be left for future treatment.

PHYSICAL SOCIETY.

At an ordinary meeting held on June 22, 1900, Mr. T. H. Blakesley, vice-president, in the chair, a Paper entitled

"Notes on Gas Thermometry,"

by Dr. P. CHAPPUIS, was read by Dr. Harker. The author, having been led to recognise that hydrogen could not be used as a thermometric substance at high temperatures on account of its action on the walls of the glass reservoirs, has had recourse to a constant volume nitrogen thermometer, with an initial pressure slightly under 800mm. The value of the coefficient of expansion of nitrogen at constant volume is variable, diminishing up to 80°C. and then increasing slightly. In fact, nitrogen at 100°C. behaves like hydrogen at the ordinary temperatures, its compressibility being less than that required by Boyle's law. A table of corrections was therefore prepared. The readings of the constant-volume nitrogen thermometer are too low, but the corrections are small, amounting to about 0·04°C. at the temperature of boiling sulphur. The mean result of the author's experiments for the boiling point of sulphur is 445·2deg. under a pressure of 760mm. The Callendar and Griffiths' result obtained with a constant-pressure air thermometer is 444·53deg. The difference is attributed to the joint action of several causes: (1) The corrections for a constant-pressure thermometer are about double those of a constant-volume instrument. This correction applied to Callendar and Griffiths' result would raise it about 0·1deg. (2) Callendar and Griffiths have used a value for the gas constant which is larger than that obtained by more recent experiments. Adopting the latter value, the boiling point would be raised to 445deg. (3) The divergence may be due to the expansion of the reservoir. The most accurate way of determining this is by the interference method of Fizeau. This method is used with small pieces of the material, and the author has employed it to determine the coefficient of expansion between 0deg. and 100deg. Extrapolation to 450deg. might cause errors. The linear expansion has recently been determined by Bedford between 0deg. and 840deg. by a comparator method. The homogeneity of porcelain is doubtful, especially when glazed, and the great differences occurring between the expansions obtained from the above methods is attributed to the change in form of the tube in Bedford's experiments, brought about by unequal thickness and want of homogeneity and consequent unequal expansion. The author therefore adheres to his value of the boiling point obtained from the expansion by the Fizeau method, whilst recognising the uncertainty attaching to the application of the coefficient of expansion of the reservoir over an interval four times as great as that over which it was determined.

A Paper on

"A Comparison of Impure Platinum Thermometers,"

by Mr. H. M. TORY, was read by Prof. Callendar. The object of this Paper is to investigate the probable order of accuracy attainable in the determination of high temperatures by the use of ordinary commercial specimens of platinum wire. Five wires were compared—from 400°C. to 1,000°C. The fundamental coefficients of the wires varied within 40 per cent. of the maximum value, but the temperatures observed by them when calculated on the platinum scale by means of the ordinary simple formula, did not differ by more than 9deg. at 1,000°C. Each wire was directly compared with a pure standard wire, the two being wound side by side in the same tube. Curves have been drawn with the platinum temperatures of the standard wire as abscissæ, and the differences between the temperatures indicated by the two wires compared as ordinates. These curves are all straight lines within the limits of observation, and hence the determination of two constants is sufficient to enable us to compare an impure platinum thermometer with the standard, and therefore with the scale of the gas thermometer. The two constants can at once be obtained from observations at the boiling point of sulphur and the freezing point of silver, and thus a practical thermometric scale can be established, which between 0deg. and 1,000deg. never differs by more than two or three degrees from the gas scale.

Prof. H. L. CALLENDAR said he was unable to agree with the correction to his observations suggested by M. P. Chappuis. He considered that the uncertainty in the coefficient of expansion of the gas was due to uncertain changes in the volume of the bulb, and to uncertainty in the coefficient of expansion of mercury. The fundamental coefficient of mercury was 0·00018153 according to Regnault, 0·00018216 according to the later reduction of Broch, and 0·00018256 according to experiments by Chappuis with a hard glass bulb. It made a difference of no less than 4 per cent. in the fundamental coefficient of expansion of the glass, according as the original results of Regnault, or the value found by Chappuis, assuming the linear expansion of the glass, were adopted. The importance of the changes in the volume of the bulb had been fully pointed out, and a method of taking approximate account of these changes had been explained in the Paper on the boiling point of sulphur in 1890. Unfortunately, the glass employed was rather soft, and the changes of volume which occurred were too great to permit of the most accurate determination of the coefficient. The boiling point when corrected for the smaller expansion of the bulb, came out lower than 444·53deg. With regard to porcelain, Prof. Callendar did not consider it a good material on account of the glaze. He did not think that the average coefficient of a tube or bulb over a large range of temperature could be inferred from a small and possibly a symmetric specimen. The results might be less inconsistent in the case of homogeneous and well-annealed metallic bulbs. The correction for the expansion of the bulb was, he believed, given by the expression $dt=(c+b\theta)\,t\,(t-100)$. He did not agree with M. P. Chappuis that the correction was independent of c, although the value of b was certainly most important at high temperatures. He also wished to take exception to the method adopted by Chappuis of calculating the correction of the nitrogen thermometer. According to Joule and Thomson, the correction should be greater, and according to other authorities it might be less. He hoped to discuss this in a future communication to the Society.

Mr. R. T. GLAZEBROOK said that, although he placed confidence in Chappius' formula for a definite piece of porcelain between certain temperatures, he thought further and careful work was necessary before fixing on a formula for ordinary use.

Prof. CARHART said he would like to see a comparison made between the results of experiments with gas thermometers and those with platinum and platinum-rhodium couples.

Mr. ROSE-INNES expressed his interest in the behaviour of nitrogen, at about 100°C, as mentioned in M. Chappuis' Paper.

Dr. LEHFELDT said the peculiarities of the nitrogen scale between 70deg. and 80deg. might be explained by the reversal of the properties of nitrogen between 0deg. and 100deg.

A Paper on

"The Law of Cailletet and Mathias and the Critical Density."

was read by Prof. S. YOUNG. The law of Cailletet and Mathias is very nearly, though in most cases not absolutely, true. It appears to be only strictly true when the ratio of the actual to the theoretical density at the critical point has the normal value 3·77. The curvature of the "diameter" is generally smaller the nearer the ratio approaches its normal value. The curvature is in nearly every case in opposite directions according as this ratio is greater or less than 3·77. The curvature is generally so slight that the critical density may be calculated from the mean densities of liquid and saturated vapour at temperatures from about the boiling point to within a few degrees of the critical point with an error generally not exceeding 0·1 per cent. If, however, the critical density is calculated from the mean densities at low temperatures the error may be considerable; in the case of normal decane it is between 5 per cent. and 6 per cent.

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The law does not, as a rule, hold good at all for substances the molecules of which differ in complexity in the gaseous and liquid states.

Mr. ROSE-INNES said that in his Paper the author had used the generalisations of Van der Waals, although the author himself had shown that they were not strictly true.

Prof. S. YOUNG said that the generalisations held in some cases, although they did not in others. In all cases they were approximately true, and it was therefore advisable to use them and study the results as far as possible.

The Society then adjourned until next October.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Kahle. 1899, No. 3. (Berlin: Julius Springer.)

"Municipal Affairs." No. 1, Vol. IV. Issued Quarterly. (London: P. S. King and Son.) 2s. 6d.

"Aberration and Some Other Problems connected with the Electromagnetic Field." An Adams prize essay, by G. T. Walker. (Cambridge: University Press.) 5s. net.

"Science Abstracts." June, 1900. Edited by W. R. Cooper. (London: E. & F. N. Spon.) 2s.

"The Official Gazette of the United States Patent Office." No. 11, Vol. XCI. Published by authority of Congress. (Washington: Government Printing Office.)

BATTERY MOTOR CARS.

In No. 9 of the *Centralblatt für Accumulatoren und Elementenkunde* Herr P. Weber discusses some of the questions which have arisen in connection with the arrangement and use of accumulators for traction purposes, with the view of obtaining a more uniform practice in these respects, such as has already been obtained in regard to the voltage (110 volts) to be employed. Much has been written and said concerning the best number of cells to employ, but this is a matter of little importance, since it depends on the make of cell used, and has nothing to do with the arrangement and coupling up of the battery, which Herr Weber considers a point whose importance has been under estimated. It is often stated that the disadvantages of working with a battery divided into two halves which can be coupled in parallel outweigh the advantages of the arrangement, and that a pure series method of connection is to be preferred. But in the latter case a loss of energy results from the resistance which has to be inserted to reduce the voltage of the battery, which, on the other hand, can be instantly reduced by one-half by connecting the two portions of the battery in parallel. It is not advisable, however, to subdivide the battery further. The chief point which has to be considered in determining the arrangement of a battery is whether it will have to drive one or two motors. In the latter case two speeds are given by connecting the motors in series or in parallel. The number of speeds which the battery should furnish is another matter concerning which there is much diversity of opinion, and in which a free discussion of the subject might lead to greater uniformity of practice. In general, it is sufficient if the regulating switch gives four to five speeds, has two brake positions, and will reverse the car. There are some regulators so constructed that the reversal of the movement of the car can only be effected by a special switch, but such an arrangement is scarcely practical. The best form of regulator is one in which the reversal position follows the brake position, so that the car is slowed down before its motion is reversed. In deciding on the size of the battery it must always be remembered that cells never give as good results when employed in traction work as they do when tested in the laboratory. The author tested some motor-car cells for the Berlin Accumulatoren und Elektricitätsgesellschaft on a specially-constructed shaking apparatus, so as to reproduce practical working conditions, and found that the cells when thus shaken had a smaller capacity than they had when at rest, although it might have been thought that the reverse would have been the case, on account of the better circulation of the acid. The jarrings, however, to which the cells were subjected were more violent than those which would be experienced even on a bad road, as it was desired to test the solidity of the construction of the cells. The cause of the extraordinary diminution in capacity which cells often exhibit when employed on traction work, as compared to their behaviour in the laboratory, is principally due to the temporary severe strains to which they are subjected, and often amount to from one and a-half to two and a-half times the normal working load. The reserve of capacity which must be provided will be determined from a consideration of the working conditions on the road which the car will usually have to travel. In general, an excess of capacity of about 40 per cent. will not be too much to allow in the battery, and firms that build electric cars must take this factor into consideration, in addition to considering the weight, dimension and price, if these cars are be depended on.

ELECTRICITY WORKS ACCOUNTS.

Hammersmith Vestry Electric Supply Works.

The year of working to March 25th last was the second completed by the Hammersmith Vestry electric supply undertaking. The accounts show excellent results and progress.

During the year the lamp connections increased from the equivalent of 21,825 8 c.p. lamps to 30,131, or 38 per cent. Still better is the improvement in the output of from 517,629 units sold to 891,301, or over 72 per cent. Not only this, but the character of the load was much more favourable to low costs, in that while the load factor of 1898-9 was 11·8 per cent.—even thus above the average—this factor rose last year to 14·5 per cent.

Turning to the revenue and expenditure figures, a general and material reduction in the costs has enabled the working profit to be well maintained notwithstanding the reduction in the average total revenue per unit of from 4·28d. to 3·68d., or 14 per cent. The costs column shows figures which may fairly be said to be uniformly representative of good practice under similar conditions of output and load factor. Allowance has, of course, to be made for the high prices which have been the rule rather than the exception in the coal trade during the last year, and the figure of 0·787d. per unit for fuel may therefore be passed as quite satisfactory in the circumstances.

It will be seen that the plant capacity at the station has been increased to 1,300 kw., and that the capital expenditure for the year was £32,078. From the report of the Chairman of the Lighting committee, it appears that a large proportion of this expenditure was only lately made, and that the average capital during the year was probably about £30,000, to which the year's working profit represents about 73·7 per cent.

Richmond (Surrey) Electric Light & Power Co.

Although the accounts of the working of this undertaking during 1899 show that the costs have slightly increased, the results are most commendable in view of the output of only 191,084 units sold, and a load factor of 8·9 per cent.

The increased expenditure is limited to the two items of fuel and distribution wages. It is satisfactory to find that in spite of increases in the rents, rates and taxes, the management and property charges have been reduced, since this collective item stood somewhat high in 1898. Probably the rents, rates and taxes will always continue to militate against any very favourable figures being obtained in this department.

The lamp connections and the output continue to make but slow advances. Last year the former showed an increase of only 13·7 per cent., and the latter little more than 15 per cent. This slow progress was inevitable while the tariff stood as it did, and exacted an aggregate revenue of nearly 7·17d. per unit sold. However, we are glad to learn that a substantial reduction, not only in the charge for current, but also in the meter rentals, was decided upon to take effect after March 31 last. With the favourable costs which have lately been attained at Richmond, such an alteration in the tariff cannot fail to be of benefit by increasing the business done.

In the following table are repeated the more interesting figures of the last five years:—

Year.	No. of consumers.	Lamp connections.	Units sold.	Plant capacity.	Max. supply demanded. Kw.	Total revenue per unit.	Total costs per unit.
1895	116	5,486	80,456	290	107	7·25d.*	7·08d.
1896	143	7,125	97,044	290	135	7·89d.	5·02d.
1897	167	9,512	138,916	290	185	7·72d.	3·86d.
1898	215	12,538	166,087	290	213	7·37d.	3·22d.
1899	...	14,256	191,084	590	244	7·17d.	3·27d.

* Exclusive of rents.

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	HAMMERSMITH.		RICHMOND (SURREY).	
Undertaking Worked by	Hammersmith Vestry.		Richmond (Surrey) Elec. Light and Power Co.	
Date of Commencement of Supply	June 21, 1897.		October, 1893.	
System of Supply	2-w. from alt.-current transformer sub-stations.		Continuous-current 3-wire battery system.	
Chief Engineer	G. G. Bell.		Malcolm C. Flemyng.	
YEAR ENDED	MAR. 25, **1899.**	MAR. 25, **1900.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	723,354	1,247,730	185,461	206,205
„ SOLD (TOTAL)	517,629	891,301	166,087	191,084
„ sold to consumers	372,191	620,078	166,087	191,084
„ sold for public lighting, &c.	145,433	271,223	nil	nil
„ used on works	37,834	252,389	1,862	1,950
UNITS SOLD PER 8 C.P. LAMP CAPACITY	23·7	22	18·3	10·4
Maximum supply demanded	501 kilowatts	700 kilowatts	213 kilowatts	244 kilowatts
Number of public lamps	87	150 arc	nil	nil
Number of consumers	275	464	215	—
Connections to mains in 8-c.p. lamps	21,825	30,131	12,538	14,256
CAPACITY OF PLANT IN 8-C.P. LAMPS	21,860	40,600	9,070	18,430
CAPACITY OF PLANT IN KILOWATTS	700	1,300	290	590
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£66,661 / £95·2	£145,581 / £112	£75,000 / £259	£75,000 / £127
Share	— / —	— / —	50,000 / 172	50,000 / 84·8
Loan (including Debenture charges)	66,661 / 95·2	145,531 / 112	25,000 / 85·2	25,000 / 42·4
RECEIVED (TOTAL)	66,661 / 95·2	101,481 / 78·1	50,580 / 174	56,330 / 95·5
Share	— / —	— / —	31,330 / 108	31,330 / 53·1
Loan (including Debenture charges)	66,661 / 95·2	101,481 / 78·1	19,250 / 66·4	25,000 / 42·4
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	44,100 / 33·9	24,420 / 84·2	18,670 / 31·7
Share (unissued)	— / —	— / —	18,670 / 64·4	18,670 / 31·7
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	44,100 / 33·9	5,750 / 19·8	— / —
REPAID (TOTAL)	1,902 / 2·72	3,656 / 2·81	— / —	— / —
RESERVE OR SINKING FUND	nil / —	— / —	−800[a] / −2·76	— / —
DEPRECIATION FUND	nil / —	— / —	800 / 2·76	1,300 / 2·20
EXPENDED (TOTAL)	72,426 / 103	104,499 / 80·4	51,246 / 177	59,866 / 101
Lands and buildings	16,177 / 23·1	24,367 / 18·8	11,015 / 38·0	14,947 / 25·3
Plant	33,150[a] / 47·4	45,664[g] / 35·1	18,783 / 64·8	21,637 / 36·7
Mains	22,930 / 32·8	34,221 / 26·3	20,221 / 69·7	21,961 / 37·2
Miscellaneous	163 / 0·24	247 / 0·19	1,226 / 4·23	1,322 / 2·24
BALANCE OF CAPITAL ACCOUNT	−5,765[b] / −8·24	−3,017[b] / −2·32	−666[b] / −2·30	−3,536[b] / −6·00
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£9,223 / 4·280d.	£13,660 / 3·680d.	£5,101 / 7·372d.	£5,702 / 7·165d.
Revenue from supply	7,172 / 3·330d.	10,195 / 2·748d.	4,699 / 6·790d.	5,313 / 6·673d.
„ meters, &c.	— / —	— / —	224 / 0·324d.	277 / 0·348d.
„ public lighting	1,958[c] / 0·908d.	3,375[h] / 0·910d.	nil / —	— / —
„ sale of lamps, &c.	— / —	90 / 0·024d.	nil / —	— / —
„ miscellaneous sources	94 / 0·044d.	— / —	178 / 0·257d.	113 / 0·142d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£5,484 / 2·543d.	£7,765 / 2·092d.	£2,229 / 3·222d.	£2,600 / 3·266d.
WORKS COSTS	4,247 / 1·970d.	6,059 / 1·632d.	1,381 / 1·994d.	1,657 / 2·083d.
Generation of electricity	*3,521[d] / 1·633d.*	*5,205 / 1·402d.*	*1,286 / 1·858d.*	*1,517 / 1·906d.*
Fuel (including cartage, &c.)	2,207 / 1·024d.	2,918 / 0·787d.	693 / 1·002d.	839 / 1·054d.
Oil, waste, water, stores	431 / 0·200d.	476 / 0·128d.	62 / 0·090d.	72 / 0·090d.
Wages at station	960 / 0·445d.	1,106 / 0·298d.	365 / 0·528d.	405[e] / 0·509d.
Repairs and maintenance at station	138 / 0·064d.	706 / 0·190d.	166 / 0·240d.	180 / 0·226d.
Distribution of electricity	*339 / 0·157d.*	*122 / 0·033d.*	*95 / 0·137d.*	*140 / 0·176d.*
Wages, &c.	242 / 0·112d.	93 / 0·025d.	61 / 0·093d.	109[e] / 0·137d.
Repairs, renewals of mains, &c.	97 / 0·045d.	29 / 0·008d.	30 / 0·043d.	30 / 0·038d.
Public lighting	*387 / 0·179d.*	*732 / 0·197d.*	nil / —	— / —
Attendance	197 / 0·091d.	341 / 0·092d.	— / —	— / —
Renewals	190 / 0·088d.	391 / 0·105d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,237 / 0·574d.	1,706 / 0·460d.	818 / 1·226d.	943 / 1·185d.
Royalties	— / —	— / —	nil / —	— / —
Rent, rates, taxes	*499 / 0·231d.*	*560 / 0·151d.*	*387 / 0·559d.*	*531 / 0·667d.*
Management	*738 / 0·342d.*	*1,146 / 0·309d.*	*461 / 0·666d.*	*412 / 0·518d.*
Salaries	360 / 0·167d.	664 / 0·179d.	233 / 0·337d.	107[e] / 0·134d.
Stationery, &c.	77 / 0·036d.	72 / 0·019d.	41 / 0·059d. }	154 / 0·193d.
Establishment charges	111 / 0·051d.	167 / 0·045d.	57 / 0·082d. }	
Law charges, &c.	190[e] / 0·088d.	243 / 0·066d.	130[e] / 0·188d.	151 / 0·190d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,739 / 6·68%	£5,895 / 6·66%	£2,872 / 5·98%	£3,103 / 5·59%
Sum carried to Depreciation Fund	— / —	— / —	300 / 0·625%	400 / 0·720%
Sum carried to Reserve or Sinking Fund	949 / 1·69%	1,754 / 1·98%	450[d] / 0·937%	— / —
Net interest on loans (incl. Debenture charges)	1,371 / 2·45%	2,525 / 2·85%	897 / 1·87%	1,310 / 2·36%
BALANCE FROM LAST ACCOUNT	−699 / −1·25%	721 / 0·82%	164 / 0·342%	129 / 0·232%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	721 / 1·29%	2,336 / 2·64%	1,391 / 2·90%	1,522 / 2·74%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	4% / —	4% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	59·5%	56·8%	43·7%	45·6%
Expenditure per kilowatt capacity	£7. 16s. 10d.	£5. 19s. 5d.	£7. 13s. 10d.	£4. 8s. 2d.
REVENUE PER KILOWATT CAPACITY	£13. 3s. 7d.	£10. 10s. 0d.	£17. 12s. 0d.	£9. 13s. 5d.
Expenditure per 8-c. lamp capacity	3s. 0¼d.	3s. 10d.	4s. 11d.	2s. 9⅜d.
REVENUE PER 8-C.P. LAMP CAPACITY	8s. 5¼d.	6s. 8¾d.	11s. 3d.	6s. 2¼d.
REVENUE PER 8-C.P. LAMP CONNECTED	8s. 5½d.	9s. 0⅜d.	8s. 1½d.	8s. 0d.
Price charged for lighting, per unit	6d. to 4d.[f]	4d.	7d.	7d.
Price charged for power, per unit	2½d.	2½d.	6d.	4d.
Price charged for public lighting	£22. 10s. per lamp	2·9d. per unit	—	—

HAMMERSMITH.—REMARKS—*a* Includes £4,680 to public lamps. *b* Over-expended. *c* For supply of 145,438 units of electricity, carbons, cleaning, trimming, daily attendance and repayment of capital cost of arc lamps and interest thereon. *d* £215 having been deducted, being penalties under contract. *e* Being to insurance. *f* On "Wright" system, 6d. first two hours, 4d. after. *g* Includes £5,287 on public arc lamps. *h* 150 lamps at £22. 10s. per annum.

RICHMOND (SURREY).—REMARKS—*a* Suspense account. *b* Over-expended. *c* Includes auditing £26, insurance £98 and law expenses £5. *d* Allocated to reduction of suspense account. *e* Apparently only directors' remuneration (£107) is included under management salaries, the engineers' salaries being divided—into £71 under distribution charges and £87 under generation charges.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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THE CENTRAL LONDON RAILWAY.

H.R.H. the PRINCE OF WALES formally inaugurated the Central London Railway on Wednesday, and, though the line is not yet quite ready for continuous traffic, its opening to the travelling public will not be delayed longer than a few days. An illustrated description of this railway forms the subject of a series of articles now appearing in our columns. We give this week some illustrations of the line and an account of the opening ceremony.

The completion of the Central London Railway marks an event in the history of electric traction unparalleled by any similar event throughout the world. Beyond question this railway stands *facile princeps* among electric railway undertakings. The overhead railways of Chicago, and the lines of the same type now being converted from steam to electric traction in New York, undoubtedly are undertakings each with a greater track mileage than that of the latest of London's underground railways; and some may consider, on this account, that they are correspondingly more important. To the electric railway engineer, however, their significance cannot be regarded as being so great as is that of the important problem just solved by the successful completion of the Central London Railway. The overhead railways of Chicago were merely the adapting of New York steam railway practice to electric traction; there was not, in the same sense that there has been with the Central London Railway, a completely new and unsolved problem to be grappled with and solved. Indeed, it has been rather a whole galaxy of problems—some electrical, some relating to other branches of railway engineering—that the engineers have had to face. To the civil engineers the tunnelling has presented difficulties which were only anticipated in a partial and limited degree by the earlier experiences with the much smaller railway between Stockwell and the City; and the same may be said about the electrical difficulties. If for no other reason, the introduction of high-pressure polyphase generation and transmission cast the Central London Railway problem in a new and hitherto untried mould. Much then depends upon the attainment of the successful issue, of which the royal ceremony on Wednesday was the official and popular expression. Electric railway traction, to an extent which

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perhaps is little comprehended by the general public, has been awaiting that event. Its occurrence is the signal for marked and widespread extension in the use of electric power for railway traction in this country. An impetus has been imparted which, while directly affecting the multiplication of railways of the same type as the Central London Railway, cannot fail to stimulate indirectly a more rapid development of electric traction of every description.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

The Management of Dynamos. By G. W. LUMMIS-PATERSON. (London: Crosby Lockwood and Son. 1900).

The extended title of this work describes it as "a handy book of theory and practice." We cannot but regret, after reading the first three or four chapters devoted to the elementary theory of the subject, that the author had not confined himself more exclusively to the practical considerations merely to be expected of a book of this size and nature. At any rate few, if any, of those who would be likely to turn to its pages for enlightenment in the theory of the dynamo would derive much profit therefrom. Without attempting to mention all we take exception to in these first few chapters, we may say we are struck by what is surely an inexcusable contradiction in terms when the writer refers—as he does repeatedly—to the "ends" of a "circuit." Commencing with chapter V., and on to the end of the book, the management of dynamos and motors is really usefully dealt with, and there is a particularly useful little section on the starting of motors and the special devices for this operation. We should have imagined that the management of alternate-current machinery might well have received some notice. For all the attention this type of plant receives it might be practically non-existent. For this reason, and judging from its general tenour, the book would probably be of use only to those in charge of small private plants and isolated installations.

Wireless Telegraphy and Hertzian Waves. By S. R. BOTTONE. (London: Whittaker and Co.). 3s.

Mr. Fahie has recently shown that wireless telegraphy, broadly speaking, has a history going back to 1838. It will soon have a literature. It has passed through the marvellous stage, represented by the newspaper and periodical press, and is now the subject of books. Mr. Bottone's is the latest contribution in this form, but, as the title implies, confines itself to one only of the three orders of wireless telegraphy—the Marconi method.

Chapter I. deals with the elementary facts of electricity shortly and clearly, but this information is not wanted by readers who know anything about the science, and for those who do not it is too scanty to be of any help. Chapter II. is more to the purpose, and deals historically with a few subjects of interest, as the action of charged conductors, lateral discharge, action of discharge on iron filings, electric syntony, and one or two other matters. Chapter III. is excellent so far as it goes. It gives a good *aperçu* of Hertz waves and their application to telegraphy, to firing cannon and mines, and to steering torpedoes; but in a work on telegraphy by Hertz waves one would expect to find this particular application worked out in more detail, giving a view of the whole art and practice, and with some references to the scientific and physical conditions making for and against its use and extension. The fourth and last chapter, occupying 54 out of 113 pages, is devoted to "constructional details," of no use to the general reader, who does not want to make the machinery himself, but to learn something about its working and its possibilities. Twenty-two pages of minute instructions tell us how to make an induction coil, nearly eight pages are given to the making of a Wimshurst machine, and the remainder to the fabrication of transmitters, coherers, relays, bells and tappers, and batteries. Very many of these 54 pages could be better employed in the way we have suggested above.

We have noted a few errors, possibly clerical, in figures and names, and there are, besides, two or three statements of facts to which we must take exception. We do not think that Righi had any share in Branly's discovery, and we are under the impression that Branly himself (not Lodge) observed the property of decoherence in filings and the ways of effecting it, as did Varley and Onesti before Branly (p. 20). The references (pp. 24, 59) to Guarini's "invention called a repeater" and "very delicate and peculiar form of relay" give altogether a false impression. There is nothing peculiar or delicate about it: simply the ordinary relay as used by Marconi actuates (instead of a Morse instrument) another transmitter which sends on fresh strong waves corresponding to the enfeebled ones received (see *The Electrician*, Vol. XLIV., p. 932). Syntony is said to be essential for the detection of electric waves (p. 29 *et seq.*). It is desirable certainly, but not absolutely necessary. The Marconi long-distance apparatus is not syntonised, and if Mr. Bottone can make it so he will have done something for fame.

The "Practical Engineer" Electrical Pocket Book for 1900. (Manchester: Technical Publishing Co., Ltd. 1900). 1s.; in leather, 1s. 6d.

In a technical pocket book one might, from its name, expect to find a collection of tables and memoranda on matters concerning which the owner is likely to require information when away from his office and books of reference, yet it has become the custom that such a book should be a miscellaneous compilation, half text-book, half encyclopædia, embracing for instance subjects as widely apart as dynamo design and statistical data of existing submarine cables; and these so-called pocket books are frequently of such a size and weight as to test to its utmost the capabilities of even a schoolboy's pocket.

The new electrical pocket book brought out by the publishers of the *Practical Engineer*, although excellent value for its price, does not yet, however, fulfil the ideal of what a book of this class should be. Its convenient size and shape ($5\frac{3}{4}$in. × $3\frac{1}{2}$in. × $\frac{1}{2}$in.) certainly affords no ground for complaint, but considering the wideness of the subject and the impossibility of dealing with it educationally, practically and in detail in 250 small pages, it is to be regretted that the editor has not omitted those parts which are purely of the text-book order, and replaced them by useful tables of which there are already some—but, alas, too few—excellent examples in it. For instance, the chapter on magnetism occupies more space than that on electric traction, and the only tables in the latter section are some giving the relative costs of working, &c., on horse, cable, steam and electric lines. In another part of the book, reference is made to Matthiessen's standard, but no value of it is given, and a table of "feet per ohm" for solid wire and stranded cable is calculated to four and five figures, but it is not stated to what standard they are calculated. The areas and circumferences of circles are given for diameters, advancing by eighths of an inch, it being forgotten apparently that wire is gauged in decimals of an inch. In the section on polyphase systems, no formulæ are given for the currents carried by the several wires for transmitting a given power at a given pressure. The "earth-lamps" method is cited for indicating leakage on mains, but it should have been added that it is useless in the majority of existing three-wire networks in this country so long as the permanent Board of Trade earth connection is left on the middle wire. The table of the "most valuable types of primary cells in common use" should include the Fuller double-cell bichromate battery.

We hope to see a second, and indeed a third and fourth edition of this pocket book in which the above-mentioned defects are rectified.

The Slide Valve Simply Explained. By WILLIAM J. TENNANT. (London: Dawburn & Ward, Ltd.)

This little pamphlet—one of the "Model Engineer" series—should prove of great help to those many budding engineers who find the intelligent following of the movements of the slide valve an intellectual poser. The illustrations, being clear, generally well fulfil their function, and the author is to be commended for recognising the importance of showing what is the full effect of altering any particular quantity in the valve dimensions or movements.

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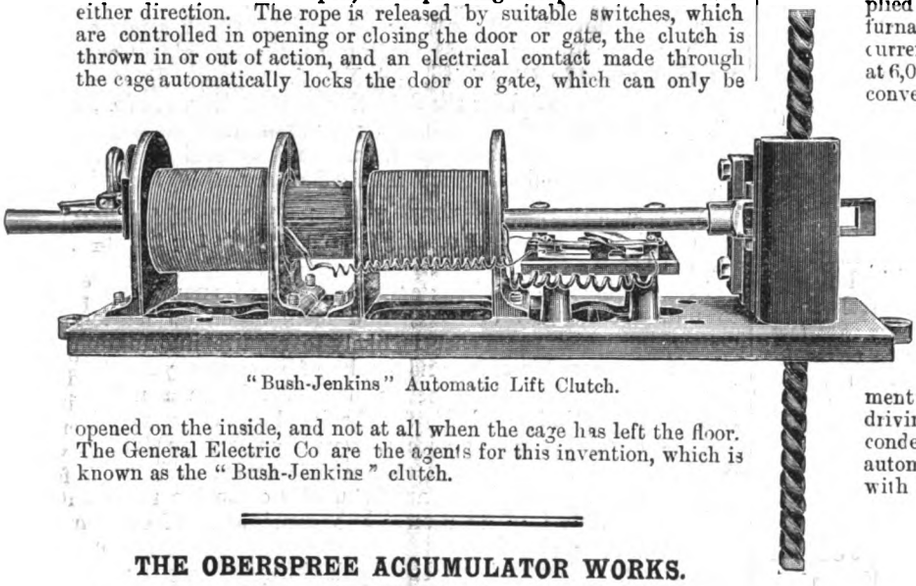
AN AUTOMATIC SAFETY LIFT CLUTCH.

There has recently been patented and placed on the market a new safety lift clutch, which is automatic in action, and is claimed to be the simplest and most effective safety clutch in use. It is further claimed that with it the possibility of lift accidents due to the cage being moved away from the floor while the door is still open, or insecurely fastened is prevented. The lift cannot be started when the door is open, nor can any lift-door be opened excepting the one at which the lift is stationary. In the illustration the clutch is shown with the starting rope seized. This condition is maintained all the time the door is open, the rope being incapable of motion in either direction. The rope is released by suitable switches, which are controlled in opening or closing the door or gate, the clutch is thrown in or out of action, and an electrical contact made through the cage automatically locks the door or gate, which can only be opened on the inside, and not at all when the cage has left the floor. The General Electric Co are the agents for this invention, which is known as the "Bush-Jenkins" clutch.



"Bush-Jenkins" Automatic Lift Clutch.

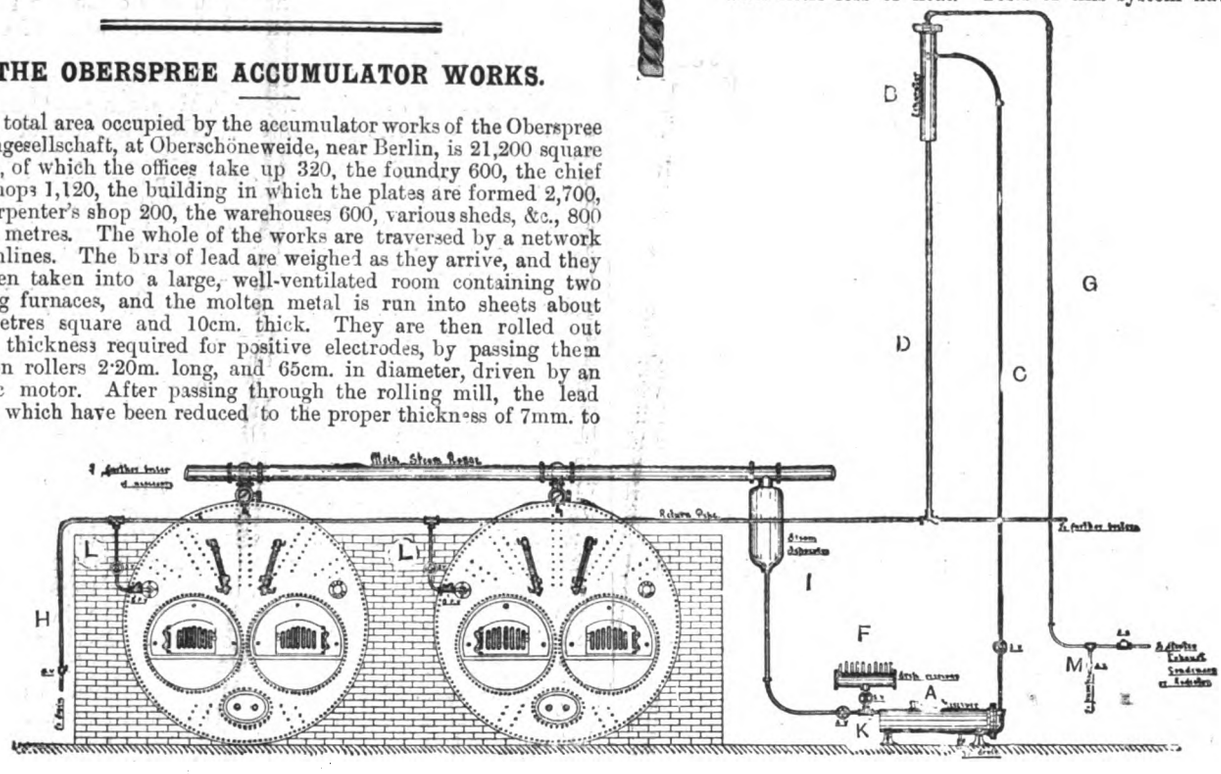
THE OBERSPREE ACCUMULATOR WORKS.

The total area occupied by the accumulator works of the Oberspree Aktiengesellschaft, at Oberschöneweide, near Berlin, is 21,200 square metres, of which the offices take up 320, the foundry 600, the chief workshops 1,120, the building in which the plates are formed 2,700, the carpenter's shop 200, the warehouses 600, various sheds, &c., 800 square metres. The whole of the works are traversed by a network of tramlines. The bars of lead are weighed as they arrive, and they are then taken into a large, well-ventilated room containing two melting furnaces, and the molten metal is run into sheets about two metres square and 10cm. thick. They are then rolled out to the thickness required for positive electrodes, by passing them between rollers 2·20m. long, and 65cm. in diameter, driven by an electric motor. After passing through the rolling mill, the lead sheets, which have been reduced to the proper thickness of 7mm. to 8mm., are cut up into plates of the required size by an electrically-driven circular saw. The plates are next taken to the principal workshop, which contains 18 Majert-Berg planing machines (see *The Electrician*, Vol. XLIV., p. 218), which turn up a series of thin shavings on the rough lead plate. The Majert positive plate in its most recent form is stamped out with a stiffening rim. instead of having the latter burned on to it as formerly. The grids for the negative plates are cast in another room, in moulds of the well-known pattern, and about 6,000 can be turned out daily. These castings are trimmed by a circular saw, and then taken to a room where they are cleaned by means of a sand blast, and are well brushed, after which they are taken to the pasting room. Here the active material, which has been prepared in an adjoining room, is applied to them by hand. From the pasting room the plates are taken to the forming room, which contains about 1,000 vats, capable of holding 20,000 plates. At about the level of the height of the vats there are exhaustors, opening into underground channels, to carry off the air laden with sulphuric acid spray and the gases given off in formation. After the plates have been discharged and washed, they are dried on frames in a current of air, and prepared for sending off. In this part are also stored the glass and other containing cells.

On the first floor of the building in which the plates are formed is the testing room of the electrical laboratory, and in the passage near it is the main switchboard, and a large window which enables the whole of the forming tanks to be kept under observation. The chemical laboratory is on the next floor, and amongst other features worthy of notice is the plant for producing water-gas, which is capable of yielding 20 cubic metres of gas per hour for use in the laboratories, and for soldering, &c. The steam required for heating the factory is supplied from two boilers, and the administrative block is separately heated. Washing and bathroom accommodation is supplied for the employés, as well as dining rooms. Next to the furnace room is the chamber in which the pressure of the current supplied by the Allgemeine Elektricitätsgesellschaft at 6,000 volts is transformed down to 70 volts or 80 volts, and converted into continuous current for use in the tanks and for lighting purposes. In the factory, which is thoroughly equipped in every respect, about 250 hands are employed, while 150 are engaged in installation work. The description of works given in No. 8 of the *Centralblatt für Accumulatoren und Elementenkunde*, from which the above is taken, contains six large illustrations of the various rooms in the factory.

THE HOLLY GRAVITY RETURN SYSTEM FOR STEAM PIPES.

The accompanying illustration shows the arrangement of steam pipes for the "Holly" system of steam driving. This apparatus is arranged so as to draw away the condensed water from steam pipes and return the same automatically and continuously to the boilers, consequently with little loss of heat. Tests of this system have been recently carried out at the Huddersfield electricity supply works where the apparatus is erected. The Huddersfield apparatus is capable of returning 3,000lb. of condensed water per hour to the boilers, an amount of liquefaction and priming which no central station engineer would wish his steam plant to exceed or even attain to. The apparatus is attached in 16 positions to the main steam pipe draining the condensed water from this into a drip receiver. From the drip receiver it passes to a main receiver, and thence, partly by steam pressure and partly by suction, to the separator which is fixed about 25ft. above the boiler water level. Thence it returns by gravity to the boilers. Tests carried out show that the average amount of water returned per hour was 384lb., the temperature of the condensed water thus returned being 363deg. The heat saved per hour was 273 heat units, representing, with coal at 12s. per ton, a saving of £35. 18s. 9d. per annum. As the cost of the arrangement is only about £100, it will be realised what a great profit-making apparatus it actually is. We have taken the details relative to these tests from a report drawn up last August by Mr. A. B. Mountain, the borough electrical engineer at Huddersfield.



The Holly Gravity Return System for Steam Pipes.

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ELECTRICITY SUPPLY FOR SMALL TOWNS. *

BY C. S. VESEY BROWN.
(City Electrical Engineer, Lincoln.)

The subject of the Paper, as suggested by the Council of this Association, was "The Best System of Supplying Small Towns," but the above title was substituted, the object aimed at being to elicit, by discussion, the experiences and ideas of those members of the Association who have given the matter their attention. There is no doubt that the rapid advances which have been made in electricity supply in the larger towns of Great Britain, coupled with the facilities which modern legislation has provided for the purpose of municipal ownership of such undertakings as gas, water, electricity and tramways, has prompted the smaller and possibly less densely populated and prosperous districts to apply for statutory powers under the Electric Lighting Acts.

For the purposes of this Paper, the author has chosen those towns and districts with a population not exceeding 40,000. At the end of 1899 there were in operation six towns under this size: 56 works (28 owned by local authorities and 28 by limited companies); there were also 161 local authorities and 23 limited companies who had acquired statutory powers, of which number 50 local authorities and 16 companies were reported to have completed arrangements for equipping works, thus leaving 111 local authorities and seven companies who had not made up their minds what to do. Of these 111 local authorities, the following obtained their provisional orders on the dates given—viz., one in 1890, two in 1891, four in 1892, two in 1893, and two in 1894, and of the remainder the larger proportion were granted in 1897, 1898 and 1899. There are also a large number of applications during the present session, of which it is difficult to give an exact account until the orders are granted.

The analysis of the works in operation, as regards system of distribution, is as follows:—

Local Authorities.		Limited Companies.	
High Tension Alternating.	Low Tension Continuous Current.	High Tension Alternating.	Low Tension Continuous Current.
11	17	12	16

and the capital expenditure and results from those in operation for more than one year is as follows:—

	Local Authorities. 14 Towns.		Limited Companies. 9 Towns.
Capital Invested	£406,175	...	£332,490
Average profit after payment of working expenses	4½ %	...	4½% (average dividend)
Kilowatts installed	5,240	...	3,065
Average price per B.T.U. obtained	5·1d.	...	6·4d.

It will be seen that to a certain extent the local authorities have been oblige to subsidise their works with contributions by the general body of ratepayers, for in order to pay interest and sinking fund on the capital invested at 3 per cent. and repayable in 25 years, a return of at least 5¾ per cent. is needed. The author tried to investigate the corresponding gas returns for these towns, but owing to the involved accounts of new and old capital, different rates of interest, and also the fact that, as a rule, the gas companies supply outside the local authorities' area, the figures would not have been of any real value as a comparison.

Having obtained the necessary powers, the local authority's attention is at once directed to a number of questions, of which the following are the more important:—

A choice of system.

A selection of a site.

The question of an expert to advise on what is to be done and how to do it.

The capacity of the generating plant.

The extent of the area of supply to start with.

Whether or not street lighting should be undertaken.

The price of supply, and on what terms there should be a rebate, according to the consumption of electricity.

Are "free wiring" contracts to be entered into, &c, &c.

It is one of the good fortunes of this country that the municipal government, as a rule, is carried on with the firm desire to do what is best for the "citizens," and the author makes no exception to this rule in the case of electricity supply, and begs respectfully to point out to the local authorities in question the advantages of sinking all differences of opinion in politics, &c., when dealing as trustees to a commercial undertaking for the benefit of the general public. If the expert's advice can be depended upon the local authority can leave all technical details alone, and exercise in a greater degree those commercial and managerial qualifications which it is presumed have placed them where they are.

The choice of an engineer to advise and superintend the scheme is a knotty point to solve in some places. At times the surveyor is asked to carry out the works. Other places depend on a scheme propounded by manufacturers; and, again, some authorities appoint an engineer, after considerable expense in advertising, at the wage of a first-class foreman, who is supposed to be competent to advise on all the intricate questions in the maintenance and construction of the undertaking, which though small in size and area, yet has principles involved which require the same consideration as if the undertaking was to supply a greater district; and not only is he called upon to carry out this undertaking, but to draw plans and specifications, and in contracts provide himself as sole arbiter in cases of dispute with manufacturers, who may have in their employ engineers and experts of world-wide fame. The author's suggestion to small local authorities is that they should employ a competent expert to advise and initiate a policy and system, and for the first stage of the undertaking pay him the usual fees; that then they should engage a resident manager, whose duties would be to manage both commercially and technically the whole undertaking, and that as extensions are required, the consulting expert should be called in to advise, he being paid an annual retainer to cover the advice given. In this manner the local authority would obtain the maximum of expert advice with the minimum of expense, and in connection with this suggestion the author would point to the very magnificent results which have been obtained by gas, water, and railway undertakings where somewhat similar arrangements have been made.

The site for an electricity works should be, if possible, near to a stream of water and adjacent to a coal depôt. If preference is to be given to either situation, that where easy arrangements can be made for condensing the exhaust steam is preferable. In the author's opinion it would be a difficult matter to find a better system than the three-wire continuous current, supplying consumers at a pressure of 200 volts to 250 volts, the choice of pressure being determined by the probable extension of the feeder cables. The generating plant should be of a simple and yet efficient character; nothing should be installed which has not stood the test of time and experience. Lancashire boilers, or where it is possible that foggy weather may be experienced, water-tube boilers are equally suitable; 125lb. to 130lb. steam pressure seems to be the most suitable standard to adopt. The addition of an economiser or feed-water heater is distinctly an advantage, and should not be omitted, especially where the character of the feed-water necessitates some depositing apparatus to soften it. The steam and feed pipe arrangements should be of the best character. There should be no possibility of joints failing or valves leaking, and in the whole of the system of electricity supply there is no policy more penny-wise or pound-foolish than that of the substitution of inferior material or curtailment of expense in this part of the generating plant. The engines and dynamos should be direct coupled to each other, and as far as possible should be arranged in standard sizes. By "standard" sizes is meant the standard size of any manufacturer as near to the expert's "standard" as possible; if the expert's "standard" is insisted on, additional expense is incurred, which in the author's opinion is not warranted.

At the first stage of the undertaking, it is probable that two or three sets of from 50 kw. to 100 kw. each would be installed, and that as extensions are required 150 kw. to 250 kw. machines would be added, the sizes depending on the probable demand to be made for power and traction, as well as for lighting. Compound two or three crank engines appear to be the most useful type. The dynamos, for the first stage, should be so arranged that they will balance the three-wire system, if necessary, without the assistance of a storage battery. A storage battery should be provided of sufficient capacity to take all the lighting that may be required between midnight and some time in the afternoon of the next day, for, say, two years, after which time it acts only as a "safety valve" to the supply pressure. The switchboard should be so arranged as to be easily extended, and at the same time confined to as small a limit as is consistent with safety and ease of controlling the supply. Recording instruments for various purposes should be used. There is nothing more annoying than to be assailed occasionally with the statement that the supply is or was unsteady at some specified time, and there should be recording voltmeters to refute or confirm such statements. Each dynamo should be provided with a recording instrument to enable its output to be calculated.

Sufficient attention is not paid to the necessity for keeping accurate records of everything in an electricity works. The author has had occasion lately to examine the accounts and records of most of the undertakings at work in the country, and is surprised to find that, for example, records as to the number of units generated, or the amount of cable laid, and other details essential to the good order of such an establishment are not kept. In the minor details of the works, the author is inclined to use motors for driving the various pumps, economiser scrapers and cranes that may be required, but would make an exception in the case of providing a reserve steam-feed pump. With regard to the distributing system, concentric and triple concentric cables are most suitable. These should be laid on what is known as the "solid" system, which serves the double advantage of forming a mechanical protection against picks and water, and also against electrolytic effects, which may be

* Paper read before the Municipal Electrical Association, at Huddersfield, June 20th.

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deleterious to armoured cables buried direct in the ground, where tramways are in operation. The author prefers to adopt one standard size of cable (say, 0·075 sq. in. to 0·125 sq. in. sectional area) throughout the distributing net-work, and to throw out feeders of different sectional areas to different parts of the net-work as the demand increases, and by a judicious selection of the size of feeders, it should be possible at some future date, if the district which is being supplied increases in value or importance, to use the feeder cables already laid as distributors, and re-lay larger feeder cables, for just as the gas and water companies commenced operations with small pipes, &c., so does the electricity undertaking commence operations with small plant and cables. The meters used in consumers' premises should be well tested before being put on the circuit.

With regard to the price of supply, the author is inclined to the adoption of a price which will require little variation in the future. If a high price is fixed to start with, it is certain to have the effect of restricting the output, even though a profit may be made, and the intention of the legislature in granting the local authority powers (which amount to an absolute monopoly) is undoubtedly not that electricity should be for the rich, but for those who desire to avail themselves of it; and in connection with these remarks the author would add that a broad policy of extending the network cables over a considerable area of the district each successive year will have the effect in the long run of establishing a good connection amongst all classes of inhabitants.

In concluding this Paper, the author would refer to the supply of electricity in those towns where the gas undertaking is carried on by the local authority, and would suggest the following possible solutions of the difficulty which may occur in these cases:—

(1) If the town is within the area of supply of one of the large power distributing companies who are or will shortly be operating, then a cheap and efficient way would be to lay down a net-work of distributing mains, and allow the company to supply "in bulk" what electricity is required, the local authority retaining the distribution of the energy and the collection of the accounts in their own hands.

(2) To lay down a net-work of distributing mains, and instal a gas engine plant to the extent of probably 15 kw., as a pioneer undertaking, and if the demand requires, then to put up a steam generating plant.

The author has felt some diffidence in going beyond the bare outline of the suggested arrangement for dealing with this problem of supplying these small towns,* and hopes that the discussion will elicit information which will be useful to guide the powers that be into the right groove towards the establishment of efficient and successful electricity works all over the United Kingdom.

*On account of the many varied conditions which obtain, say for example, in towns in Devonshire, Staffordshire, Durham County, or in the North of Scotland.

CORRESPONDENCE.

ELECTRIC TRACTION CURRENTS AND SUBMARINE CABLE WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with Prof. Jamieson's ingenious theory as to the manner in which the stray sheathing currents have affected the cable at Cape Town, it seems to me that his conclusion as to the nature of the disturbances being electromagnetic is an extremely doubtful one. In a comparatively well conducting homogeneous electrolyte like sea water, it

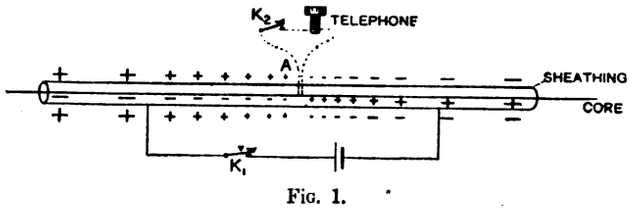

FIG. 1.

seems difficult to imagine a slope of potential of any appreciable magnitude at a distance apart expressed in terms of a single diameter of the cable. During June last year I personally observed a maximum difference of potentials between Robben Island and Cape Town, due to tramway disturbances, which only slightly exceeded one volt.

There are two main disturbing effects, both electrostatic in character, which I think sufficiently account for the phenomena observed, and which I have only just had an opportunity of verifying experimentally. First, consider the case of an ordinary armoured or lead-sheathed cable having the conductor of its core completely insulated (Fig. 1). The difference of potential due to the stray external current has the effect of simultaneously disturbing the normal electrostatic charges on the copper conductor within the dielectric. This results in a redistribution of charges with every variation of the external potentials, and consequently is responsible for internal surgings of charge which sympathetically affect the receiving condensers. By placing a sufficiently sensitive detector in the conductor circuit near the neutral zone at (A), the effect of these surgings becomes apparent. In further proof of the electrostatic character of these undulations, by joining up a

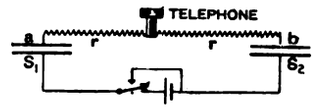

FIG. 2.

key and telephone or other detector, as shown by the dotted lines, and releasing k_2 before k_1, and then again depressing k_2, the click due to the re-arrangement of charges becomes audible.

The case is indeed analogous to that shown in Fig. 2, where S_1 and S_2 are elements of the sheathing at different potentials; (*a*) and (*b*) the elemental portions of the conductor which become charged inductively, whilst *rr* is the resistance of the conductor separating (*a*) and (*b*).

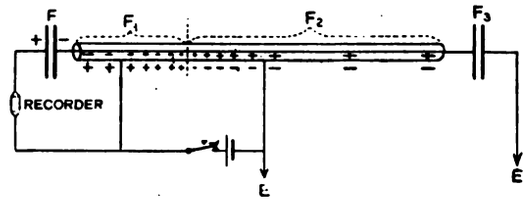

FIG. 3.

Fig. 3 represents the state of affairs in the general case where condensers are used at both ends of the cable. (Compare with Fig. 3A). The condenser F_3 at the distant end may be considered an extension of F_2; or, if instead of it we insert a resistance of 10,000 ohms or more, it acts simply as a leak across F_2. Quite apart from these surgings between F_1 and F_2, the potential due to the stray current operates in charging the signalling condenser F, and the main portion of the cable F_2 in cascade, as pointed out by Mr. Alfred Hay; and the recorder being in that circuit, it is the combination of these effects which disturb the receiving instrument.

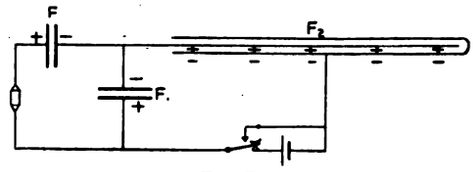

FIG. 3A.

With these explanations of the phenomena it is evident that perfect compensation can alone be secured by means of a twin core cable, which should be laid out well beyond the limits of the affected district.—Yours, &c., C. W. SCHAEFER.

Gibraltar, June 12.

ADJUSTABLE HIGH RESISTANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may interest some of your readers to know that an excellent and easily adjustable high resistance for use in the "Modified Thomson Capacity Test," recently described by Mr. Elton Young, can be obtained by using ordinary glass siphon tubes filled with water. Their value can, of course, be adjusted by putting a sufficient number of tubes in parallel or series or by altering the conductivity of the water. I find that a tube 8in. long, filled with ordinary drinking water, has a resistance of 25 megohms.—Yours, &c.

Lima, Peru, June 12. A. DAVIDSON.

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THE B.E.T. SUPERANNUATION FUND ASSOCIATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the remarks which you were good enough to make on p. 311 of your issue of June 22nd on the subject of the B.E.T. superannuation scheme, it may be of interest to state that the rules relating to the adhesion of our own associated undertakings to the scheme are equally applicable to other electrical companies wishing to make pension arrangements for their staffs, and the directors of the B.E.T. Company are favourably disposed to extend the scheme to such other companies as may desire to join.

There must be many electrical concerns desirous of making proper provision for the old age of their salaried officers and clerks, but unable, owing to smallness of numbers, to start a superannuation fund of their own. The Railway Clearing House superannuation fund was devised to provide for similar circumstances, and the B.E.T. scheme is based on the model of the Railway Clearing House scheme.

The affairs of the Association will be managed on independent lines by a representative committee, and ample protection will be afforded both to the fund and to the officer in the event of his associated company withdrawing from the fund.

Mr. W. G. Bond is acting as secretary to the committee having charge of the matter, and he will be prepared to give further information upon application to him at this address.—Yours, &c., E. GARCKE.

Donington House, June 27.

PARLIAMENTARY INTELLIGENCE.

MUNICIPAL TRADING.

The Joint Committee on Municipal Trading resumed its sittings on Friday last, the Earl of Crewe presiding.

Mr. EMILE GARCKE said that during the last 18 years he had been concerned in the promotion of electrical companies. He formed and was managing director of the British Electric Traction Co., which had a capital of over £1,C00,000, and was interested in nearly 60 tramways and light railways in various parts of England. The concessions which the company held brought it into relation with something like 200 local authorities, and he had consequently had opportunities of looking at the question of municipal trading from all sides. He was very largely in sympathy with the evident desire of many local authorities to extend the sphere of their operations and to undertake industrial enterprises. He was in favour of the municipalisation of industrial undertakings which had for their object the rendering of public services, and which could be better carried out by elected bodies than by public companies or private capitalists, but he was strongly opposed to what was called municipal trading. Any undertakings carried on by local authorities should be so carried on with a view of rendering a service better, more efficiently, and more cheaply than could be done by private enterprise, and not with the view of making profits. Any surplus should be applied in reduction of the price or in reduction of the capital account created for the purpose of the undertaking and not in reduction of rates or in providing for some other enterprise.

The CHAIRMAN: What is your objection to applying a surplus to some other object of equally general use?—I think it would be bad finance to do so. The Nottingham Corporation the other day boasted that they were able to pay for their technical institution out of the profit they made on their gas undertaking. I think that is a wrong view to take. The technical institution, if it is a desirable institution, should be initiated and carried on independently of whether they make a profit on the gas undertaking or any other undertaking. I think it would lessen financial control if the surplus on one undertaking were devoted to making good a deficit on another.

Sir W. FORTEE: You are aware that the Post Office makes a large profit. Do you think that bad finance?—No, but I should think it bad finance if the profits were applied to some other undertaking without separate accounts. Many local authorities were working their undertakings with a view to profit. On the average corporations supply the electric light at rather less per unit than the companies, but they were in a somewhat better position for producing electricity economically, inasmuch as 60 corporations supplied electricity for public lighting, whereas companies had very great difficulty in persuading local authorities to go in for public electric lighting.

The CHAIRMAN: What is your objection to municipalities working at profit?—I think the foremost is the danger of municipalities over-trading they are allowed to extend their enterprises with a view to a profit without a limit or restriction. A corporation having an electric lighting order was most anxious to take up electric tramways for one of two reasons—either because they had made a profit on their electric lighting or because they wanted to largely increase the demand for electricity and thus render remunerative an electric lighting undertaking which would not be remunerative as a lighting undertaking alone. There were several instances in which local authorities who had obtained provisional orders had not taken up electric lighting because they were doubtful whether there would be a sufficient demand for such lighting. When, however, he went forward and asked for a concession for electric tramways, the first question they asked was whether he would buy his electricity from them if they put up a station. There were several cases in which he had made such an arrangement, and had had to wait for the electricity for his tramways until the local authorities were able to establish an electric lighting undertaking, which they probably would not have established but for the possibility of obtaining a large customer for the tramway. He would give the Committee one instance of what he regarded as bad treatment on the part of a local authority. He was interested in the development of a very large electric traction scheme in South Staffordshire, and their railroad company undertaking to supply electrical power over nearly the same area. Some of his representatives went to one of the local authorities in the district, and asked for their consent to the substitution of electric for steam traction on the tramways. The local authority suggested that he should purchase the electric current from them for the purpose of the tramway. His representative replied: "You had not got a power station, and are not likely to have one, for you are in treaty with the other company to take current in bulk." The answer was: "Oh, but we can buy our electricity from the other company and sell it to you at a profit." He thought that municipal trading could hardly be carried farther than that. He considered that it was contrary to the public interest that such things should be done, because it prevented a company giving the lowest fares or working their lines in the most efficient manner. In the case of the electrical industry, he thought that considerable harm had been done to the country generally by the attitude taken up by local authorities. After the passing of the Act of 1888 many local authorities refused to grant concessions to electric lighting companies, and applied for provisional orders themselves. For many years, however, nothing was done to carry out those provisional orders. About one-third of the orders granted to local authorities had not been proceeded with. English electrical manufacturers had been hungering for orders for electrical machinery, but they had been unable to establish large factories. Meanwhile electrical manufacturers on the Continent and in America had had the benefit of supplying the electric light for many years past and had been able to establish large factories, to take up all kinds of experimental work and to develop the industry in every way. The result was that the English manufacturing companies were not in as good a position to deal with the demand that had now sprung up as were foreign manufacturers. Consequently a very large proportion of the electrical apparatus needed was being imported from America and elsewhere. In 1899 the exports of telegraphic apparatus from this country amounted to £1,000,000, while those of miscellaneous electrical apparatus amounted to only about £400,000. It was clear that the telegraph industry, which was not hampered in this country, was in a far better position than any other department of electrical industry. The imports of electrical apparatus for the first two months of this year amounted to as much as £125,000, and this figure did not include the rails and cars, a large proportion of which came from America. He was promoting a system of electric tramways in the district between Leeds, Bradford, and Halifax, and the question had arisen as to the gauge that should be adopted, inasmuch as each of the three towns mentioned had a different gauge. If the tramways in those towns had been in the hands of companies when mechanical traction was adopted he believed that they would have had sufficient insight to have seen that it was necessary to have the same gauge in each of the three towns. He thought it highly desirable that the veto of the local authorities on the operations of companies should be modified.

Mr. A. A. CAMPBELL SWINTON expressed a strong opinion that the great backwardness of this country in electrical matters was almost entirely due to the opposition encountered by companies from municipalities. He agreed with Mr. Garcke and witnesses that municipalities should not be allowed to make profits.

On Tuesday, Sir BENJAMIN BROWN (Messrs. R. W. Hawthorn, Leslie & Co., shipbuilders, Newcastle) said he had experience as a member of local authorities and had also been a director of two electric lighting companies He did not consider that local bodies were suitable authorities for carrying on trading enterprises, particularly as regarded electric tramways. At the same time he thought the power of doing street work themselves ought to be given to the local authorities. He did not think there was much objection to a local authority purchasing electricity in bulk and distributing it to consumers. The development of electric lighting had, in his opinion, been largely interfered with by the policy adopted by local authorities in opposing the formation of companies for supplying electric current. The backwardness of this country in regard to electrical enterprise was largely attributable to the way in which private enterprise had been discouraged.

Mr. W. M. MURPHY, chairman of the Dublin United Tramways Co. and of the London Southern Tramways Co., said that for many years he had been largely interested in the promotion, financing and construction of tramways throughout the United Kingdom, and was now engaged in constructing electric tramways to connect Ramsgate, Margate and Westgate. Electric lighting in Dublin was in the hands of the Corporation and had not been successfully worked. He ascribed the failure to mismanagement and want of enterprise. Last year Dublin charged consumers 6·1d. per unit, and lost money by it. The Cork Tramways Co., on the other hand, which had an electric lighting order, charged only 2·98d. The advance which had been made in the United States in regard to electricity was, in his opinion, due almost entirely to the freedom which the American companies had had. When horse tramways were first introduced into Europe from America they spread from England to the Continent, and several of the Continental lines were built by English enterprise and capital. Now a condition of things which was exactly the reverse of this was observable. In the case of the Cork tramways he got an offer

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of capital from France, and, in fact, it was French capital which built the line. There had, of course, been cases in which municipalities had been successful in working tramways, but where a local authority became possessed of a tramway undertaking that had been worked for 21 years, and took over the whole of the staff, it could not very well fail to succeed. The legislation which gave local authorities the right to purchase tramway undertakings after a certain period was a great discouragement to capitalists, who would otherwise invest money in tramway schemes. Parliament had set its face against the exaction of wayleaves by local authorities from tramway companies, but they were still paid under private agreements between the parties. The local authorities, of course, had a right to withhold their consent to a scheme unless their conditions were complied with, but in some cases they tried to exact conditions of too onerous a character with the result that schemes were abandoned. He himself had had to abandon tramway schemes from this cause more than once, one of those so abandoned relating to a proposed line at Dumbarton.

Lord AVEBURY (Sir John Lubbock), president of the Associated Chambers of Commerce and of the English Bankers' Association, said he believed the majority of the mercantile community viewed the spread of municipal trading with apprehension, and most of the Chambers of Commerce were opposed to it. The municipal debt had shown in late years an alarming tendency to increase. Hitherto investors had considered that in taking up municipal loans they were making an investment which had no appreciable risk, but if a municipality was to engage in trading operations there must be an increase of risk. The more money a municipality had to borrow the greater amount of interest it would have to pay, though, of course, if a local authority had a very well paying undertaking in its hands that would tend to improve its credit. He was of opinion that the action taken by local authorities under the Electric Lighting Acts had had the effect of checking the development of the electric light and other electrical enterprise in this country. Bills to enable companies to supply electric power to manufacturers had been opposed by municipalities, to some extent successfully, though he thought it clear that if power was to be distributed in the cheapest possible manner it must be from some considerable centre. He also thought it clear that no single municipality was likely to be able to supply electric power as cheaply as a company. One effect of trading would be to involve local authorities in labour questions, and he thought it undesirable that the members of a Corporation should have to settle the wages of their own constituents.

The Committee adjourned till to-day (Friday).

LONDON COUNTY TRAMWAYS.

On Friday the Committee of the House of Commons, presided over by Mr. W. H. Holland, resumed discussion on this bill (No. 1).

Mr. ALFRED BAKER, tramways manager to the London County Council, speaking as to the results of the working of the Council's tramways on the south side of the Thames, said the gross receipts for 1899 were £467,000, and the working expenses £377,964, leaving a balance of £89,036. Interest on capital came to £45,000, which made the net surplus £44,000. He anticipated an improvement of these figures from the conversion of the tramways to electric traction. Experience of electric traction in other places showed that by its adoption receipts increased and expenses diminished. The published accounts of the Glasgow Corporation showed that, for the year to May 31, 1899, the receipts from horse traction were 11·51d. per mile run, and expenses were 8·51d., leaving a margin of 3d. per mile. During the same period the Glasgow electrical tramways receipts reached 13·89d. per mile, and the expenses only 6·38d., leaving a profit of 7½d. per mile, a difference in favour of electric haulage of 2·38d. on receipts and of 2·13d. on working expenses. The receipts per mile on the London County Council's system in South London were at present only 10·64d., the fares being very low, and the expenses were 8·52d., leaving a profit of 2·12d. per mile run. If electric traction were substituted he estimated the receipts would rise to at least 1s. per mile. That was an estimate 2d. below the receipts in Glasgow from electric traction, whereas the Council's receipts from horse traction were only 1d. less than in the case of Glasgow. The Council's expenses should not exceed the horse traction expenses, 6·38d., which would leave a balance of 5½d. against 2·12d. with horse-power. Last year the tramway miles run over the 8 miles of lines proposed to be electrically equipped in South London were 1,917,160, so that the difference on that mileage would amount to £27,000 increased profits. The alteration of the system of haulage over these 8 miles would release 900 horses, which would greatly conduce to an improvement in the sanitary condition of the streets. There would also be an economy of space, as the electric car would carry 70 passengers, against the 46 of the horse car, and would occupy 5ft. less of road space. The electric car would be over all 31ft., whereas the measurement of the horse car and pair of horses was 36ft.

The case for the promoters being closed, the evidence of a large number of local witnesses was heard against the tramway extensions proposed.

Mr. FRANK DODD, for the St. Saviour's District Board of Works, asked the Committee to insert a clause that the County Council should be liable for any damage done by leakage of electricity to the property of anyone along the tramway routes. He said that, while he accepted the assurance of Prof. Kennedy that no leakage would take place under the systems to be adopted, yet electricity might escape by accident or otherwise, and it was reasonable to ask that nothing under the Act should exonerate the Council from liability.

Mr. VESEY KNOX, for the Wandsworth District Board of Works asked the Committee to strike out the provision from the bill before the Committee providing for the electrical equipment of the Westminster and Tooting tramways. As a similar power was included in bill (No. 2) and the Wandsworth Board asked for power of veto with reference to the surface-contact system, the board considered they ought not to be called upon to oppose the same proposal in two bills.

Mr. POPE, Q.C., for the promoters, said that whatever provisions had been or might be inserted in bill (No. 2) in favour of the local authorities should also be placed in the present bill.

Mr. H. J. MARKHAM, surveyor to the parishes of Streatham and Tooting, said two systems of traction were put forward by the Council—the surface-contact and the conduit systems. There was no objection to the conduit system, but the surface-contact system was an experimental one. It might be dangerous to the traffic and would certainly be inconvenient where a gradient occurred. There was an incline of 1 in 22 on the proposed route, and if a series of plates were placed in the road 18in. in length there would be danger to horse traffic. The Wandsworth Board therefore desired to retain a veto in regard to the surface-contact system, or any other system that had not been properly tried.

Mr. H. EDWARDS, surveyor to the Lambeth Vestry, said he considered the surface-contact system would not be suitable. He agreed that the knobs or studs projecting up in the roads would be very dangerous, especially to cyclists. The centre of the plates would be formed of metal and the remainder of another material, probably unequal in its wear.

On Tuesday, after hearing the addresses of counsel, the Committee decided that the preamble of the bill had been proved, inclusive of all the new tramways proposed. The application of Wandsworth and Lambeth in respect to placing the mains from the generating station to the tramways under the Electric Lighting instead of the Tramways Acts was refused. With respect to injury from nuisance, the Committee considered it was quite right for the Council to be liable for any injury caused by their own negligence, but not for injury arising otherwise. With reference to omnibuses, the Committee considered that it was inevitable in the march of improvement that omnibuses should be supplanted in some streets to meet the needs of a growing population.

The clauses were adjusted, and the bill was ordered to be reported.

WELLINGBOROUGH AND DISTRICT TRAMROADS BILL.

This bill came before a Select Committee of the House of Lords, presided over by Lord Fermanagh, on Tuesday.

Mr. BALFOUR BROWNE, Q.C., said the bill was promoted by the British Electric Traction Co. for the purpose of constructing tramroads in the county of Northampton. It was proposed to make a line beginning at Wellingborough, which had a population of 20,000, whence (from the centre of population) it passed to the goods yard of Wellingborough station on the London & North-Western Railway Co., so as to carry passengers the considerable and inconvenient distance between the two places, and thus feed the railway company. From this place the line would run to Irchester, where it would enter the station yard of the Midland Company, and so lead to an exchange of traffic to the mutual advantage of both. Thence the line would pass to Rushton on to Higham Ferrers, going north again to Higham Ferrers station on the London & North-Western Railway, and so on to Raunds. To complete the circle it was proposed to pass through Irthlingborough and Finedon, returning to Wellingborough station on the Midland. The whole district, with a population of from 60,000 to 70,000, and all the local authorities supported the proposal, and not only offered no objection, but were anxious to have the tramways. The only petitioners were the London and North-Western Railway, who objected to a level crossing proposed by the bill. That company, although they crossed 22 public roads on the level between Northampton and Peterborough, objected to the tramway crossing their line at one place. The objection was utterly unreasonable, because the road belonged to the public, and there was no danger. In Hull, where they had electric tramways, there was not a single electric line which did not cross the lines of the North-Eastern Railway Co. on the level; and the traffic in a town like Hull was infinitely greater than on a country road between Wellingborough and Irchester. The Committee of the House of Commons which considered the bill passed the preamble, but hoped the promoters would be able to come to some understanding with the railway company with a view to constructing a bridge, to which both parties should contribute. Negotiations had followed, but the railway company stated that they could not approach the promoters with any offer of constructing a bridge in lieu of a level crossing, and so no progress had been made.

Mr. C. WOOLESTEN, member of the Northampton County Council said it was of importance that when goods were placed on a tramcar to be transferred to a railway that the car should enter the goods yard of the railway so that the exchange of traffic could take place without cartage. As to the objection of the London & North Western Company to the tram crossing their line near Wellingborough station on the level, it was on a main road, and the proposal had received the approval of the County Council, who were the road authorities. He knew of no instance of an electric tram crossing a railway on the level.

Mr. STEPHEN SELLON said the length of the tramway in this bill was 20 miles and its estimated cost £136,000. It was intended to carry every possible class of goods which could be laid hold of—to make the line common carriers all over the district to the various railway stations. As the handmaid of the railway companies, the tramway would be of great assistance in distributing goods between the railway stations and the various towns, from which the stations were some distance. There would also be considerable local traffic arising from local industries such as iron smelting, brick making, boot making and coal carriage. Protection was given to the London & North-Western Railway Co. by clause 9 of the bill, under which these tramways could not be constructed without the consent of the railway company; but there was a provision that if they refused their consent they should, in the event of the tramway company constructing the remaining portions of the tramroads, afford reasonable facilities for the exchange of traffic at the cost of the tramway company, and if any difficulty arose it should be determined by arbitration in the

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usual manner. The effect of that was that the tramway company could not make trams within the bounds of the London & North Western Company; but that if they made the outer portions they could require the railway company to give reasonable means of interchange at the stations. As to the level crossing at Wellingborough station, the proposal was simply to lay the line in a road which already crossed the railway lines. If the railway company's objections were sustained it would mean that all light railways or tramways in the district would have to provide bridges at serious expense, which would go far to prevent the development of schemes of this nature. A bridge was not necessary, and he was quite unable to appreciate the argument of the railway company that there would be danger. There were plenty of cases of tramways crossing a railway on the level. A man in the signal box at the level crossing could see the whole country round, and thus know when a train or car was approaching.

Mr. COOPER, C.E., gave similar evidence.

Mr. LITTLER, Q.C., for the London & North Western Railway Co., said that if the present proposal were sanctioned, it would be quoted in support of similar proposals in respect of many other level crossings on their system. The promoters were going to make the profit from the scheme, and they should bear the cost of making the bridge which was required to carry the scheme out. It was said that the railway company would be safeguarded because the regulations for the crossing would have to receive the approval of the Board of Trade; but the Board of Trade could only make such regulations as were consistent with the running of the trams,—to which the railway company object. The proposal to run into the railway company's yards was an audacious one, because it was an interference with the private property of the railway company; and if assented to would open all the company's stations to speculators who might desire to save themselves the cost of purchasing land alongside stations. If the tramway company wanted to come to the railway, let them buy land alongside; and if they could not or would not do that, they should trust, as omnibus and cab proprietors trusted, to the goodwill of the railway company. The railway company were not opposed to the tramway scheme, and if the bill were passed would give the tramway company such facilities and access to the stations as were reasonable; but they strongly objected to this compulsory power. If the railway company did not give them reasonable facilities the tramway company could always apply to Parliament for relief. As to the crossing of the railway company's main east and west line on the level, surely they were entitled to the protection of a bridge, which would add little to the whole cost of the scheme.

Mr. TURNBULL, superintendent of the London & North-Western Railway Co., said there was the strongest possible objection to any railway crossing another railway on the level; and in this case the tramway was practically a railway, for they proposed to carry goods. All the danger which attached to the crossing of one railway by another attached to the crossing of the railway line by the electric tramway; in fact, in this case the danger was greater because, whereas in the case of two railways crossing there was an elaborate system of block sections to protect each of the trains coming from the four directions, in the present case there would not be that protective system. Further, the man in the signal box at the crossing would not have a good view of the train coming from Irchester because the line turned a corner just before approaching the railway.

Mr. FRANCIS STEPHENSON, engineer-in-chief to the London & North-Western Railway Co., said in some places level crossings could not be avoided, but where possible they should be avoided; and therefore the proposed level crossing in this case should be avoided, as might easily be done, by a bridge. The gradient of the road towards the crossing was about 1 in 28, and therefore, if the rails were greasy, quite possibly a tram might run through the railway gate when they were closed.

Major-General HUTCHINSON, for 28 years an inspector of railways under the Board of Trade, said during the latter part of his career one of his special duties was to report on level crossings. It was absolutely unknown for railways in these days to cross on the level; and of late years everything possible had been done to discourage the crossing of a road on the level. Such crossings were only recommended for adoption where local and other considerations rendered them desirable. All level crossings were dangerous, admittedly; if a railway line was crossed on the level by a horse tramway it tended to increase the danger, and if the tram was worked electrically it still further increased the danger. An electrically worked tramway was to all intents and purposes a railway. If from any cause the driver of an electrically or mechanically worked car became incapacitated or lost control of the car as it approached the railway when the gates were closed the car would dash through them, whereas horses would stop almost of themselves against the gates. Then, when trains crossed on the level there was a system by which trains were prevented from approaching the crossing-place while one was passing there, but that was not the case with tramways. A similar case to the present was before Parliament in the Grimsby Tramways bill, and was rejected.

Mr. J. L. WILKINSON, general manager of the Great Western Railway Co., gave similar evidence.

Mr. WORSLEY TAYLOR, Q.C., for the promoters, pointed out that the contention of the railway company in this case amounted to this, that simply because there was a level crossing in a bill the scheme should not be sanctioned. There was no general rule that level crossings were not to be allowed. For about 21 hours of the day the gates at the level crossing were open to all classes of traffic. A traction engine drawing a number of trucks could cross the lines at any time that the gates were open, and it was absurd therefore to say that the tram drawing probably two cars should not cross. The answer to the contention that a bridge should be erected to take the tramline over the railway was that the local authority did not want it because they recognised that it would be a mistake to have a gradient on a tram route like this. As to the tramway running into the Wellingborough and Higham Ferrers stations on the London & North Western Railway, that company were given protection which in similar cases had satisfied the Midland Railway Co.

The chairman said the Committee found the preamble of the bill proved, but disallowed the two portions of line giving access to the two stations on the London & North Western Railway, and allowed the level crossing.

READING CORPORATION TRAMWAYS BILL.

On June 21 the Reading Corporation Tramways bill came before a Select Committee of the House of Lords, presided over by Earl Erne.

Mr. PEMBROKE STEPHENS, Q.C., for the promoters, said the bill provided, amongst other matters, for the introduction into Reading of the modern system of electric tramways. The horse tramways, in Reading were owned by a company which obtained its powers in 1878. In 1899 the Corporation obtained authority to extend the tramways and the use of mechanical power generally; and the present bill was for a further extension. The existing line was 2½ miles in length. Under the company's Act of 1878 the Corporation had power to purchase within a shorter period than that authorised by the general Act of 1870. The contention of the company was that having failed to purchase within that shorter period the Corporation could not now purchase at all, because by the Act of 1878 the Corporation varied the provision of the general act as to period of purchase, and they had not acted in accordance with that variation. The same point arose in the case of the Wallasey tramway and the Wallasey District Council. Mr. Justice Ridley, in that case, held that the contention of the company was correct, but the Court of Appeal decided the other way, and an appeal was now pending to the House of Lords. If the House of Lords agreed with the first court, the Corporation of Reading could never purchase at all; consequently the company held that the Corporation should not have the powers sought in this bill, which must have the effect of injuring the tramway company if they could never purchase. Counsel urged that the company were trying to raise some legal point which, if raised at all, should be raised elsewhere. Continuing, he said running powers were authorised over the company's lines as soon as the proposed lines of the Corporation, five in number, were constructed. These new lines were greatly needed, and would be of real public advantage, and in any case would not affect the tramway company in the least, except at the points of junction. The only opposition other than that of the company to the tramways portion of their scheme was by Messrs. H. & G. Simonds (Ltd.) and others, who alleged that part of the route was too narrow, that the trams would interfere with their business, and be dangerous.

Mr. HENRY DAY, town clerk of Reading, in supporting the bill, went into the history of the tramways, pointing out that as late as last year, in certain objections made to the Board of Trade, the company recognised the right of the Corporation to purchase under the general Act of 1870, statutory notice was given in proper form to purchase under that act, and was followed by a writ from the company against the Corporation proceeding with the purchase. That case was now pending before the Courts. The contention of the Tramway Company was that inasmuch as the Corporation had varied the language of the general Tramways Act, and did not purchase under the terms of that variation they could not purchase at all.

Mr. COWARD said all he wanted to do was to preserve the *status quo*. Even if the House of Lords restored the decision of Mr. Justice Ridley, the effect of this bill would be to give powers to the Corporation to construct tramways which might injure the company.

Mr. W. B. MONK, chairman of the Tramways committee of the Reading Corporation, said the Corporation had for years desired to purchase the tramways, but had decided to wait till they could do it at old-iron price. The power sought was to make a north and south and a supplementary east and west system, and to couple with it the trams proposed to be acquired from the company.

Other evidence having been given,

Mr. STEPHEN SELLON said the scheme was a good one and there would be no engineering difficulty in construction, or in running the trams by electricity. As to the crossing he could give no case of two opposition lines crossing at right angles; but there were a number of cases in which lines crossed in that way. There would be no difficulty in lines in either case so crossing.

Mr. G. W. PALMER, M.P. for Reading, generally supported the scheme.

Mr. JOHN BOWEN, borough engineer and surveyor of Reading, said there had been a growing feeling that something better than the existing horse tramways on single lines with passing places was needed. The present proposal would add a north and south system to the existing east and west system and would be worked with the most modern electrical equipment. The estimate for the electrical equipment, trams, and works, &c., was £135,000, which would provide power sufficient not only to work the tramways in this bill, but the Corporation tramways authorised in 1899, and the tramways of the company when they became the property of the Corporation.

Mr. J. KINCAID (Messrs. Kincaid, Waller & Manville) said the tramway scheme was well laid out and would be advantageous to the town.

Mr. I. WINSLOW gave evidence as to the suitability of the electric system proposed. The overhead trolley system, which the Corporation had adopted, was well adapted to the requirements of Reading. There was no electrical or engineering difficulty in working or constructing a line worked by electricity which crossed a horse tramway.

This closed the case for the promoters, and evidence having been given on behalf of the frontagers,

Mr. LEWIS COWARD, on behalf of the tramway company, submitted that until the House of Lords had given their decision in the Wallasey case—the legal principles involved in which were identical with those in the present bill—it would only be right and fair that the Committee should

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give a clause to the company, protecting them in the event of the Corporation never being in a position to purchase the tramway undertaking. He asked for a clause similar to that inserted in the Tramways Order Confirmation Act, obtained by the Corporation in 1899, to the effect that nothing in the Act should authorise the interference by the Corporation with any of the lines of the tramway company until the tramway undertaking had been actually purchased and taken over by the Corportion. It had been admitted that two tramways, worked electrically, crossing each other at right angles, in different hands, must be not only a source of considerable interruption to the traffic of both systems, but of real danger to the public. Hence the necessity for the clause.

Mr. PEMBROKE STEPHENS, for the promoters, offered the tramway company, in place of the clause suggested, the ordinary junction clause.

The CHAIRMAN announced that the Committee found the preamble of the bill proved, They thought, however, the river opposite the brewery, and near the site of the proposed generating station, should not be narrowed; and with regard to No. 2 tramway (the Bridge-street main proposed route), they held that the ordinary junction clause offered by Mr. Pembroke Stephens would be sufficient.

Subsequently the clauses were adjusted, and the bill ordered to be reported.

WESTON-SUPER-MARE TRAMWAYS BILL.

On Wednesday the House of Commons Committee, presided over by Mr. de Tatton Egerton, considered the bill to confirm the provisional order granted by the Board of Trade authorising the Weston-super-Mare and District Electric Supply Co. (Ltd.) to construct some 3 miles of tramways at Weston, to be worked by electricity on the overhead trolley system.

Mr. J. C. GRAHAM, for the promoters, said the only opponent remaining was the Commercial Cable Co. That company alleged that the current leakage from the tramways would prevent the reading and proper working of the delicate recording instruments in use at their cable station at Weston. The answer of the tramway company was that the whole question had been considered by a Committee of Parliament in 1893 in the case of the telephone companies, who had for a long time opposed all electric tramways. Before that Committee it was proved that the telephone company could entirely get rid of interference by the adoption of metallic returns. That Committee had reported against compelling tramways to use insulated returns. Interference with telegraph cables, such as was now referred to, had occurred at Coney Island, New York, but in that case it was got rid of by running a wire to earth some 2 miles out at sea outside the area of interference. The same kind of interference had been neutralised at Capetown by laying a second cable parallel to the existing one for some miles out to sea. The promoters said that the obvious remedy in this case was for the cable company to do what had been done with success in other cases.

Mr. J. E. NORMAN, vice-chairman of the District Council, and of the Electric Lighting committee of Weston, said his Council were unanimously in favour of the proposed tramways, which were much needed.

Mr. STEPHEN SELLON, C.E., said the Commercial Cable Co. could protect itself from these electric leakages by the adoption of twin core cables. When the first electric tramway was laid down at Leeds it was found that the whole telephone system was affected, and an action was brought against the Leeds Corporation, which failed. Since that time the telephone company had put up a service of metallic returns. The proposed tramway would pass along the sea front, and the conduit system would be objectionable there, as at Blackpool it had been found that the sand and water so affected the working as to cause frequent stoppages. He considered the expense of a double trolley insulated return system would be too great in the present case, and he should not advise the construction of the tramways under such conditions.

Mr. H. M. SAYERS, said that although a twin-core cable would obviate interference from the tramways, it was difficult to say how far the double cable would have to be carried out to sea. If the strata were a good conductor it would extend the area of disturbance. On the other hand, the earth round the tramway might be a good conductor and the outlying strata a bad one. The shape of the tramway and its position in relation to the line of the cable and the position of the sea were all factors in the question of disturbance. In this case the line of tramway would give rise to the smallest amount of interference. It was not practicable either theoretically or commercially to have insulated returns on this tramway. All conductors negative to the rail leaked much more than the positive, and caused disturbances. If the surface-contact system were adopted there might be less interference than with the rail return.

This evidence closed the promoters' case.

Mr. GEORGE G. WARD, vice-president of the Commercial Cable Co., said the cable at Weston was worked nearly all the 24 hours. Three-fourths of the messages received at the cable station in Ireland came on to the Weston cable, which was the most important cable owned by his company. Another cable from Ireland was about to be landed at Weston. By the expenditure of money his company might protect the cable from disturbance, and the tramway company by spending money might also prevent their system doing the Commercial Company any injury. There was some doubt, to his mind, as to whether his company could efficiently protect the cable. This company had found a current of 25 volts 4 miles or 5 miles out to sea in the case of their cable at New York, caused by the electric tramways. Even if they moved their cable station from Weston, which would be most expensive, there would be no assurance that they would not suffer from disturbance. The instruments used by his company were very delicate, and even a small tramway like the present would release enough electric current to seriously disturb the instruments.

Mr. J. GOTT, chief electrician to the Commercial Company, said the cable at Coney Island was a four-core one. Two cores were used for working the cable and two cores for neutralising the leakage disturbances. The cost per mile of carrying a twin-core cable out to sea would be £600. No case of interference with cables from electric traction had yet arisen in this country. The interference arose both from induction and direct transmission of currents into the cable. If the tramway were sanctioned it might even be necessary to protect the cable for 100 miles.

Mr. H. A. C. SAUNDERS, electrician-in-chief to the Eastern & Associated Telegraph Companies, agreed that the proposed tramway would be detrimental to the working of the Weston cable. What had happened at Capetown, where the positions of the tramway and the telegraph cables were somewhat similar, was that the cable had been doubled—first for 5 miles, and then 10 miles, and eventually for 40 miles out to sea—which had to a certain extent overcome the difficulty. He had no doubt as to the certainty of the tramway now proposed affecting the cable.

Yesterday, Mr. JAMES SWINBURNE said in the present case it was impossible to say how great the disturbance would be to the telegraph cable; they could only judge by what had happened in other cases. The remedy for the disturbances was to run a return circuit out for some miles to sea. It would not be fair to ask for compensation for an indefinite number of miles. The Commercial Company's cable was a short one, about 350 miles in length, and the signals used upon it could be stronger ones than in the case of a longer cable. The cost would be about £1,000 per mile to carry out a second cable to sea. The question here was, who was to pay for this cable and its laying. The Committee of 1893 did not consider the question of cables in relation to disturbance by electric tramways.

Prof. W. E. AYRTON said that from his experience in relation to other submarine cables, the chance of disturbance would be very great. He said that with a knowledge of the working of the cables at Weston, and what had occured at Capetown. A tramway could be so constructed with insulated returns that there would be no risk of disturbance, but perhaps the tramway in this case could not bear the expense. The laying of a twin-core cable end to the telegraph cable at Weston was perhaps the simplest way of obviating the disturbance.

Mr. PEMBER, Q.C., for the Commercial Company, said there could hardly be a more important public interest than the protection of telegraph cables against disturbance. The promoters admitted the probable disturbance, and the only question was who should pay the cost of remedying that disturbance. He asked the Committee to insert a clause that if the promoters constructed this tramway the Commercial Company should be allowed to carry out any works necessary to prevent disturbance at the expense of the tramway company, with reference if necessary to an arbitrator to be appointed by the Board of Trade.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said that what was being now attempted in the matter of submarine cables had been attempted before in the case of telephones, and had had for the time the effect of stopping the tramway industry. But Parliament had interfered, and while giving a certain amount of protection to telephones, and compelling the tramway companies to stop leakage where possible, had otherwise left the telephone companies to protect themselves by metallic returns. Bristol was not far from Weston and was extending its electric tramways, and a tramway was coming into Weston. The Commercial Cable Co. were now seeking to protect themselves from all these at the expense of this small undertaking. They had no protection granted them on the American side, and there was no reason why it should be granted here. If it was, Parliament would again have to interfere to prevent the crushing out of these small tramway enterprises.

The Committee adjourned, postponing their decision.

PLYMOUTH, STONEHOUSE AND DEVONPORT TRAMWAYS BILL.

This bill came before the House of Commons Committee on Unopposed Bills on Monday. The object of the bill is to confer further powers upon the Plymouth, Stonehouse and Devonport Tramways Co., which seeks power to construct double lines of tramway in Plymouth and Stonehouse to a gauge of 3ft. 6in. and to work these and the existing tramways of the company by electric power. The period assigned for the completion of the works is three years. The preamble was proved, and the bill was ordered to be reported.

SOUTH LANCASHIRE TRAMWAYS BILL.

The Leigh Rural, the Tyldesley, Atherton, and Westhoughton Urban Councils, and other local authorities in the Manchester and Wigan districts have been informed by their Parliamentary agents that practically the whole of their protective clauses in this bill, which were inserted by mutual agreement with the promoters, have been struck out by Lord Morley, the chairman of Committees in the House of Lords. At a conference on Monday it was decided to appoint a deputation to wait upon Lord Morley with a view to securing the clauses, which relate principally to road widenings, failing which the Councils will oppose the bill and endeavour to throw it out.

CAMBORNE AND REDRUTH TRAMWAY BILL.

On Wednesday, the Committee of the House of Lords, of which the Duke of Northumberland is chairman, commenced the consideration of this bill.

Mr. ERSKINE POLLOCK said the bill was promoted by the Urban Electric Supply Co. (Ltd.) to construct tramways from Camborne, passing through Illogan, to Redruth. It would be 3 miles 3 furlongs in length, 2 miles 6 furlongs being single line and 5 furlongs double line, and the gauge would be 3ft. 6in. The motive power was electricity, and the system proposed to be used was the overhead or trolley. The trams would run along the main road between Truro and Penzance to the centre of the town of Camborne. The population of Redruth was 10,000, of Camborne 14,000,

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and of the intermediate district over 9,000, and the tramway would meet a great want in the neighbourhood. The only opposition came from the Great Western Railway Co., who ran eight trains daily each way between Camborne and Redruth. Tramway traffic was essentially pick-up traffic, and while the line would doubtless do some injury to the railway in some respects it would prove a feeder. The opposition of the railway company was on the ground of competition. They alleged that the service of trains run by them was sufficient to meet the needs of the traffic.

Yesterday the Committee found the preamble proved.

Mr. MOON, on the consideration of clauses, asked that as the tramway company's line crossed the line of the Great Western Railway Co. on the level, in the interests of the public the promoters ought to pay for any additional cost incurred by the railway company in consequence of the passing of the bill. The Board of Trade might direct that the railway company should put up additional signals in consequence of the tramways crossing the line.

Mr. ERSKINE POLLOCK contended that the provisions of the general law covered the case.

The Committee decided against Mr. Moon's proposed clauses.

MUSSELBURGH ELECTRIC TRAMWAYS BILL.

Opposition has been withdrawn, and the bill will now proceed as an unopposed measure.

BRAY AND ENNISKERRY RAILWAY BILL.

This bill came before a Select Committee of the House of Commons, presided over by Mr. de Falton Egerton, on June 20. The object of the measure is to empower the Bray and Enniskerry Railway Co. to make extensions of their authorised lines in the counties of Dublin and Wicklow, and to work the same and the railways authorised by an Act of 1886 by electric power; to raise £25,000 additional capital by shares and £12,500 by loan; to extend the time for the completion of the railways authorised by the Act of 1886, and to empower the company to enter into agreements with the Bray District Council and the Dublin, Wicklow & Wexford Railway Co. The Wicklow County Council suspended their appearance, it having been stated that the promoters agreed to insert a clause protecting their rights as the road authority, and to lodge £1,000 in the bank as security for the completion of the line.

Mr. Worsley Taylor, Q.C., represented the promoters; Mr. Littler, Q.C., the Dublin, Wicklow & Wexford Railway Co., who opposed, and Mr. Pembroke Stephens, Q.C., the Earl of Pembroke, who also opposed.

After hearing the evidence,

The CHAIRMAN said the Committee found the preamble proved so far as related to the extension of time for the completion of the original line from Bray to Enniskerry, and so far as related to the new branch from Bray to Bray Harbour; but declined to grant the proposed extensions to Hollybrook and Scalp.

Protective clauses were inserted for Earl Pembroke and the railway company, and the promoters were ordered to lodge £1,000 with the National Bank at Wicklow as security to the County Council for the completion of the line and the re-instatement of the Council's roads.

THE ELECTRIC POWER BILLS.

The Select Committee of the House of Commons on Electric Power Bills resumed, on Friday last, its investigation into the South Wales Power Bill. Sir J. Kitson presided.

Mr. PEMBER, Q.C., continuing his opening speech for the promoters, said his clients sought nothing more than the right to trade in the ordinary course of commercial competition in the business of electrical supplies, and did not seek to prevent local authorities or anyone else competing with them. As to the districts already supplied they would restrict their business to dealing with the local authority except in regard to customers for whom the local authorities did not attempt to cater, and for whom they would never be able to cater. He then referred to the restrictions imposed by the Board of Trade on electric supply companies, and, in illustration, produced specimens of two kinds of cable—one the overhead cable used by the Niagara Co., and made at Providence, U.S.A., and the other the kind of cable that was to be used by the South Wales Co. The first, he said, cost £700 a mile, and the second, under the restrictions of the Board of Trade, £2,000 a mile, and yet the first did over three times the amount of work done by the second.

Mr. E. H. REECE said he wished to give evidence in place of his partner, Mr. Porter Brown. His firm acted as agents for many large colliery owners in the South Wales district, the total output of the collieries at present under their control being 2,000,000 tons per annum. At the present moment the question of the cheap production of coal was exercising the minds of everybody in the district, the more cheaply worked seams being now exhausted. He understood that the promoters of this bill would provide power at from £4 to £10 per H.P. per annum. It was costing at present more than that at the collieries, and if only a portion of the power used at the collieries could be obtained at a cheaper rate it would make a considerable difference in the actual production of coal and would simplify the problem of working the more costly seams. Some of the collieries had already electric installations, but only for lighting. The capital of the undertakings represented by the promoters of the company was nearly £23,000,000, and they were interested in pretty nearly all the large works in the district. He admitted that if the company spent £50,000 on the undertaking they would have the right to supply the whole area. They would not, however, ask for powers unless they did intend to supply. The bill provided that the company would not supply within the area of any local authority without the consent of the local authority. There was a sliding scale clause in the bill so that the company would only be able to increase their dividend when they reduced the charge for electricity to 2½d. per unit. He did not know that the second readin of the bill in the House of Commons was obtained by the promoters accepting the undertaking of the President of the Board of Trade that they would not supply within the district of any local authority without the consent of such authority.

Mr. RAM, Q.C., for the promoters, said that as soon as it was found that Mr. Ritchie had made the statement referred to the promoters waited on him and said they could not agree.

WITNESS (continuing) said he did not think the operations of the promoters would ruin the Pontypool Electric Lighting Co., but if the promoters supplied more cheaply than that company the public of course would benefit. He did not see why a company should be protected from the effects of competition. Electric power could be used in collieries for lighting, pumping, and hauling. In a large colliery as much as 1,000 H.P. could be used for hauling purposes alone. The charge under the bill was to be £10 per H.P. per annum at the outside, while the promoters hoped that it would not exceed £4. Under present circumstances £15 per H.P. was the cost of fuel alone, so that he anticipated that in a colliery raising 750,000 tons of coal there would be a saving of £10,000 a year. He was of opinion that the development of electric energy in the district was behind the times, and he did not think that the local authorities contemplated supplying electric energy except for lighting. As he objected to local authorities engaging in trade, he did not blame them for having neglected to provide power.

Mr. CORBETT, surveyor of the South Wales estates of the Marquis of Bute, said there were enormous industrial works at Cardiff, and most of them needed steam power. It was only the largest undertaklngs that could afford to provide electric installation of their own, and he thought there was little chance of the Corporation of Cardiff supplying electricity for power purposes. Even if they did, he doubted if it would be possible for them to do so as cheaply as the company. The Corporation, of course, having to safeguard the ratepayers' money, could not be as speculative as a company. He considered it essential the bill should provide for lighting as well as power, and thought that a limited competition with local authorities would be a wholesome stimulus. The Cardiff ratepayers had recently declined to allow the Corporation to extend electric tramways into the outside areas.

Mr. JENNINGS, timber merchant, Cardiff, said if timber merchants could obtain electric power they would be able to insure their yards and stocks at a much lower rate than at present. He did not know Cardiff Corporation had offered to supply electric power at 2d. per unit for 4,000 units, and 2½d. per unit for smaller quantities, but he saw from the local papers that they could not generate enough current for lighting.

Mr. ANDREW, Chairman of the Cardiff Chamber of Commerce, said that body had passed a unanimous resolution in favour of the bill.

Mr. E. P. MARTIN, manager of the Dowlais Iron Co., and a director of several large colliery companies, said he was anxious to obtain electric power both in the collieries and in the ironworks. He considered it necessary that manufacturers and traders in South Wales should have such a power in order that they might compete effectually with the foreigner.

Sir J. GUNN, director of many large colliery and other companies in South Wales, considered it important that a good and cheap supply of electric power should be forthcoming, and that the local authorities would hardly be justified in putting down plant sufficient for such a supply.

Mr. G. W. WILKINSON, director and engineer of the United and National Collieries (Ltd.), declared that the company would be very glad to get such a supply of electric power as would be obtainable under the bill. Electric power would be admirable for driving drilling machinery, and he believed it would enable colliery proprietors to work small seams of coal which could not be at present worked at a profit. He thought it would be possible in time to use electricity as an explosive and for hauling and other colliery purposes.

Mr. MAURICE DEACON, mining engineer, said steam and compressed air were the chief sources of power at present in use in mines, and the transmission of the power from the engines was managed by means of compressed air, electricity and hydraulic power. It would be very costly for individual manufacturers to supersede the present method by the adoption of electricity entirely. There would not only be the cost of installation but the old plant would have to be abandoned. He believed that the cheapest method of supplying electricity was by establishing generating stations over a large area, though very large mines could supply themselves economically by having installations of their own. Something must be done, and done quickly, to meet the very serious foreign competition now threatening the South Wales industries, and in the general use of cheap electricity he saw a means to that end.

Mr. T. CALLENDER said the solid system of laying electric mains was the one almost universally adopted. He regarded the provision in the bill empowering local authorities to break up the streets and lay the cables as affording sufficient protection to local authorities.

Mr. H. GRAHAM HARRIS (Messrs. Bramwell & Harris) thought the company would be able to carry out their undertaking throughout South Wales. He considered that the "brand" of electric current supplied by the Cardiff Corporation though suited for lighting was unsuitable for power.

On Wednesday Mr. BALFOUR BROWNE, Q.C., for the Corporations of Cardiff, Swansea, Newport, and Barry, contended that the South Wales district was unsuitable for a scheme of this kind, as there was plenty of steam coal with which the collieries could produce power more cheaply by electricity. Under one of the clauses of the bill a town like Barry would be deprived of its right to set up a generating station, and would be compelled if it supplied electric power at all to purchase current from the company in bulk. Consequently, if the Corporation could manufacture electricity more cheaply than the company it would not be allowed to do so.

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The CHAIRMAN: The Committee think the time has arrived when it would be convenient for them to make a declaration. Sir J. Kitson then read the following statement:—

"A local authority which undertakes and is prepared to give a full "and ample supply of electrical energy for all purposes to consumers "within its district ought not, without its consent, to be required to "give facilities for the supply within its district of electrical energy "by other undertakers. But if a local authority is unable or unwilling "to provide, on reasonable terms and within a reasonable time, a full "and adequate supply of electrical energy for any purposes to any "company or person applying for the same within its district, such "company or person should be at liberty, after notice to the local "authority, to obtain their supply from other authorised undertakers, "and the local authority should be required to give all necessary "facilities for this purpose. Any difference arising out of the above "questions should be the subject of arbitration, as provided by the "general acts."

Sir James Kitson added: Of course this overrides the clause providing that in any event the company shall be at liberty to supply to any person within such area as is willing to undertake to receive a supply of not less than 20,000 Board of Trade units per annum.

Mr. BALFOUR BROWNE said in view of the Committee's decision he would close his case and concede the preamble.

Counsel representing other local authorities took a similar course.

Evidence was then given in support of the petitions of the Venarth and Pontypool electric lighting companies.

Yesterday Mr. WEDDERBURN was allowed to speak on behalf of some of the smaller local authorities. He pointed out that Tredegar and Ebbw Vale were partly in Brecknock and partly in Monmouthshire, and would therefore have to be specially dealt with. He also drew attention to a circular issued by the South Wales Electrical Power Distribution Co. in which they stated that they did not intend to deal with electric lighting, and said that if the Committee allowed lighting powers to remain in the bill it would permit the company to break faith with those who had acted on the circular. He hoped the Committee would agree to make clearer the provisions in the bill as regarded consent of the local authority and supply in bulk.

Committee's Decisions.

The CHAIRMAN said:

"I have to announce that the Committee are of opinion that, subject "to the principles contained in their declarations being embodied in "clauses to be approved, and subject to such additions to and amend-"ments in clauses . . . . as on going through the clauses of the "bill appear necessary, the preamble of the South Wales Electrical "Power Supply Bill is proved. It may be convenient, though the "business is not down for to-day, to announce that the preamble "of the Durham Electric Power Supply Co.'s Bill is proved, that the "preamble of the Tyneside Bill is not proved to the satisfaction of "the Committee, and that the preamble of the Lancashire Electric "Power Bill is proved to the satisfaction of the Committee. The "intention of the Committee is to insert, as far as may be applicable, "the same conditions in each of the bills."

The Committee then adjourned until Tuesday, when the clauses of the bills will be considered.

ELECTRIC LIGHTING ORDERS.

The bill to confirm the Electric Lighting Provisional Order (No. 9) came on Tuesday before the Select Committee of the House of Commons presided over by Sir A. Godson. The bill was to confirm five orders, but the only orders opposed were those referring to the Isle of Wight and Gosforth (Northumberland).

THE FRESHWATER ORDER.

The first order considered was the Freshwater and Totland Bay order. This was an order of the Board of Trade under the Electric Lighting Acts of 1882 and 1888, empowering a company to construct works and supply electricity in the districts of Freshwater, Totland Bay, Yarmouth, and the Isle of Wight.

Mr. RIGG, for the promoters, called

Mr. C. EDMUNDS, solicitor, a director and present secretary of the proposed company, which, he said, was formed in March last to supply the district. Except at Yarmouth, where there was a small gas works, there was no system of lighting at all. The capital of the new company would be £15,000, with borrowing powers of £5,000. There would be five directors, who were all residents. Since the provisional order was issued the circumstances had somewhat changed. The period for the purchase of the undertaking by the local authority had been fixed by the Board of Trade at 42 years; but in the case of Bonchurch the period had been fixed at 7, 14 and 21 years. In this case, however, current was supplied from Ventnor, Bonchurch having no independent generating station.

Mr. FRANK CHRISTIE (Messrs. Christie Bros. & Middleton, Chelmsford) gave details of the equipment of the undertaking, which he considered would be a successful commercial speculation. They had secured a site close to the station with a siding from the railway, where there was a good supply of water. They would instal a plant capable of supplying 3,000 8 c.p. lamps at a cost of £10,000. They estimated that the first year they would supply from 1,200 to 1,500 8 c.p. lamps, which would about pay the expenses and leave a small margin. When they got a supply of 3,000 lamps they would be able to pay a dividend of 5 per cent. They could double the plant at a cost of £5,000, and could then pay a dividend of 10 per cent. The charge for current would be 7d. per unit, which was less than the usual charge in places of like population.

Mr. WEDDERBURN, Q.C. (for the District Council of the Isle of Wight, who opposed, but called no witnesses) said when the order was promoted Freshwater was only a rural district, but since that time it had become an urban district, and as such would be able to get a loan for electric lighting from the Local Government Board. They thought, therefore, they should not be debarred by any grant to the company from exercising their rights. He asked, in any case, that the period of purchase should be reduced to a maximum of 21 years; that the price for current should be reduced from 7d. to 5d., and that they should have some security beyond the deposit of £500 for the Company going on with the works.

The Committee found the preamble proved, but reduced the period for the purchase from 42 years to 21 years, with a premium of 15 per cent. above the value, 28 years with a premium of 10 per cent., or 35 years with a premium of 5 per cent.

THE GOSFORTH ORDER.

This was a Board of Trade provisional order empowering the Newcastle-on-Tyne Electrical Supply Co. (Ltd.) to extend their area and supply electricity in Gosforth. The only opponents were the Newcastle Corporation.

Mr. MOON, for the promoters, said the company was formed in 1889, and in 1890 erected their present generating station at Pandon Dene. At that time there were very few houses near but with the growth of the town building operations had been carried on, and the Corporation objected to any increase of the station. But the company were proposing to take an area of land outside the town, near the Tyne, on which to erect a generating station. The Council objected also to the interference with their streets in the company's carrying their mains to Gosforth, but it was now generally held that a company had the right to pass through the roads of any public authority for the purpose of supplying a district beyond. Dr. Merz, a director, and Mr. W. M. Harris-Burland, engineer of the company, gave evidence in support of counsel's statement, and after consultation an arrangement was arrived at by which the Corporation withdrew their opposition.

Yesterday a clause was brought up to protect the rights of the Corporation as to the route of the cable through the city, and the bill was ordered to be reported.

WEST HAM CORPORATION BILL.

The Select Committee on Police and Sanitary matters, presided over by Mr. Reginald M'Kenna, last week considered the bill of the West Ham Corporation, which empowers the Council to enlarge the present electric generating station, to acquire and work by electricity several lines of tramways, &c., at an expenditure in all of nearly £900,000.

Mr. BALFOUR BROWNE, Q.C., for the Corporation, said West Ham was a rapidly growing place, and at present the population was estimated at 310,000. The only opposition to the tramways portion of the bill was that of the North Metropolitan Tramways Co., the point raised being as to the portion of the company's undertaking the Corporation desired to purchase. The present tramways in the district were two—one from Bow to Wanstead (the lease of this portion had expired, and an arbitration was now pending as to what the Corporation had to pay); the second was from Stratford to East Ham, the lease of which would expire in 1904. The Corporation were endeavouring to arrange for the purchase of this undertaking at once. The estimated cost of the tramways would be £210,000, and the whole were to be electrically equipped.

Mr. JOSEPH WALLER (Messrs. Kincaid, Waller & Manville) detailed the proposed lines, which would be of great service in bringing people from the docks to the centre of the town and from the centre to the country. The tramways would be worked in connection with the proposed lines of East Ham, and would become an important system. Notice had been given to purchase so much of the undertaking of the North Metropolitan tramways as was in their district. As soon as the price has been decided by arbitration, the Corporation would be able to take over that portion of the North Metropolitan system, but until 1904 they would not be in possession of the remainder. The overhead system of electric working could be adopted.

The Committee ultimately passed the tramways portion of the bill, and the bill was ordered to be reported.

DUBLIN ELECTRIC LIGHTING BILL.

In the House of Commons on Tuesday, on the motion for the consideration of this bill, Mr. CAREW moved: "That the bill be considered this day three months." He maintained that if the bill passed, it would be the first time that a private company had been allowed to enter into competition with a local authority. The Dublin Corporation had power under a provisional order to supply electricity, but having spent £89,000 in plant and exhausted their borrowing powers the service had not been satisfactory. They had recently, however, obtained new borrowing powers, and the Local Government Board had sanctioned an electric lighting scheme which had been prepared for them by a competent engineer. Parliament ought not therefore to allow a private company to come in and compete with the Corporation.

Mr. BROWN, chairman of the committee which considered and passed the preamble of the bill, said it was proved that for many years past the Corporation of Dublin had had power to generate and supply electric current for lighting, and had failed to do so. If the Corporation had done their duty there would have been no case for this bill. As they had failed in their duty, the Committee thought it reasonable and fair that a new company should be allowed to enter into competition with the Corporation and to supply this great want to the citizens of Dublin and to some of the out townships.

Mr. TREVELYAN, another member of the committee, said he differed so strongly from his colleagues that he took a division on the preamble of the bill. The House was asked by this bill to create an entirely new precedent. It had been the consistent policy of Parliament to refuse to

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permit any private company to come in and compete in the matter of electric lighting in any town where the Corporation had undertaken the work and was unwilling to permit any private company to enter into competition. He contended that the Dublin Corporation had done their best under the circumstances. They had obtained power to borrow £250,000 to put stations all over Dublin. He believed if such a bill as this were proposed for, say, Glasgow, it would not be listened to.

Mr. T. M. HEALY said it was a remarkable fact that the people who were most anxious for a continuation of this monopoly in the hands of the Corporation of Dublin were the gas company. Why was the gas company so extremely anxious that this monopoly should remain in the hands of the Dublin Corporation? Because it knew well that the Corporation, having muddled away, with the assistance of the gas company, £100,000 of the ratepayers' money, would muddle away £100,000 more. Why should he pay as a ratepayer of Dublin 7d. for electricity which, if he lived in Cork, he could obtain for 3d.? The chairman of the tramway company, about which a good deal had been said, was formerly a member of the House—Mr. Murphy. What the House had not been told, however, was that the tramway company was paying the Corporation for this concession a rent of £12,000 a year and £300 per annum extra for every mile of tramway it made. He thought the Corporation had made an extremely good bargain for themselves. The Corporation had never taken any step to improve their position in the matter of electric lighting until this bill was brought in.

Eventually the motion for the consideration of the bill was carried by 13 votes, and with slight amendment, the bill was ordered for third reading.

CITY OF LONDON ELECTRIC LIGHTING CO.'S BILL.

This bill, which empowers the company to acquire lands for erecting additional generating stations, has now been sanctioned by a Committee of the House of Lords in the form in which it was amended by the House of Commons.

TELEPHONING TELEGRAPHIC MESSAGES.

In the House of Commons on Monday, Mr. HENNIKER HEATON inquired of the Secretary to the Treasury whether it was an instruction to postmasters throughout the country that they were not to forward telegraphic messages over the wires of the National Telephone Co.; and, if so, what was the explanation of the new policy exemplified in such an instruction?

Mr. HANBURY: The Postmaster-General does not now undertake to deliver telegrams by telephone to subscribers of the National Telephone Co. who may desire this privilege, but it remains to explain that this arrangement has not been withdrawn from any subscriber to whom it has been accorded in the past.

Mr. HENNIKER HEATON: When was this extraordinary new principle introduced?

Mr. HANBURY said the instruction had been issued because it was found that there were obvious disadvantages in the Post Office entering into what was practically a partnership arrangement with a private company, especially as that company was itself in direct competition with the Post Office and persistently refused similar facilities to Post Office subscribers.

LEGAL INTELLIGENCE.

Tramway Track Sanding.

On Tuesday and Wednesday last week, in the Queen's Bench Division Dublin (before the Lord Chief Baron, Mr. Justice Andrews, Mr. Justice Madden, and Mr. Justice Boyd) arguments were heard in the appeal of the Dublin United Tramways Co. from the decision of the divisional police magistrate (Mr. Swifte). Particulars of this case were given in our issues of Nov. 10, Dec. 1 and Dec. 10, 1899. The defendant company had to answer two summonses at the instance of the Dublin Corporation for having made default in maintaining and keeping in good condition and repair with such materials as the Corporation directed the tramway tracks within the city. On the hearing of the summonses by Mr. Swifte, fines of £5 and £10 costs in each case were inflicted. From the evidence submitted Mr. Swifte found that the tram tracks had not been maintained and kept in good condition and repair as directed by the Corporation, and had become, through their slipperiness, a danger and annoyance to the ordinary traffic. One cause of the slipperiness of the track was that in dry weather the "swishing" or brushing away of grit, gravel and dust lying on the tram tracks, which, if permitted to remain, would afford a certain amount of foothold to horses' hoofs, but which were "swished" away by the draught produced in the transit of electric cars over the track at a high speed. Mr. Swifte further found that to a small extent the slipperiness was caused by the setts or stones forming the tram track requiring to be re-dressed. He found, however, that defendants had made reasonable effort to keep the tram tracks re-dressed from time to time, and that their structural condition was fairly satisfactory. This latter was the only question of fact substantially controverted in the case, and he thus found it in favour of defendants. The proper remedy for the slipperiness complained of was, in his worship's opinion, the sanding of the tram tracks. Defendants raised a preliminary objection to his worship's jurisdiction to hear the summons founded on sec. 33 of the Tramways Act, 1870, and contended that under that section he should have sent the case to be settled by an engineer or other fit person nominated as referee by the Board of Trade; but he was of opinion that, even assuming that section to be applicable at all, as the main question in controversy was one of law—namely, the construction of the 28th section of the Act of 1870 and the 37th section of the Act of 1897—he had at least concurrent jurisdiction, and he convicted the defendants. The judgment of the Appeal Court was sought on the following points:—(1) Had the magistrate jurisdiction to adjudicate on the summonses? (2) If so, was he right in deciding that, on the facts so found by him, the defendants were guilty of the offence charged by having failed to comply with the provisions of sec. 28 of the Tramways Act, 1870, taken in connection with sec. 37 of the Dublin United Tramways (Electrical Power) Act, 1897?

The arguments against the magistrate's decision were delivered by Mr. Ronan, Q.C., and Mr. Gordon, Q.C.; and in support of the decision by The MacDermot, Q.C., and Mr. O'Shaughnessy, Q.C.

JUDGMENT.

Judgment was delivered on 14th inst., and by a majority the Court affirmed the magistrate's convictions.

Mr. Justice BOYD reviewed the Acts regulating the construction and maintenance of tramways in the city of Dublin, and held that the obligations cast on the company by these Acts had reference only to the fabric of the roads. It was not contended that the company had not constructed their lines in strict conformity with the statutes, or that they had not kept them in good repair. The words in sec. 37 of the Act of 1897, "Shall maintain in good order and repair, &c., so as not to be a danger or annoyance to the ordinary traffic," referred, according to his construction of the section, to structural works, wires, tubes, and electrical apparatus. The work which the Corporation could compel the company to do should be constructive work and nothing else. He thought it was to be regretted that the Corporation did not adopt the alternative provided by the section of the Act, do whatever work was necessary, and then sue the company for the cost. Had they done so the matter could be taken to a higher Court, but under the course that had been pursued there could be no appeal from the decision of the Queen's Bench. He was of opinion that the conviction should be set aside.

Mr. Justice MADDEN, in delivering the judgment of the majority of the Court, said the obligation cast on the tramway company by the Act of 1897 was obviously a duty with regard to the general public. Was a pavement that in certain weather became so slippery as to be a danger and annoyance to the ordinary traffic maintained in conformity with the statute, which provided that the tram tracks should at all times be maintained and kept in good condition, so as not to be an annoyance and danger to the ordinary traffic? So long as the roadway was a danger to themselves the tramway company sanded it, but when it only became a danger to the public they ceased to sand. The sections seemed to be for the protection of the public. He was of opinion that both convictions of the magistrate should be affirmed.

Mr. Justice ANDREWS thought the evidence of the chairman of the company was admissible, but as the magistrate said it would not have affected his findings, his disregard of it was immaterial.

The LORD CHIEF BARON concurred.

Washington & Co. v. Barraclough.

In the Chancery Division, last week, Mr. Justice Buckley heard an action brought by plaintiffs, manufacturers of electric cable-making machinery at Sowerby Bridge, against defendant, engaged in the same branch of industry at the same place. The parties had worked as partners. They had separately purchased certain patterns, drawings, &c., and agreed to work jointly, but disputes arose, plaintiffs contending that defendant had failed to produce proper accounts, and defendant alleging that plaintiffs had not paid him the proper proportion of profits due to him.

His LORDSHIP held that plaintiffs' version of the partnership agreement was the correct one, and directed an account to be taken on that basis. He also held that defendant had failed in his counterclaim for damages for alleged negligence by plaintiffs in manufacturing certain machines. Judgment for plaintiffs, with costs.

Telephone Rentals.

In the Westminster (London) County Court last week the National Telephone Co. sought to recover £18. 5s. for the hire of a telephone from the Transvaal and Australian Gold Concessions (Ltd.). The defence was that the Concessions received a letter from the company, stating that as the London County Council objected to underground wires and the Duke of Bedford to overhead, excepting upon very onerous terms, the National Company saw no prospect of being able to continue the service. The defendants therefore claimed that they were not responsible for the rent until after the year had expired; but Judge Lumley Smith, Q.C., held that, as the service was still supplied, and the defendants' contract with the National Company bound plaintiffs to return the money for the unexpired portion, they must pay, and he gave judgment for plaintiffs for the amount claimed, with costs.

In re the River Plate Electric Light and Traction Co. (Ltd.)

On Tuesday Mr. Justice Cozens-Hardy granted a compulsory order for winding up this company on the petition of Messrs. Glyn, Mills, Currie & Co.

Mr. YOUNGER, Q.C., on Wednesday mentioned the petition against the company and said before granting the order the learned judge had asked if anyone appeared for the company, and as no answer was given his lordship presumed the order must go. The petitioners had misunderstood the fact that negotiations for reconstruction of the company were still proceeding, and if carried through (as they probably would be) everyone would be paid. Counsel now asked that the order might be stayed, and that the petition might be put in the paper in a fortnight's time.

Mr. Justice COZENS-HARDY ordered the petition to be restored to the paper on July 10, and in the meantime to stay the order.

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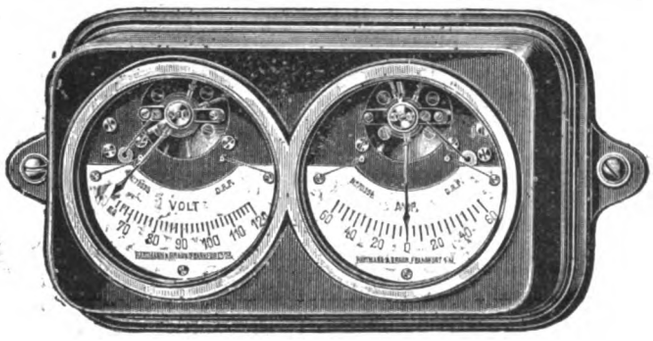
COMBINED VOLT AND AMPERE-METER FOR ELECTRIC TRAM AND MOTOR CAR WORK.

The combination volt and ampere-meter, shown one-third size in the accompanying illustration, is placed on the market by Messrs. O. Berend & Co., of Basinghall-avenue, London, E.C., and is especially designed for electric railway, tram or motor car work, for electric launch and crane work, and for use on small switchboards where space for separate instruments is frequently not available. Both instruments are constructed on the Deprez d'Arsonval principle—a moving coil in a permanent magnetic field—and are mounted in an air and watertight iron case. Iron has been selected for the case in preference to aluminium, as it renders the case less liable to accidental damage and at the same time protects the instruments from external magnetic fields. The slightly increased weight arising from the use of iron is therefore more than compensated for by the increased accuracy of the instruments and the efficient protection this material affords. Each instrument is entirely independent, and in the event of damage can be replaced without interfering with the other.

It is claimed that the frame on which the moving coil is wound, in fact, the complete coil, has been kept as light as possible, which is of great importance in instruments exposed to extreme vibration in use; moreover the powerful damping action of the magnetic field renders the instruments absolutely deadbeat. The dials of the instruments are protected by glass covers of $\frac{5}{16}$in. plate glass, bevelled and bedded into the case in cement. As will be seen, the pointers are not arranged opposite. With the pointers side by side, and pointing either upwards or downwards, errors in reading due to the instruments being at an angle to the observer's eye are practically eliminated.

The amperemeter scale is arranged either with zero in the centre or with zero somewhat away from the centre, as the rate of charging is scarcely ever at the maximum rate of discharging, and this design



admits of higher readings for the discharge. The scale can, of course, be graduated with zero at the left hand for motor work. The instrument shunts for current measurement are not fitted in the case, but can be fitted where most convenient, which saves taking large cables to the instrument, the connections from the instrument to the shunt being made with small flexible leads about 2¼ yards long; these flexibles should not be cut or lengthened, as this would affect the calibration of the instrument.

The voltmeter scale can be arranged either to read from zero or from any desired initial pressure. In the latter case the initial readings are about half the maximum limit, a more open scale at the normal working pressure can thus be obtained.

The voltmeter resistances up to 160 volts are mounted inside the case, but for higher pressures the resistances are in separate cases with perforated metal sides.

The above arrangements also apply to this type for switchboard work, and the instruments can be supplied with either back or front connections for this purpose.

City and Guilds of London Institute.—The report of the Council upon the work of this Institute for the year 1899 is just issued. This is the 20th year of the Institute's working, and a perusal of the report shows the important position occupied by the Institute in connection with secondary education. It is interesting to read that many students of the Institute are at present engaged in the military operations in South Africa, and the names of these students are given. Further, most if not all of the assistants in charge of the Marconi wireless telegraph apparatus in South Africa are men from the Finsbury and Central Colleges. A communication has been received by the Council from the Secretary of State for War offering 15 commissions in the army (viz., 10 in the Royal Artillery and five in the infantry), to students in the schools and colleges maintained by the City and Guilds of London Institute. Much matter of a similarly instructive character is given in the report, which can be obtained at the head offices, Gresham College, Basinghall-street, London, E.C.

TRAMWAY AND LIGHT RAILWAY ACCESSORIES AT ISLINGTON.

In another portion of this issue space is given to a description of the chief electrical features of the Tramways and Light Railways Exhibition now being held at the Agricultural Hall, Islington, London, and those particulars may here be supplemented by a cursory reference to the remaining exhibits, which give the exhibition a fairly representative character. The show is not a large one, but may be taken as an earnest of what is to follow. In the near future an electric tramway and light railway exhibition will doubtless have to be run on a much more extensive scale; for there is gradually being developed all the material for a most instructive and interesting display of electrical power and traction, calculated to vie with the most ambitious of the Earl's Court shows. From the commercial aspect such a show would undoubtedly be remunerative. The British public has by this time become fully acquainted with the overwhelming advantages of electrical over all other kinds of illumination, but it has still something to learn in respect to the advantages of the application of electricity to domestic purposes of almost every kind—to the propulsion of vehicles, and for driving machinery. In London especially, the public knows little of the great development of these branches of the electrical industry, and the time is near at hand when an opportunity on a large scale, with all the éclat of a royal inauguration &c., should be provided for its delectation. This expression of our views is not intended to detract from the usefulness or the interest of the Islington show, which, although small, serves a useful purpose in bringing together under one roof many of the latest improvements in electric tramway and light railway equipment. We miss from the show a great many of the leading firms in the electrical industry, who most probably at the present time are much too busy to give the necessary attention to such secondary aids to business as a small exhibition must necessarily be; but, notwithstanding, this the list of exhibitors include many firms in the first rank. We have only room here to deal briefly with the principal remaining exhibits.

Messrs. Askham Bros. & Wilson, of Sheffield, show an infinite variety of points, crossings, springs, tyres, plates, tools, and general accessories for permanent way construction, similar to those supplied by the firm to Nottingham, Manchester, Halifax, Blackburn, Aberdeen, Dundee, Glasgow, Bury, Dublin, Liverpool, London, Bristol, Sheffield, Bradford, Birmingham, Hull, Middlesbrough, Oldham, Birkenhead, and other towns, and to the numerous lines owned and worked by the British Electric Traction Co. Wherever electric tramway working has been introduced this firm's manufactures are much in evidence.

Messrs. R. Becker & Co. show several continuous-current electric motors of their enclosed type, one of which is at work driving a patent circular cold-sawing machine of the same firm's manufacture.

At stand 18, at the top of the hall, is a neat display of the well-known cables of the British Insulated Wire Co. Typical examples are shown of paper-insulated cables used on the Aberdeen, Glasgow, Manchester, Bradford, Blackpool and Fleetwood, Sheffield, and many other tramway lines in this country. A short length is also shown of the three-phase cable to be used on the Isle of Thanet tramways, now in course of construction and expected to be opened, in part at least, in the autumn. Some good examples of section pillars are also shown at this stand.

At the British Thomson-Houston Co.'s stand, No. 40, is shown a fully-equipped car, similar to those now being supplied by the company to the London United Tramways. A fine type of car, built by Messrs. Hurst, Nelson & Co., mounted on Brill trucks, is also shown here. In this car electric heaters are installed, controlled by a simple switch, giving several easily-regulated gradations of temperature. A quantity of B.T.H. standard overhead material is a feature of the exhibit.

The Brush Company show a bogey vestibule car arranged to seat 44 passengers in two compartments, divided into two classes if desired, or into smoking and non-smoking. The car has a middle entrance, and is a fine example of what can be turned out at Loughborough. A number of tramway controllers are also shown.

The Cape Asbestos Co., at stand No. 72, show a model of a steam boiler covered with the company's patent blue asbestos removable mattresses, and also several steam and hot water pipes, flanges, &c., covered with removable blue asbestos pipe covering. Some interesting examples of crude blue asbestos are also displayed, from the company's mines in Cape Colony. This company are issuing a timely pamphlet containing "Notes on Locomotive and other Boiler and Steam Pipe Coverings." Blue asbestos is claimed to be considerably lighter and to yield a longer and stronger fibre than other classes of asbestos. For use in the form of mattresses and ropes it makes a removable covering for boilers and steam pipes the superiority of which over cement coverings is generally admitted. Removable coverings are made in blue asbestos which are shown by Government experiments to give excellent results compared with many other forms of boiler covering, including silicate cotton, hemp,

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rope, hair, felt, and Pascal cement. A removable covering for steam pipes is of course of equal if not of even greater importance than for boilers, and for this purpose a blue asbestos hollow rope is woven and is coiled round the pipe. This can be removed and replaced over and over again, and allows of perfect freedom of expansion and contraction in cases where cement covering is likely to crack and fall off. These blue asbestos ropes are made in four sizes. The fact that the company's commodities are in extensive use in the chief electricity supply stations, in many of the largest factories, as well as in the British, Japanese, and other navies and on the locomotives of British, Continental, and Colonial railways is fairly claimed by the company as a standing testimonial to the claims made for Cape blue asbestos goods.

At Messrs. CHAS. CHURCHILL & Co.'s stand, No. 64, a grand exhibit of high-class American machine tools for an infinite variety of work are on view. This exhibit deserves careful attention from machine tool users.

An interesting exhibit is that of the CONSOLIDATED CAR-HEATING CO., who show a variety of electric car-heaters, for which many advantages are claimed.

Messrs. CROSSLEY BROS.' exhibit of gas and oil engines is a representative one. The "O. E." type of high-speed gas engine is shown driving a dynamo for electric lighting. The engine gives 12 actual H.P. as a standing working load.

The combined exhibit of Messrs. DICK, KERR & Co., the ENGLISH ELECTRIC MANUFACTURING Co. and the ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS, will be found at stands Nos. 25, 26 and 27. Here are on show four examples of tramcars—No. 1 a vestibule top-seat car for heavy town service, No. 2 a cross-bench car for high-speed summer suburban traffic, No. 3 a 4-wheeled top-seat car, and No. 4 a 4-wheeled single-deck car, with seating capacity for 26 passengers. The car bodies in each case have been manufactured by the Electric Railway and Tramway Carriage Works, and the electrical equipment by the English Electric Manufacturing Co. A large exhibit of permanent way plant and material, including rails, foundations, junction points, rail joints, &c., manufactured by Messrs. Dick, Kerr & Co., is also displayed.

THE ELECTRIC CONSTRUCTION Co. make a fine show of E.C.C. plant, including a 70 kw. variable ratio transformer now largely employed in the distribution of current on the Oxford system for lighting. These machines are also employed on the City and South London Railway as reducers. The arrangement of double field in these transformers, enabling the ratio of the primary and secondary voltage to be varied within any desired limit, is patented. Other exhibits at this stand include a 30 H.P. tramcar motor, stationary motors of the "Bushbury" type, the E.C.C. form of trolley for side suspension, switchboard apparatus, &c.

The ELECTRIC TRAMWAY EQUIPMENT Co. show a number of trolley line and other insulators, made on the "Verus" insulation. Other features of this exhibit are a good show of cars, arm suspensions, frogs, switches and crossings.

At MESSRS. ELLIOTT BROS' stand, No. 26, at the lower end of the east side of the main hall, is displayed a fine group of electric measuring instruments, speed indicators, recording watt and ammeters, and an instructive switchboard panel showing a variety of instruments and methods of fixing to the switchboard for easy reading. A Board of Trade panel shows the instruments necessary for carrying out the tests required by the Electrical Standardising Department in connection with electric tramway undertakings. This is the best instrument exhibit in the hall.

Messrs. S. Z. DE FERRANTI (Ltd.) are content with an excellent display of photographs of Ferranti plant and apparatus for all classes of lighting and power work, which has been installed in many of the chief supply stations of the country.

MESSRS. WALTER T. GLOVER & Co. have a large exhibit in the centre transept, and here samples of a large variety of this firm's well-known types of cables for lighting, power and traction work, are on show, including a drum of single lead-covered cable for tramway feeders. A notable feature in this exhibit is a good display of joint boxes, straight tee and four-way jointers for single concentric, double concentric, twin and three-core cables of all sizes, including a patent cable connector.

THE BRITISH MANNESMAN TUBE Co. have on show a large variety of traction poles, arc lamp posts, trolley poles, &c., in great variety of design and ornamentation. Large quantities of these poles have been supplied for the principal public installations in Great Britain and the Continent.

Amongst the indispensable accessories for tramway working, car-wheels form an essential part. An excellent exhibit of these wheels is made by Messrs. MILLER & Co. at stand No. 24. It is claimed for this firm's manufactures that they have run under electric motor cars in direct competition with the best wheels of other makes, and have given very satisfactory results. A special design of wheel press is shown, working up to a total pressure of 150 tons. A working model is exhibited at this stand of a system of chilled iron double shifting points, as supplied to the Naples Electric Tramways.

Among other well-known firms exhibiting a variety of apparatus and accessories for electric tramway working may be mentioned Messrs. W. F. Dennis & Co., Doulton & Co., Simplex Steel Conduit Co., St. Helen's Cable Co., Estler Bros., Le Carbone, Ohio Brass Co., Mossberg Roller Bearings, Wheeler Condensing & Engineering Co, and the Worthington Pumping Engine Co.

It is fitting that in an exhibition dealing with the latest specialities in tramway and light railway building and equipment, special attention should be given to minor but essential details, and the exhibition under notice is particularly strong in some of these accessories. A noticeable feature is the large number of patent collapsible seats, the object of all the inventions alike being to provide a dry seat for the passenger. Little exception can be taken to the seat which secured the first award. This is a weighted seat for each passenger and tilts to an angle on the passenger rising, leaves the under part of the seat free for advertisements (not an unimportant feature from the tramway owners' point of view), is reversible by the shifting over of the upper rail, and unless the rain is accompanied by a strong wind will keep the seat quite dry. Many ingenious devices (some very simple others much too complicated) are shown in the annexe adjoining the large hall, where also may be seen several examples of tramcar protection fenders of American design and manufacture.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Correspondence for "The Electrician."—Correspondence, both editorial and business, for *The Electrician*, is suffering such considerable delay at the hands of the postal authorities that communications requiring urgent attention should be sent by rail or special messenger when possible. Any communication containing drawings, original MS., or remittances should be separately advised.

Acts of Parliament.—The Royal Assent was given on June 25 to the Electric Lighting Orders Confirmation Acts (1900), Nos. 1, 3, 4, and 5, and the Central London Railway Act (1900).

Ambleside.—The Local Government Board decline to sanction the agreement between the Council and the Windermere Electricity Supply Co. for the supply of electric energy to Ambleside on the ground that the latter have no powers to supply electricity out of their district, and the Council would either have to erect their own generating station or lease their order to the Windermere Company. The Council deem it inadvisable to incur further capital expenditure at present, and the company is to be approached with a view to taking a lease of the order.

Ashton-under-Lyne.—In presenting his annual financial statement to the Council on Wednesday, Ald. Wilson, chairman of the Finance committee, stated that there was a deficiency on the working of the electricity department for the past year of £1,060. 11s. 8d. The account would, however, soon rectify itself and show a surplus instead of a deficiency. The electricity department was still an undeveloped department of the Corporation, but it was progressing and advancing towards prosperity.

Ballarat (Victoria).—The British Insulated Wire Co. have completed the purchase of the undertaking of the Ballarat Horse Tramway Co. for £12,000. It is proposed to reconstruct the lines for electric traction, and to considerably extend the system, the Council being asked to grant a lease for 30 years.

Batavia (Java).—The electric tramway (serving the Sourabaya and Madura districts), which was commenced in 1898, is now completed and in working order for one-third of its length.

Battersea.—The ceremony of laying the foundation stone of the electricity supply station will be performed on July 28, by the chairman of the Vestry (Mr. W. Matthews).

The dispute with the Post Office authorities on the subject of laying telegraph tubes has been settled. The Highways committee reported that it had been decided to give consent to the works on the following conditions:—

(1) The Postmaster-General shall make good damage done in the execution or maintenance of the work. (2) The Postmaster-General shall give notice in writing to the Vestry, in case at any time any of the said telegraphs shall be used or required to be used to connect exchanges of the National Telephone Co. or exchanges of the National Telephone Co. and Post Offices. (3) On receipt of such notice as last aforesaid, the Vestry shall be at liberty, by notice in writing, to withdraw the consent hereby given so far as relates to any telegraphs to be used as aforesaid, and the Postmaster-General, if he objects to such withdrawal, shall take immediate steps to obtain a determination of the difference thus arising in manner prescribed by the Telegraph Act, 1878.

Birmingham.—The Corporation have acquired the site of the old general hospital in Summer-lane for £23,000. It will be utilised as an electric power station, from which energy for lighting, for tramways and for power will be supplied. The area purchased consists of about 4 acres.

Bolsover.—The Council have entered into an arrangement with the Sheepbridge Company for the electric lighting of Whaley Thorne.

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Bournemouth.—Electric lighting is to replace gas in the upper and lower gardens, which form so important a feature of this town.

Brighouse.—The new sewage works at Cooper Bridge were formally opened by the mayor (Mr. Councillor Clay) on Saturday. The tanks and exterior of the buildings are lighted by enclosed "Ark" lamps supplied by Messrs. Johnson & Phillips, and a battery of chloride cells has been provided for the incandescent lighting of the works, manager's house, and committee rooms when the generating plant is not running. "Churton" dynamo, switchboard, and controlling apparatus is installed.

Cambridge.—Negotiations between the Council, the Cambridge Street Tramways Co., and the British Electric Traction Co. for regarding the acquisition of the local tramways have, we understand, been dropped for the present.

"Cassier's Magazine."—The July issue contains articles on "Electric Power for Factories," "Invention as a Factor of American National Wealth," "Machine Tools in the Mechanic Arts," "Economies in Machine-Shop Work," and "The Development of Flywheels."

Chatham.—The Chatham, Rochester & District Electric Light Co. will introduce the maximum demand system of charging for electric current from Oct. 1. The charge will be 7d. per unit for the first hour and 2d. after. The company will introduce "free" wiring. A consumer can, under this system, have the first six lamps fixed without initial charge. The revised charge for current to consumers will be 7d. per unit for the first hour and 2½d. after.

City of London.—The City of London Electric Lighting Co. has been granted permission to substitute 14in. by 11in. troughing for the 9in. by 6in. troughing at present in the Queen Victoria-street subway between Blackfriars and St. Andrew's-hill. Increased rent in accordance with the scale laid down by the Council in respect of the space which will be occupied in the subway by the larger troughing has to be paid.

Cleckheaton.—The Council have purchased land for the erection of electricity supply and refuse destructor works.

Cork.—Eighty-five additional public arc lamps are to be erected here. The annual charge for the supply of current to and for the maintenance of the lamps will be about £1,275, and the present cost of gas lighting (about 270 lamps will be displaced) is £766. 8s. 4d. The illuminating power of the arc lamps will be equivalent to 168,000 c.p., against 2,705 c.p. of the existing gas lamps.

Devonport.—An inquiry was held on Wednesday into the application of the Corporation to borrow £69,727 for electricity supply. The town clerk (Mr. A. B. Pilling) gave evidence of the town's assessable value, &c., and technical details were furnished by the borough electrical engineer (Mr. Charles Furness), who explained that the station premises on the waterside frontage would be capable of storing about 1,200 tons of coal. It was proposed to have three steam dynamos, one of 300 H.P. (which would be used for lighting), one of 600 H.P. for traction work, and a third unit of 600 H.P. would be held in reserve. They would start the working of the plant with an assured demand for 700,000 units per annum. The system of distribution would be the low-pressure continuous current.

Driffield.—The Council has resolved to oppose an application by the Northern Counties Electricity Supply Co. for a provisional electric lighting order.

Dundee.—The Perth-road electric tramway route is approaching completion, and the line will be ready for traffic about the middle of July.

Electrical Bills.—In the Westminster (London) County Court on Monday, Judge Lumley Smith, Q.C., heard a claim (Smeeton and Page v. Collings) for £2. 5s. 9d., balance of a bill for £32. 1s. 9d. for electrical work done. An estimate was made for a small electric job at defendant's house to include all materials, casings, tubing, cables, wires, switches and wall plugs, and wiring, for 16 additional lamps. The estimate was £13. 10s. Other items in the rendered account for the work were said to be for extras ordered afterwards. The JUDGE: If I have a pair of trousers made I should not expect a bill to come in for extras. Mr. FIRTH (for plaintiff): Electrical bills are always made out like this. The JUDGE: I have paid a good many, and it was not so. The judge said the charge was in excess of what it ought to be, and found for plaintiffs for 30s. and costs.

Electrical Cabs in London.—On the subject of the failure of the London Electrical Cab Co., Mr. Carl Oppermann (who has occupied for many years a prominent position in the electric automobile industry) writes:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir,—One would think, from reading the circular of the directors of the late London Electrical Cab Co. (Ltd.) that the electrical vehicle was an impossibility, and that the vast sum subscribed by the public was used in endeavouring to put a practical vehicle on the streets. From the manner in which the capital was spent, some might feel inclined to suggest that the only reason for which the company was started was to obtain the £25,000 for the valuable (*sic*) licences, without which, we were told, you could not make electrical vehicles at all, although the electrical landau shown to would-be shareholders at Winchester House, E.C., was made under quite a different system, and one for which no licence was required other than that conveyed to the purchaser of any patented article.

The directors say that although the designs were approved of by engineers and experts, several defects developed themselves in the vehicles. To my knowledge, the directors were advised to make only two cabs in order to find out what was required to stand the London street traffic; but instead without any actual experience to guide them, the directors put in hand 40 cabs at once. They say these were too heavy for the rubber tyres. Of course 38cwt. to 40cwt. was too much for the same kind of wheels and rubbers that one would find on an ordinary four-wheel horse-drawn cab weighing only 8cwt., and which were put on the first electric cabs. The vibration, too, we are told, destroyed the cells. One cannot be surprised at vibration in a vehicle built practically without springs. What further damaged the cells was the enormous amount of the current taken from them owing to the want of attention to the gearing and sending out of the cabs without proper oiling arrangements. Not any of the vehicles had an ampere meter, so that however anxious a driver might be to run the cabs successfully, he had no certain means of telling whether his cab was running properly or not.

Then there was the driver bogey. Can one expect men who have a living to earn not eventually becoming disheartened and reverting to the old horse-drawn vehicle in consequence of the continuous breakdowns—breakdowns which could in all cases have been prevented by proper supervision and examination of the cabs after each day's run? I know that it is possible to obtain any number of men who could, with slight training, properly drive an electrical vehicle.

Consider, again, the large sum spent upon the alternating transformer plant put down to supply current for the accumulators, and which turned out to be practically useless, and was abandoned, as the current ultimately cost 4d. or so a unit, a continuous-current plant being afterwards put down at a further cost of several thousand pounds, although all the current necessary for the undertaking could have been obtained without a farthing outlay at about 1½d. per unit from supply stations in London.

To show that electrical vehicles can be made to run, and at a profit, when properly managed, you have only to turn to New York, where, starting with a modest 20 cabs, the number is now increased to over 200; or to Berlin, where electrical omnibuses are in use successfully; and also to some electrical victorias, which have been recently hired out in London and have proved an unqualified success. But no company started to hire out electrical carriages can ever prove profitable if run upon the lines of the late London Electrical Cab Co.

That smart, comfortable, and reliable electrical carriages will eventually appear in our streets in large numbers there is not the shadow of a doubt, as their popularity is beyond all question. The entire absence of noise and vibration, heat, or unpleasant odours either to the passengers or to anyone in their immediate neighbourhood, and the ease with which they are controlled, all tend to make them an ideal means of locomotion.

Glasgow.—The revenue of the Corporation tramways for the year ended May 31 amounted to £469,965, compared with £439,224. 1s. 8d. in 1899, and the working expenses to £344,661, against £318,105. 18s. 11d, leaving a balance of £125,304, compared with £121,118. The balance has been applied as follows: Rent of Govan and Ibrox tramways, £1,983; interest on capital, £17,295; sinking fund, £11,636; depreciation, £32,079; common good, £12,500; general reserve, £46,809. The traffic revenue showed an increase of £31,658. The revenue on the electric system was about 1s. 2d. per car mile, and from the horse cars 11½d. During the year about £400,000 has been spent on renewal of track and on conversion and electrical equipment.

Hackney (London).—To encourage the demand for electric current the Electric Lighting committee, on a report from the consulting engineer (Mr. Robert Hammond), recommend that the charge for current for private lighting be fixed at 4d. per unit, and 2d. for motive power.

Hammersmith (London).—The Vestry have fully discussed the question of extension of the electric lighting mains, and have decided that 24 additional thoroughfares should be scheduled, and the work carried out at an estimated cost of £8,877. In order to meet the cost of these extensions, the necessary transformers, &c., the Vestry intend to borrow £15,500. The Electric Lighting committee have reported against the proposal to reduce the charge for electric current.

Hanley.—The special Electric Lighting sub-committee recently appointed to consider and report upon the reasons for the deficiency shown on the working of the electricity department for 1899 presented the result of their investigations to the Council on Tuesday. The borough engineer (Mr. Joseph Lobley), in conjunction with the electrical engineer (Mr. C. A. Cowell), had prepared reports on the matter. Mr. Lobley stated that loans amounting to £70,009 had been sanctioned, and £64,990 had been borrowed. Applications had been made for further borrowing powers for £4,000 to cover cost of boiler-house requirements. During the past year £7,044 had been expended on capital account, bringing the total expenditure up to £67,829. The capital outlay amounted to £55 per kw. of generating capacity. There were only three local authorities and one company where the expenditure had been lower than Hanley. There was, therefore, no cause for apprehension as to the future financial success of the undertaking. The total capacity of the station is 1,224 kw. The maximum demand last year was 550 kw.; this year it might be expected to reach 650 kw. There was no ground for the suggestion

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that the plant was obsolete and out of date, and should consequently be valued at much less than cost price. The land had not become less valuable, and the buildings were maintained up to the original value, or even beyond it. As regarded the mains, there was no general experience extant as to how long they would last. No sign whatever of depreciation had become apparent, and all local defects arising from extraneous causes were put right out of revenue. The street lamp posts did not deteriorate, and the arc lamps were maintained out of revenue. The same remark applied to all other items, with the exception of machinery, which must be specially treated. The early Brush engines and rope-driven dynamos were not quite up to date. The capacity of these Brush engines and dynamos was 324 kw. The remaining plant, including boilers, condensers, pumps, Ferranti steam alternators, rectifiers, &c., were thoroughly up to date. The machinery, including that which was not quite up to date, was doing exceedingly useful work. The mechanical stokers had not proved altogether a success, notwithstanding the efforts of the committee to secure good ones. New furnaces had been provided out of revenue, and thus the plant was maintained at its original value. Mr. Lobley further states that there is no dual control. He did not in any way interfere with Mr. Cowell in the control of his staff. The expenditure on revenue account amounted to £7,632, the receipts to £8,609, leaving a gross profit of £1,177 and interest and sinking fund charges amounted to £3,446, causing a deficiency of £2,269, which had had to be transferred from the general district rate account. Places of worship were charged 4d., and heating and power 2½d. and 1d. per unit, but the total revenue from these sources had been less than £100 a-year. Notwithstanding the reduction in the price charged, the total revenue had steadily increased year by year. The expenditure had also increased, and particularly during 1899. The deficiencies began with the reduction in the charge per unit. It was quite expected that there would be some deficiency for the first year or two. If the original charge of 6d. and 3d. per unit had been adhered to, the revenue would have been greater in 1895 by £200; 1896, by £300; 1897, by £800; 1898, by £900; and 1899, by £1,400; or a total of £3,600. The increase of the sinking fund continued, and now amounted to £5,638. Their high figures charged on revenue account for maintenance disposed of the argument that this fund should not be regarded as a valuable asset to its fullest extent. The expenditure on revenue showed a great increase in several items. If the works had been carried on during 1899 at the same price per unit as in 1898 (2·48d. instead of 3·18d.), the gross profit would have been £2,746 instead of £1,177. There was an increase in the cost of coal of £959, after allowing for the additional output. The average price received for private supply in Hanley was 4·09d. per unit. Sixteen local authorities and three companies in this country had received a lower average price. To a considerable extent Mr. Cowell's report covered the same ground as Mr. Lobley, but went more into detail as to works costs, maintenance, renewals, &c. It concludes by stating that a considerable sum could be saved per year if better arrangements were made for handling coal. In the plans prepared for the new boilers, &c., this had been provided. Hanley was one of the very few stations that did not work with fuel economisers for heating the feed water. What would do more than anything to reduce the quantity of fuel used would be to put down economisers in connection with the present boilers as well as with the proposed new ones. In the plans now being sent to the Local Government Board this provision was included. The sub-committee reported that, after full consideration, they were of opinion that the deficiency in the revenue account for last year was to be attributed to the following causes: (1) Too early reduction in the price of current before a reserve fund had been formed; (2) increased cost of fuel, wages and materials; (3) abnormal repairs to generating plant; (4) increased charges to sinking fund and interest on further capital. They decided to recommend the Council to increase the present prices for the supply of electric current of 5d. and 2½d. to 6d. and 3d. per unit from July 1, less discounts, as before. They also recommended that the charge for supply to places of worship be increased from 4d. to 4½d. per unit, and for heating and power supplied through separate meters from 2½d. to 3d. up to four hours' consumption per day, and 1d. per unit after. The adoption of the minutes was carried after considerable discussion.

Holborn (London).—On the recommendation of the Works committee it has been decided to invite the electric lighting companies serving the district (County of London & Brush Co, the Metropolitan Electric Supply Co. and the Charing Cross and Strand Electricity Supply Corporation) to send in estimates for lighting the district electrically.

Infirmary Lighting.—On the recommendation of the Building committee the Southampton Board of Guardians are providing an electric lighting installation to their new infirmary.

Kilmarnock.—The council have acquired a site for electricity works at Riccarton.

Lancaster.—Profit on the Electric Lighting department for the past year was £420. 18s.

Light Railways.—The Peterborough and District Light Railways Order has been submitted to the Board of Trade for confirmation. Objections must be lodged by July 21.

An inquiry was held on Friday into the application of the Oldham, Ashton & Hyde Electric Tramway (Ltd.) for an order to authorise the construction of a light (electric) railway from Ashton, through Dukinfield to Hyde, and from Hyde to Denton. The Ashton, Dukinfield, Hyde, and Stourbridge Corporations and the Denton Council opposed, and the chairman (Earl Jersey) announced that the Commissioners could not, in face of the strenuous opposition of the local authorities, force a scheme of the kind upon the district. The application was accordingly refused.

The Bexhill and St. Leonards light railway order was recently confirmed by the Board of Trade. The promoter (Mr. W. M. Murphy, J.P.) is also promoting a bill for the construction of electric tramways in Hastings, and both schemes will eventually be connected up and probably amalgamated.

At a special meeting of the Northwich Council the engineers of the United Kingdom Tramway & Light Railway Electric Syndicate (Major Tulloch and Mr. H. W. Handcock) explained the proposal to construct a light electric railway on the overhead trolley system between Northwich, Winsford and Middlewich. For the Northwich district it is proposed to commence the line on the Manchester main road, run to the station, carry a branch to Broken Cross, construct the overhead system from the station through the town and on to the Winsford and Middlewich main roads. These towns would thus for the first time be connected. Goods, as well as passengers, will be carried. The Council unanimously adopted a resolution in favour of the scheme, but subject to details to be submitted to a future meeting being acceptable.

An inquiry was held on Wednesday, at Mansfield, into the application of Messrs. Fell, Lewis & Kershaw for authority to extend their original electric tramway scheme for Mansfield and district. Three new lines were proposed. After hearing evidence, the chairman (the Earl of Jersey) announced that the Commissioners would report in favour of granting the order.

London County Council.—At Tuesday's meeting it was decided that, having regard to the price at which the recent issue of County Council stock was subscribed, the rate of interest for loans granted by the Council to the London local authorities should remain at 3½ per cent. Loans of £20,000 to Battersea, £10,000 to Poplar, and £20,000 to Shoreditch for electric lighting purposes were approved. The Asylums committee presented a report involving a capital expenditure of £39,000 for a central station at the Horton estate for the supply of water and electricity to the Asylum and to the suggested epileptic colony. The report states that the buildings have been so designed that they could be extended from time to time to whatever capacity may be required. The lighting plant is for an installation of 3,800 lamps, equivalent to 8,187·8 c.p. lamps, and will also provide current for 16 motors ranging from 1 B.H.P. to 22 B.H.P. The three-wire system at 400 volts is recommended, with 200 volt distribution in all rooms occupied by patients and staff. The estimated cost of the electric lighting plant was £18,000. Consideration of the report was postponed for a week.

Lowestoft.—The Council have applied for sanction to borrow £20,000 for electric lighting extensions. This sum is to be applied as follows: For extensions already authorised £4,760, additional mains £1,900, feeders and pilot wires to Pakefield and Park £3,890, additional distributing cables to be laid when desirable, together with additional meters, cut-outs and house service connections, £5,000; additional steam dynamo, boiler, steam pipes, switch gear, &c., £3,000; legal and advertising expenses, printing, engineering fees, &c., £1,450. The Council have also decided to invite offers from firms willing to undertake the wiring of premises on the hire-purchase system. The following charges have been fixed for the supply of electric current for lighting: 7d. per unit for the first 100 hours' maximum demand per quarter, and 3d. per unit beyond. For power 7d. per unit for the first hour's maximum demand per day and 1½d. after. The Council have further decided to appoint a resident electrical engineer at a salary of £200 per annum. The consulting engineer (Mr. W. C. C. Hawtayne) has been instructed to submit a specification for the lighting of the town hall.

Lymington.—Some time ago the Council entered into a contract with the Lymington Electric Light & Power Co. for public lighting for five years. The contract for gas lighting terminated on 24th inst., and the gas company refused to continue the lighting for a shorter term than 12 months. The Electric Light Company intimate that they will not be in a position to supply current for three months, but offer to pay the cost of gas lighting in the meantime.

Manchester.—At the Council meeting on Wednesday it was resolved, on the motion of Mr. F. Brocklehurst, to refer a memorial from the Mutual Telephone Co. in regard to their application for a municipal telephone licence to a special telephone committee.

Melbourne.—For some time past negotiations have been proceeding between the Electric Lighting & Traction Co. of Australia and the Victorian Postal Department, regarding the proposed

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transfer of the undertakings of the A. U. Alcock Electric Light & Motive Power Co. and the New Australian Electric Co.; but it has now been discovered that the Electric Light and Power Act does not authorise the Governor in Council to grant the transfer sought. An alternative arrangement has, however, been come to. The new English company will seek an Order in Council empowering them to carry on operations for the unexpired term of the existing orders held by the A. U. Alcock and New Australian Companies, which will be cancelled, and at the same time the Postmaster-General will introduce a bill in Parliament to amend the present Act, so that the Governor in Council may be able to grant transfers. Some three months will have to elapse before the orders can be issued. The British Insulated Wire Co., who desire to secure similar powers in regard to Ballarat and Geelong, has also determined to apply for an Order in Council.

Motor-Driven Passenger Boats.—The police authorities of Stettin and Swinemünde (Germany) have issued instructions requiring owners and masters of vessels driven by electric power, carrying passengers to and from either of these ports, to provide themselves with certificates from the local authorities granting permission to carry passengers.

Municipal Telephony.—It is stated that the response to a canvass made by the Grantham Council as to the amount of support the ratepayers were prepared to give the proposal to establish a municipal telephone exchange, has not fulfilled the expectations of those members of the Council who have taken the matter up with some spirit.

Newport (Fifeshire).—The Newport Gas Light Co. desired to obtain electric lighting powers but the Burgh Commissioners notify that they propose not only to themselves apply for a provisional order but also to purchase the gas works. The company's proposal has therefore been dropped.

Oldbury.—The District Council has come to an understanding with the British Electric Traction Co. as to the electrical equipment and leasing of the local tramways. The lease is to be extended by 21 years and the lines worked by the company. It was announced at the Council meeting last week that the Oldbury to Dudley electric tramway would shortly be opened for traffic.

Pemberton.—An inquiry has been held into the application of the Council to borrow £20,000 for electric lighting. Mr. Leach opposed on behalf of a section of the ratepayers, and said that at the present time the bulk of the residents did not even use gas, whereupon the chairman of the Council said that that was one of the reasons the Council thought it better to put down an electric lighting installation. In addition to other objectionable features accidents from paraffin lamps had been frequent.

Portsmouth.—The Tramways committee have decided to increase the original estimate of £24,000 to £32,000 for electric tramways; 80 cars are to be placed on the lines instead of 60.

Redfern (N.S.W.).—When Major Cardew recently visited Australia for the purpose of reporting on the electric lighting question for the Sydney Municipal Council, he was also invited to consider the advisability of extending and improving the electricity works at Redfern. The report which Major Cardew presented to the Council concludes as follows:—

My advice to you is to make the best of what you have got, and when the Sydney electric lighting scheme has come into operation make the best bargain you can with the City Council for supplying current for your street lighting and for the goodwill of your undertaking. If you should, however, decide to continue the electric supply business, you should certainly remodel the whole of your arrangements and lay some underground mains. The total cost of conversion would be about £10,000.

A special meeting of the Council was recently held for considering this report as well as that of the Electric Lighting committee, when it was decided to adopt the reports in so far as they recommended that the management of the electric light works shall be placed under one head at the power-house. It was also decided that the future tariff of wages to be paid at the generating station should not exceed that suggested by Major Cardew, viz., electrical engineer, £3. 15s.; engine driver, £3. 5s.; one fireman and driver combined, £2. 10s.; one assistant fireman, £2; one wireman, £1. 15s.; one lamp cleaner, 15s. Total £14.

Rugby.—The Council obtained a provisional order in 1898, and about 12 months ago issued circulars to ratepayers to ascertain their views on the advisability of establishing electricity works. A committee has been appointed to obtain offers from companies desirous of establishing electricity works.

St. Ann's-on-Sea.—The second site for the electricity supply station, which involved a second Local Government Board inquiry, has been abandoned and a third site chosen.

St. George's, Hanover-square (London).—Some time ago the Westminster Electric Supply Corporation offered to supply current to and maintain 600 lamps in this district at a cost of £13,500 per year, or 756, which the Lighting committee considered necessary, for £16,932 per year, without any capital expenditure on the part of the Vestry, and the total cost was to be subject to annual reduction. The corporation's right would extend over 32 years, but if the period of supply was limited to 10 years, the annual cost would be £15,000 for 680 lamps, and £19,230 for 756 lamps. Gas now costs £10,000 a year, so that a penny rate would cover the additional cost of the electric light. At the meeting of the Vestry last month the consideration of this offer was deferred for six months. The large increase in the charge for gas has led to the matter coming up for earlier consideration, and at the meeting last week it was decided (by 40 to 22) to rescind the previous resolution. The gentleman on whose initiation it was again discussed (Mr. W. Everitt), said there was no parish in London which was worse lighted than St. George's. Electric lighting was the best, and seeing that the Vestry could not themselves undertake a scheme he thought they ought to accept the offer of the Westminster Electric Supply Corporation. Col. Sir Howard Vincent, M.P., and Mr. Antrobus also supported the resolution to extend the electric light. Eventually a resolution sanctioning the extension of public electric lighting throughout the parish, and authorising the Electric Lighting committee to obtain expert opinion upon the offer submitted by the Westminster Corporation was approved.

Swansea.—The Corporation have decided to extend the electric lighting area to Morriston, Port Tennant, Cwmbwrla, Sketty Road, and Brynmill.

Tamworth.—Messrs. Handley & Shanks have notified the Council of their intention to proceed with the application for a provisional electric lighting order. The Council have resolved to oppose.

Tewkesbury.—The Council last week deferred the discussion of a motion to apply for a provisional order.

Thornhill.—The increase in the price of gas has led to an agitation in favour of the introduction of the electric light. The advent of an electric lighting company would be welcomed.

Torquay.—An inquiry was held on Tuesday into the application of the Council to borrow £15,000 for electric lighting extensions. The town clerk explained that the electric lighting undertaking had developed so rapidly that additions to the plant, which was laid down so recently as 1899, was imperative. At the end of March, 1898, there were 55 consumers, but on March 31 last the number was 221. The total equivalent number of 8 c.p. lamps connected in March, 1898, was 5,688, of which 3,310 were private lamps, and in March last there were 10,070 lamps. Some applications in hand could not be dealt with. The total revenue for the first year was £2,837, last year it was £3,699. There was a gross profit of £1,057 on the first year's working and of £1,256 on the second year's. Interest and sinking fund in each year was £1,188. There was thus a deficit of £138 on the first year, and a profit of £67 on the second. It showed the undertaking was rapidly coming into favour and was paying its way. Technical details were given by the borough electrical engineer, Mr. P. Storey.

Train Lighting.—The managing committee of the South Eastern and Chatham Railway Co., who are making large additions to their rolling stock, have made experiments in lighting their trains, and, having regard to the risk attendant upon the use of gas, have decided that the whole of the passenger trains on the combined system shall be lighted electrically.

Water-Power Utilisation in Italy.—A company, entitled La Società Italiana per le Forze Idrauliche del Veneto, has been formed in Venice, with a capital of £240,000, to put down plant to utilise available water power in the province of Venice. The company has acquired the rights to utilise the water power of the River Piavè (estimated at 40,000 H.P.) and of the Cellina torrent (22,000 H.P.) A 6,000 H.P. plant is to be at once installed, the electrical energy to be transmitted to Venice.

Watford.—The Council have decided to put down additional plant, and to apply for sanction to borrow £5,000 to cover cost of same.

Worcester.—An inquiry was held here on Tuesday into the application of the Council for sanction to borrow £1,000 for wiring premises in the district on the hire-purchase system. The town clerk explained that the proposed arrangement with the National Electric Wiring Co. had terminated. It was proposed to make such charge to consumers as would repay the capital outlay and interest in 10 years, the period of the desired loan. As most of the houses were let on yearly tenancies neither tenants nor landlords cared to undertake the installation, so the Corporation had drawn up a form of agreement to which the landlord would be made a party. The chief engineer (Mr. Hoadley) mentioned that he had worked out the average cost of electric current to all consumers. The cost to public houses worked out at about 3·3d. per unit, to shopkeepers and private houses about 4½d., and to churches and similar buildings, which required current for only a short period, to about 6d.

Worms (Germany).—Electricity supply works, estimated to cost about £55,000, are to be erected in this town by the Elektricitäts Aktiengesellschaft vorm. Schuckert & Co.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Extension of Time—Tunbridge Wells Corporation invite tenders for telephone instruments, apparatus, material, and accessories, particulars of which are set out in an advertisement. Copies of the specification can be obtained from the telephone engineer (Mr. A. R. Bennett), Castle Chambers, West Regent-street, Glasgow, and tenders have to be delivered to the offices of Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, not later than Thursday, July 12.

Partick Commissioners invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, &c., and for the supply and erection of cast-iron arc and incandescent lamp standards, arc lamps, automatic switches, and other fittings. Specification may be obtained at the offices of the town clerk (Mr. Jas. Donaldson), 97, West Regent-street, Glasgow. Specification may be inspected (but not obtained) at the office of the consulting engineers (Messrs. Kincaid, Waller & Manville), 29, Great George-street, Westminster, S.W. Further particulars are set out in an advertisement, and tenders must be sent in to Mr. Donaldson by July 10.

Hammersmith (London) Electricity and Lighting committee invite tenders for insulated high and low-tension cables, junction boxes, &c., and cast-iron pipes, draw-box covers, &c, required, as per schedule, for 12 months. An advertisement contains further particulars, and specification, &c., can be obtained from the engineer and manager (Mr. G. G. Bell), 57, Fulham Palace-road, W. Tenders to chairman of committee by July 12.

Lowestoft Corporation require tenders for (1) direct-current meters, and (2) cutouts. Specifications, &c., can be had from Mr. R. Beattie Nicholson, town clerk, and can be seen at, but not obtained from, the office of Mr. W. C. C. Hawtayne, 9, Queen Street-place, London, E.C. Tenders to Mr. Nicholson, town clerk's office, Lowestoft, by 12 noon of July 3. An advertisement contains further particulars.

Beckenham District Council invite tenders for the "free" wiring of premises. Specification may be obtained from the consulting engineer (Mr. R. P. Wilson), 66, Victoria-street, Westminster, S.W., or from the borough engineer and surveyor (Mr. A. Angell) Tenders to the clerk (Mr. F. Stevens) by 4 p.m of July 16. See advertisement.

Grays Thurrock District Council require tenders for electricity generating plant, particulars of which are set out in an advertisement. Specification, &c, can be obtained, after July 2, at the offices of the consulting engineers (Messrs. Preece & Cardew), 13, Queen Anne's-gate, Westminster, S.W. Tenders must be delivered at the office of the clerk (Mr. Chas. E. Hatten) by noon of Aug. 9.

Croydon Corporation invite tenders for the reconstruction of the present tramway track and the construction of new tramways and paving of roads. Specification, &c., can be obtained at the offices of the town clerk, Town Hall, Croydon, after June 25, and all further particulars can be had from the engineer (Mr. E. W. Monkhouse), 14, Old Queen-street, Westminster, S.W. Tenders must be sent to Mr. E. Mawdsley, town clerk, Town Hall, Croydon, by 12 noon of July 10.

Huddersfield Corporation Electricity committee invite tenders for a single-phase steam-generating plant of 1,000kw. capacity. Specifications, &c., can be obtained from Mr. A. B. Mountain, borough electrical engineer, Electricity Works, St. Andrew's-road, Huddersfield, and tenders must be sent to Mr. F. C. Lloyd, town clerk, Town Hall, Huddersfield, by Thursday, July 12.

Extension of Time.—The date for tenders for the overhead equipment for about 16 miles of equivalent single track of tramways, for the Corporation of *Durban*, Natal, has been extended. Tenders (in duplicate) to Messrs. Webster, Steel and Co., 5, East India-avenue, London, E.C., by July 20, or to town clerk, Durban, on or about Monday, Aug. 13.

Swansea Corporation require tenders for main switchboard and instruments and a battery of accumulators and accessories. Tenders to consulting engineers (Messrs. Kincaid, Waller & Manville), 29, Great George-street, Westminster, by July 5.

Salford Corporation require tenders for overhead equipment for tramways, exclusive of steel poles. Tenders to town clerk by 10 a.m. July 16.

Limerick Corporation require tenders for the supply and erection of electrical plant and apparatus. Tenders to town clerk by July 14.

Edinburgh Corporation invite tenders for copper strip. Tenders to town clerk by July 9.

Blackpool Corporation invite tenders for trolley poles, cables, and trolley wire, boosters, and switchboards and a storage battery. Tenders to chairman Electric Lighting and Tramways committee by July 23.

Aron Electricity Meter (Ltd.), 46, Upper Thames-street, London, E.C., require tenders for the supply and delivery of large and small metal cases. Tenders by noon July 2.

Warrington Corporation invite tenders for the installation of the electric light in the town hall, bank house, museum, school of art, &c. Specification from Mr. W. H. Grimsdale, Bank House.

London County Council require tenders for the supply (within three months of order) of about 70 arc lamp standards for lighting Victoria Embankment. Tenders to clerk (Mr. C. J. Stewart) by July 10.

Trimdon (Co. Durham) Parish Council invite tenders for public lighting by electricity or acetylene gas. Tenders by July 17.

Hackney (London) Electric Light committee require tenders for 220 arc lamp pillars. Tenders to clerk by July 11.

Tottenham Council invite tenders for fire alarm posts and instruments, &c. Tenders to clerk by July 3.

Southend Council invite tenders for about 1,180 tons of steel rails and about 46 tons of steel fish-plates. Tenders to town clerk by July 25.

Leeds Corporation require tenders for supplying and erecting two, four or six steel boilers at their Crown Point generating station. Tenders to town clerk by July 9.

Whitehaven Corporation require tenders for stores, including electric fittings, incandescent lamps, &c. Tenders to town clerk by 30th inst.

Cardiff Corporation require tenders for about 1,000 tons of steel tramway rails, fish-plates, sole plates, tie bars, bolts and nuts, points and crossings, drain rails, copper rail bonds, &c. Tenders to town clerk by July 12.

Tenders are required for wiring the *Stockport* Technical School. Tenders to gas and electricity office, Portwood, by July 5.

Tenders will be awarded on Aug. 18 next for a concession to construct and work a system of electric tramways on the overhead trolley system at *Barcelona* (Spain). Particulars relating to this matter can be consulted at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

Tenders are also invited for a concession for establishing and working for 20 years electricity supply for the town of *Lora del Rio*, Seville (Spain). This contract is to be awarded on July 5. Particulars relating to this tender are also to be obtained at the Commercial Intelligence Branch of the Board of Trade in London.

Tenders are invited until July 21 by the municipal authorities of *Algemesi* (Valencia, Spain) for the concession for electric lighting for 10 years. Tenders to El Secretario del Ayuntamiento.

Tenders are invited until July 14 by the municipal authorities of *Jumet* (Belgium) for the concession for electric lighting.

TENDERS RECEIVED AND ACCEPTED.

Watford District Council have accepted the tender of Messrs. S. Z. de Ferranti (Ltd.) for a 300 k.w. steam alternator at £3,150 Plant to be delivered, and in running order, within four months from date of order. The tender of Messrs. Babcock & Wilcox for an additional boiler, at £930, is also recommended.

Dundee Town Council have accepted the tender of Messrs. Hiley & Orchar for wiring the new fire brigade station at £50.

Luton Council have accepted the tender of Messrs. Main, Kendal & Main, Loughborough, for the erection of electricity station buildings at £4,175.

The Hammersmith (London) Vestry have accepted the tender of Messrs. Johnson and Phillips for the supply of twelve 25kw. transformers at £63 each.

APPOINTMENTS VACANT AND FILLED.

The following appointments are vacant at the Northampton Institute, Clerkenwell, London, E.C.: Senior lecturer and assistant in the mechanical engineering department, a junior demonstrator, a junior technical assistant, a junior lecture assistant and an optical demonstrator in the electrical engineering and applied physics department. Applications to the principal (Dr. R. Mullineux Walmsley). See advertisement.

Derby Technical Educational committee require lecturers and demonstrators in mechanical engineering, and in physics and electrical engineering for their municipal technical college. An advertisement gives further information, and applications must be sent to the principal by July 9.

Swansea Corporation require a resident electrical engineer to take charge, under the superintendence of the consulting engineers (Messrs. Kincaid, Waller & Manville), of the erection of electricity generating plant and the laying of electric mains. An advertisement contains further particulars, and applications must be delivered to the town clerk (Mr. Jno. Thomas), Guildhall, Swansea, by July 9.

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The directors of the Johnson-Lundell Electric Traction Co. (Ltd.) invite applications for the position of general manager. Particulars are given in an advertisement, and applications are to be made in writing to Mr. Leonard W. Holmes, 17, Soho-square, London, W.

A Council in the South of England about to erect electric lighting plant require an engineer capable of advising and superintending a small generating station. See Advertisement.

Several test clerks are required for the Glasgow Corporation telephone department. Particulars from the consulting engineer (Mr. A. R. Bennett), Castle Chambers, West Regent-street, Glasgow. See advertisement.

Norwich Technical Instruction committee require an assistant lecturer and demonstrator in physics and electrical engineering. Applications to principal (Mr. Wm. Gannon, M.A.) by July 6.

The Vestry of St. John, Hampstead (London) require an assistant electrical engineer. Applications to vestry clerk by July 2.

The Council of the King's College, London, invite applications for the post of demonstrator in electrical engineering. Conditions of appointment from Secretary, and applications by 30th inst.

An assistant electrical engineer is required for the County Asylum, Wittingham, Lancs. Applications to medical superintendent.

Salford Corporation require a clerk of works on their new Strawberry-road electricity station building. Applications to town clerk by 30th inst.

British Electric Traction Co. require additional secretaries and accountants for its subsidiary companies. Application to secretary, Donington House, Norfolk-street, London, W.C.

The Council of the University College of North Wales, Bangor, have appointed Mr. W. W. Firth, B.Sc, formerly Whitworth Exhibitioner, to the assistant lectureship in electrical engineering, which the college has been enabled to establish by the liberality of the Drapers' company. Mr. Firth commended his career in the works of Messrs. Platt, at Oldham, and was trained at Owens College, Manchester, and the Royal College of Science, London.

Mr. G. C. Lamb, demonstrator at the Engineering Laboratory of Cambridge University, has been appointed electrical inspector by the Cambridge Corporation. Mr. Lamb has undertaken to make tests of electrical pressure at consumers' terminals at a nominal fee of £5. 5s. per annum (to be paid by the Corporation) with an additional fee of 10s. 6d. for each test, to be paid by the consumer.

Mr. Dunton has been appointed resident electrical engineer at Whitehaven, in succession to Mr. J. G. Scott, who is going to Leith. The commencing salary is £150 per annum, and Mr. Dunton has entered into an agreement to remain with the Council for three years.

Mr. H. J. Robinson, at present with the Dublin United Tramways Co., has been appointed chief assistant electrical engineer to the Pembroke (Dublin) District Council.

BUSINESS NOTICES.

In connection with the recent formation of the Johnson Lundell Electric Traction Co. (Ltd.), we understand that the financial arrangements are now completed and the organisation of the works is being rapidly perfected. Mr. C. Tilley has been appointed secretary and Mr. A. F. Hall engineer to the company. Mr. Hall has had a large experience in the States, and was chief draughtsman to Mr. H. F. Parshall at the time when the latter was engaged in designing the big generators of the General Electric Co. of New York.

An advertisement in the daily papers referring to the sale of certain leasehold property in St. Martin's-lane and Charing Cross-road, London, W.C., has conveyed the impression that the Electrical Standardising, Testing and Training Institution is removing from Faraday House. The secretary, Mr. H. Foulds, writes to say that the institution holds a long lease of its present premises which it is intended to exhaust. The sale of the superior lease therefore does not affect the institution.

In order to cope with increasing business in the London district the Sunbeam Lamp Co. are opening offices at 141, Fenchurch-street, E.C. Mr. E. J. Hogan, who has for many years managed their business under the company's late agents, has been appointed London manager. Letters and other communications should be sent to the new address after 30th inst., when the present agency expires. The telegraphic address is "Outshine London," the telephone number 313 Avenue.

BANKRUPTCIES, LIQUIDATIONS, &c.

The discharge of J. A. Hirst, electrical engineer (lately trading with Jas. Fletcher as Fletcher, Hirst & Co.) at Burnley, Chester and Derby, is suspended for two years.

In the bankruptcy of H. L. Howard (trading as Thompson, Howard & Co.), electrical and mechanical engineer, at Harrogate, York, and Hull, a first and final dividend of 4⅜d. is payable on July 5, at the O.R.'s, 28, Stangate, York.

A meeting of the creditors of George H. Bentley, 63, Cross-lane, Earlestown, formerly carrying on business as electrical engineer, was held last week at the O.R's office, Manchester. The gross liabilities were returned at £1,162, of which £1,147 is expected to rank for dividend; deficiency £308. Failure is attributed to losses on contracts and failure of an engine. Mr. G. F. Clarke, Earlestown, was appointed trustee, with a committee of inspection.

At the London Bankruptcy Court an application was made to Mr. Registrar Brougham for the approval of a scheme for the arrangement of the affairs of John E. Liardet, 16, Hyde Park-gate, W., and the Old Mill Works, Cowley. Debtor had been engaged in experimenting with and developing electrical, marine, and hydraulic patents since 1887. He failed in Dec., 1898, with liabilities £13,259, against assets valued at £19,000 upon a fair realisation. It was proposed to form the Motors and Mechanical Appliances (Ltd.) to deal with debtor's patents and inventions, and a scheme of arrangement had been accepted by the creditors under which they were to receive a cash composition of 7s. 6d. in the £, or cumulative preference shares in the proposed company to the full amount of their claims. The Official Receiver reported there was no evidence to show that the shares would afford reasonable security for the payment of 7s. 6d. in the £ to the creditors. Debtor contended that the fact that the creditors, with one exception, had elected to take shares instead of cash was sufficient evidence that the security would yield not less than 7s. 6d. The Registrar adjourned the case for a week.

The estates of William Ramsay & Co., electrical engineers, &c., 195½, Argyle-street, and 11, Jamaica-street, Glasgow, and William Ramsay and William Chalmers, the individual partners thereof, were sequestrated on June 19. A meeting to elect trustee and commissioners will be held on July 3 at the Faculty Hall, St. George's-place, Glasgow.

It has been decided to wind up the Improved Electric Glow Lamp Co. (Ltd.) voluntarily. Mr. F. F. Fuller is liquidator.

It has been decided to wind up voluntarily the Sandycroft Foundry and Engine Works Co. (Ltd.) for purposes of reconstruction. The secretary (Mr. F. H. Williams) is liquidator.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. will sell by auction at the Grays Engineering Works, Grays, Essex, on Tuesday, Wednesday and Thursday next (July 3, 4 and 5), at 10 a.m. for 11 a.m. prompt, a large quantity of modern fixed and loose plant, machinery, utensils, stock, stores and other effects. Admission is by catalogue, which can be obtained (price 6d.) at the works; of Messrs. Hatten & Asplin, solicitors, Bank-buildings, Grays; or of the Auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-chambers, Albert-square, Manchester. Some further particulars are given in an advertisement.

Plant for Sale.—As announced in an advertisement, the business, premises, plant, &c., of the Acetylite (Ltd.), 400, New John-street West, Birmingham, are for disposal. Particulars can be obtained from Messrs. Wragge & Co., solicitors, Bennett's-hill, and of the liquidator, Mr. E. M. Sharp (Messrs. Sharp, Parsons & Co.), chartered accountants, Colmore-row, Birmingham.

Westinghouse Electric Tramway Equipment.—A well-illustrated pamphlet describing a number of electric tramways in Great Britain equipped, partly equipped, and in course of equipment by the British Westinghouse Electric & Manufacturing Co. (Ltd.), has just been issued. The complete equipments supplied are those to Aberdeen, Bradford, Coventry, Glasgow, Halifax, Hull, Liverpool, Norwich, Plymouth, Southampton, and Swansea, and the plant, &c., now under order is for Manchester and Newcastle. Partial Westinghouse equipment has been supplied to Bath, Darwen, St. Helens, Salford, &c.

B.T.H. Plant.—Pamphlets Nos. 66 67, and 68 of the British Thomson-Houston Co. describe and illustrate direct-current fan motors, the GE_{59} traction motor, and the B.T.H. maximum demand meter respectively.

Fire.—A small fire occurred on the works premises of Messrs. Siemens Bros. & Co. at Bowater-road, Woolwich, on Sunday. As usual, the halfpenny papers made the most of a very small affair. The fire which occurred in the T block, and was confined to that portion of the works was practically subdued by Messrs. Siemens' workmen before the brigade arrived. The company's business will be in no way interfered with.

Jubilee.—Messrs. Wheatley Kirk, Price & Co., valuers, &c., of London and Manchester, on the 22nd inst. celebrated the jubilee of the firm by giving the whole of the London and Manchester staff a holiday trip up the river Thames, the partners entertaining the staff afterwards to dinner, at which the senior partner (Mr. Henry Sherley-Price) presided, supported by Mr. S. Sherley-Price, Mr. Ernest Sherley-Price, and Mr. John Place.

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Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 20 to June 26, with the ports of destination :—

Africa—Algoa Bay, £102; Cape Town, £108; Durban, £285; East London, £23. *Australasia*—Adelaide, £30; Fremantle, £40; Melbourne, £152 (including £69 telegraph material); Sydney, £238; Townsville, £105. *Belgium*—Antwerp, £711. *Borneo*—Labuan, £61 (telegraph material). *Ceylon*—Colombo, £324. *China*—Shanghai, £366; Tientsin, £30. *France*—Calais, £28. *Germany*—Hamburg, £20. *Gibraltar*, £162. *Holland*—Amsterdam, £45. *Hong Kong*, £377. *India*—Bombay, £411; Calcutta, £678 (including £584 telegraph wire). *Japan*—Nagasaki, £12,000 (telegraph cable). *Russia*—St. Petersburg, £855 (including £505 telegraph wire). *Straits Settlements*—Penang, £37 (telegraph material). *Sweden*—Stockholm, £33. *United States*—New York, £12,700 (telegraph cable). *West Indies*—Trinidad, £40. Total £30,515, against £7,093 in the corresponding week last year (June 21 to 27).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 10, 1900.

6,704. C. Vogt. London. Improvements in induction apparatus.*
6,727. J. A. Halford. London. Improvements in electric contacts.
6,728. J. A. Halford. London. Improvements in electric contacts.
6,731. W. L. Wise. London. Combined telephone exchange and alarm systems. (A. Goldstein and J. M. Latimer, United States.)
6,748. F. M. Lewis. London. A new or improved alternating-current electro-motor.

April 11, 1900.

6,774. W. L. Spence. Alloa. Improvements in or connected with direct current transformers.
6,780. H. H. Lindon and R. F. Collinge. Liverpool. Improved electrical measuring instruments.
6,793. F. G. Tolchard. Paignton. Automatic regulating switch.
6,794. A. Eckstein and A. J. D. Krause. Manchester. An improved electrical combined switch and cut-out.
6,795. C. B. Ketley. Birmingham. Improvements in phonographs and graphophones.
6,798. S. M. Johnstone. Glasgow. Double and single-pole maximum and minimum automatic electrical cut-out.
6,826. J. C. de Janisch. London. Improvements in switches for electric currents.
6,828. M. Mildner. London. Improvements in the manufacture of electric cables, more particularly intended for conducting currents of high tension or voltage.*

April 12, 1900.

6,866. W. L. Spence. Alloa. Improvements in or connected with electricity distribution on the multiple voltage system.
6,878. H. V. James. Manchester. Improvements in electric arc lamps.*
6,893. W. Bohne. London. Improvements in phonographs.*
6,913. The British Thomson-Houston Co. (Ltd.), and F. Holden. London. Improvements in electrical speed indicators.
6,918. W. C. E. Faber. London. An improved electric typewriter.
6,923. C. F. Dussaud. London. Improvements in loud-speaking telephones.
6,931. J. G. Lorrain. London. Improvements in or connected with the transmission and distribution of electricity. (F. Bedell, United States.)
6,936. E. F. Moy and E. F. Moy (Ltd.). London. Improvements in switches for electrical circuits.
6,947. B. G. Lamme. London. Improvements in dynamo-electric machines. (Date applied for under Patents, &c., Act 1883, sec. 103, Feb. 24, 1900, being date of application in United States.)
6,948. B. G. Lamme. London. Improvements in polyphase induction motors. (Date applied for under Patents, &c., Act 1883, sec. 103, Sept. 14, 1899, being date of application in United States.)
6,951. L. J. Steele. Birmingham. An improved instrument for measuring electric currents.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

516. Muirhead. Telegraphic receiving and translating instruments.
7,525. Muirhead. Telegraphic transmitting, receiving and translating arrangements.
9,989. Mavor. Governing of engines used for driving electric generators in electric distributing systems.
7,918. Heys (Dumoulin). Manufacture or production of bands and strips of copper and other metals by electrolysis on rotary mandrels.
10,406. Miller. Wireless telegraphy.
11,678. Thompson (Becker). Electrolytic apparatuses for extracting metals lighter than the electrolyte.
11,985. Smith. Overhead conductors for electric tramways.
12,165. Still. Electric motors.
12,417. Wynne. Supports for conductors for electric railways.
12,627. Andreas. Manufacture of electric battery plates.
17,211. Wheatley (Wohlgemuth). Holder for telephones.
17,319. The Steel Nut and Joseph Hampton (Ltd.) and Hampton. Grips used in the laying of underground electrical cables.
18,132. Getty. Clocks, more particularly in electric winding, mechanism therefor.
25,446. British Thomson-Houston Co. (Ltd.) (Priest). Electric railway motors.
25,447. British Thomson-Houston Co. (Ltd.) (Case). Brakes for electric railway vehicles and the like.
25,448. British Thomson-Houston Co. (Ltd.) (Case). Controllers of electric motors.

COMPANIES' MEETINGS AND REPORTS.

Electric and General Investment Co. (Ltd.).

The eleventh ordinary general meeting was held on Tuesday, Mr. George Herring in the chair.

The SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN then said: Gentleman, from the balance sheet you will see that, as regards the amount of capital, the figures are the same, while the provision for contingencies shows an increase of £11,450 as compared with last year. The loan account is £35,000, which is money borrowed against our securities, and I may say here, that we frequently have to pass very good business in consequence of the smallness of our capital. The next item, "sundry creditors," is £9,390. These creditors are merely a sort of book entry. That is to say, on the date of making up the accounts they were creditors, but they are constantly changing. The item of "unclaimed dividends" speaks for itself, as does also the balance of profit and loss. On the other side there is the item of "investments at cost." In consequence of the securities being of an electrical character and the market not being in as good a state as formerly, I cannot say to you to-day, as I have done on previous occasions, that they are worth a *great* deal more than the figure at which they stand in our books, but I can assure you of one thing, and that is that you may safely reckon that they are worth the amount placed against them, *and more*. The item "sundry debtors" is merely a question of what was on our books on May 31st, and I am happy to say that since the company was formed we have never made a bad debt. The cash at Parr's Bank speaks for itself. Coming to the profit and loss account, we have General Charges, Interim Dividend, and on the other side Profit on the issues made, &c., amounting to £19,796. That is a pretty good profit to make on a small capital of £20,000. Still, it is £11,948 less gross profit than we made last year, but I told you then that you could not expect we should keep up the profit at that rate. With regard to one of our children—of which we are very proud—there are a few words that I should like to say to you. I refer to the British Electric Traction Co. In 1898, in addressing you on a similar occasion to the present, I made use of these words: In my speech at the last meeting I did a little boasting. I said: "The next company we started was the "Pioneer British Electric Traction Co. That we turned in the past financial year into the present British Electric Traction Co. I do not think "we shall have to wait quite so long for that to arrive at maturity. My hope "and my belief is that it will progress faster than any other, and I think "that if I live a few years, and remain your chairman, I shall be able to "point with great pride to the British Electric Traction Co. It is not "dealing with an unknown experiment—it is a thing that has been proved, "and over $50,000,000 has been put into this same traction business in "America. It has also been proved and been a great success in Germany, "and I have no doubt in my own mind that when it gets into good working "order here it will be just as brilliant a success."

Now, gentlemen, I am rather proud of that prophesy, for it has got into working order, and I am sure that it will be a brilliant success. The splendid work done by that company has been largely due to my colleague, Mr. Garcke, and if he were to speak he would tell you that the British Electric Traction Co. has only just commenced its great career.

England, Ireland, Scotland and Wales are particularly adapted to the electrical mode of travelling because of the density of the population, and yet Great Britain has only about 200 miles of electric traction lines, while America has over 17,000, and nearly every company in America is, I believe, paying well. In Germany electric traction has been very fairly developed, and there, too, it is paying well; but in this country we are only just commencing. There are hundreds of millions of money invested in gold mines in South Africa, and yet in this industry we have a gold mine right in front of us which has only to be properly looked after to pay well, and is not subject to the danger of "giving out" at any time because, as the population increases, so will the traffics. I would go so far as to say that it is nearly impossible to imagine an electrical tramway properly managed, situated in the midst of some populous town or district, which would not pay a good dividend. The debentures that we issue in the subsidiary companies pay 4½ per cent., and I make

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bold to say that they are as well secured as railway debentures which yield only 3 per cent., while the preference shares pay 5 per cent. I do not not care to prophesy as to what the ordinary shares will pay. You may say, "Why talk about the British Electric Traction Co. instead of our own?" It is because we are bringing out constantly the subsidiary companies for the British Electric Traction Co., and we are particularly anxious that it should be well known that those companies are good and sound properties. It is generally remarked, "Yes, that is all very well, but you are always asking for money." I plead guilty to that, and say that we shall have to keep on asking for money, because it will require millions to complete the orders that the British Electric Traction Co. have, and many millions more to thoroughly equip Great Britain with electrical traction. We make a profit out of these issues, and therefore it is to the benefit of the shareholders in this company to interest as many of their friends as they can in the goodness and value of this electrical business. I now move the adoption of the report and accounts and the appropriation of the profits as recommended by the directors.

Mr. J. B. BRAITHWAITE seconded the motion, and no question being asked it was at once carried unanimously.

Mr. George Herring was re-elected a director, and after the re-appointment of Mr. G. T. Rait as auditor, a vote of thanks to the chairman and directors terminated the proceedings.

Bastian Meter Co. (Ltd.).

The third ordinary general meeting of this company was held yesterday (Thursday) at the works. Mr. C. ORME BASTIAN, chairman and managing director, presided.

The SECRETARY (Mr. S. Robins) read the notice calling the meeting.

The CHAIRMAN said the results of the past year could be summed up in the words "rapid progress." They had converted a loss in 1899 of over £2,000 into a profit of nearly £400. This profit, though not startling, was enough to pay the dividend on their small preference issue several times over. How far they had progressed might be gauged from the fact that they had taken orders for more meters in the past three weeks than they did in the whole of the first six months of the year. Although their output had increased so rapidly their wages bill every week actually amounted to a smaller sum than was the case this time last year, due to the fact that the workpeople had now well learnt their duties and everything was being conducted on methodical lines. They had been very fortunate in securing the sole right to make and sell the Rimington maximum demand indicator, an instrument that worked in conjunction with their meter, showing the discount or rebate to which a consumer of electricity was entitled on his quarterly account. Thousands of these instruments were sold every year, and Mr. Rimington's invention possessed many advantages over other instruments on the market. He believed the holders of ordinary shares would soon receive ample reward for their patience. The directors were most sanguine as to the future. The Company had not yet sold a single foreign patent. The German licence had been granted on a royalty basis, with a substantial minimum annual payment. The directors had decided to waive their claim to fees for the past year. He concluded by moving the adoption of the report and accounts.

"*That the report of the directors produced, together with the annexed statement of accounts to February 28, 1900, duly audited, be now received, approved, and adopted.*"

Mr. UMBERTO CIANTAR seconded the motion, which was carried unanimously.

The retiring director (Mr. C. Orme Bastian) was re-elected, and the auditors re-appointed.

A vote of thanks to the chairman and directors terminated the proceedings.

United River Plate Telephone Co. (Ltd.).

The report of the directors for the year ended March 31 last states that the gross receipts in the River Plate were £101,169. 17s. 4d., against £85,248. 16s. 10d. for the previous year, and the working expenses in London and the River Plate £50,335. 9s. 9d. After deducting debenture interest and interim dividends, and adding transfer fees and interest on investments, and £7,889. 11s. 4d. brought forward, there remains a balance of £43,069. 5s. 6d. The directors propose to transfer £5,000 to depreciation fund and £20,000 to reserve, and recommend a final dividend of 4½ per cent. on the ordinary shares, making, with the interim, 7 per cent. for the year, carrying forward £5,019. 5s. 6d.

Continued increase in the business of the company requires large extensions in the plant at Buenos Ayres, a considerable portion of which will be permanent and underground. For this purpose the directors consider it advisable to make an early issue of the remaining 5 per cent. cumulative preference shares.

West African Telegraph Co. (Ltd.).

The report of the directors for the year ended Dec. 31 states that the revenue for that period amounted to £77,008. 4s. 6d., against which £20,297. 14s. 10d. is charged for ordinary expenses, and £11,482. 9s. 11d. for expenditure relating to repairs of cables, &c. After providing £328. 10s. 3d. for income tax, there remains £44,899. 9s. 6d., to which is added £2,179. 5s. 2d. from preceding year, making £47,078. 14s. 8d. From this sum there has been deducted £8,746. 14s. 7d. for debenture interest, and £15,033. 6s. 8d. for sinking fund, leaving £23,298. 13s. 5d., out of which the directors propose to place £23,000 to general reserve and to carry £298. 13s. 5d. forward.

The revenue for the year includes a further £12,000 in respect of subsidy due from the French Government, but which has not yet been paid. This arrear, together with the sums withheld in previous years, now amounts to £55,415. The directors, with a view to assimilate the working of the company to that of the allied companies, have considered the advisability of establishing staff pension and superannuation funds. Details have been worked out by the actuary of the already existing funds of the associated telegraph companies and a formal resolution will be submitted at the forthcoming meeting empowering the directors to carry out the necessary arrangements.

NEW COMPANIES, STATUTORY RETURNS, &c.

CINQUE PORTS LIGHT RAILWAYS (LTD.)—This company was registered on June 16, with a capital of £25,000 in £1 shares, to continue and support the application under the Light Railways Act for authority to construct the Cinque Ports Light Railway, and to carry on the business of railway and general engineers, railway and tramway proprietors, &c.

MANGANO ELECTRIC PROCESS (LTD.)—This company was registered on June 15, with a capital of £50,000, in £1 shares, to carry on generally the business of electrical engineers, electricians, and suppliers of electricity, and in particular to acquire and exploit the interest and rights of MM. G. E. Bourgoin and H. Lavollay in a certain invention for the epuration and decolouration of sugar by the Mangano electric process. The subscribers are F. Witting, C.E., A. Holliope, L. A. Price, E. F. Trone, G. F. Franks, W. Bullock, engineer, and F. C. Bell.

NORTHWOOD ELECTRIC LIGHT AND POWER CO. (LTD.)—This company was registered on June 23, with a capital of £15,000, in £1 shares, to carry on at Northwood, Ruislip, Middlesex, or elsewhere, the business of electricians, mechanical and electrical engineers, suppliers of electricity, manufacturers of electrical machinery and apparatus, &c. The subscribers, with one share each, are J. S. Hignett, A. T. Bucknall, A. H. Crossley, D.Sc., C. E. Masterman, C.E., C. H. Wickes, R. Crossley, and J. W. Tilley.

ROUNDHAY AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)—This company was registered on June 22, with a capital of £20,000, in £10 shares, to carry on the business of electrical and general engineers, electricians, suppliers of electricity, &c., at Roundhay and Seacroft, near Leeds, or elsewhere. The subscribers are M. Kitchin, C. Lupton, W. P. Green (engineer), J. E. Whiting, W. Harvey, W. S. Sykes, and A. G. Lupton. The first directors are M. Kitchin, J. E. Whiting, and W. P. Green.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since June 14, 1900). Price of silver 28 $\frac{15}{16}$d. per oz. (June 28). Consols (2¾ per cent.) 100$\frac{5}{8}$—100$\frac{7}{8}$ for money, 100$\frac{1}{16}$—100$\frac{3}{16}$ for account; 2½ per cent. 99$\frac{1}{2}$—99$\frac{3}{4}$ (June 28). Stock Exchange Settling Day: Consols, July 4; Stocks and Shares Continuation Days, July 10 and 25; Ticket Days, July 11 and 26; Pay Day, July 12; Mining Share Carry-over Days, July 9 and 24.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—This company is prepared to receive requisitions for the seventh series of coupons to be issued to holders of share warrants to bearer in this country.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPORATION (LTD.)—The directors have issued a circular giving particulars of the progress made since the statutory meeting. After some delay the lease has been transferred from the Kalgoorlie Power Syndicate to the corporation, and hoisting and pumping plant has been erected. Mr. G. R. Mair, who has been since 1888 with the General Electric Co. of America, has been appointed constructing engineer. The board invited tenders for engines from the principal European and American manufacturers, and after careful consideration the contract was awarded to Messrs. D. Stewart & Co. (Ltd.), Glasgow. The engines contracted for are of the vertical cross-compound type with Corliss valve gear, these having special suitability to the conditions existing at Kalgoorlie. Contracts have been placed for generators with the General Electric Co. of New York. This company sent in the lowest tender and offered apparatus which conformed with the corporation's specification in all essential points. Mr. Mair has left for Kalgoorlie to make preparations for the installation of the plant.

CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)—The directors have offered to the shareholders for subscription 10,000 shares of £5 each, at £5. 10s. The shares are offered *pro rata* to existing members in proportion of one share for every two shares now held. Allotment will be made on July 18.

ISLE OF MAN TRAMWAYS & ELECTRIC POWER CO. (LTD.)—A meeting of the new board of directors is, it is said, being held in Manchester this week with the object of obtaining the support of holders of the company's bills to a scheme for continuing the company and preventing its being wound up. It is stated that, should the board find that Dumbell's Bank have endorsed those bills, the directors will consider any further attempt to save the company as hopeless.

LIVERPOOL OVERHEAD RAILWAY CO.—This company are inviting subscriptions to an issue of 5,000 ordinary shares of £10 each, at £8 per share, to provide capital for the electrical equipment of the tramways leased to the company by the Waterloo-with-Seaforth and Great Crosby District Councils, for additional rolling stock, &c. The issue is limited to shareholders, and closes to-morrow (Saturday).

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MARCONI'S INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The 350,000 £1 shares in this company are now being offered to shareholders in Marconi's Wireless Telegraph Co. (Ltd.). Mr. Marconi has accepted the position of technical adviser to the company for three years, with a seat on the board.

SIEMENS AND HALSKE AKTIENGESELLSCHAFT.—It is reported that the directors propose to declare a dividend of 10 per cent. for the year ending July 31, the same as last year.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has been asked to allow 15,000 ordinary £5 fully-paid shares, 10,000 6 per cent. £5 first preference shares, 10,000 5 per cent. £5 second preference shares, and 90,000 4 per cent. debenture stock of the *Kensington and Knightsbridge Electric Lighting Co. (Ltd.)* to be quoted in the official list.

THOMAS PARKER (LTD.)—The directors' report, just issued, is short and to the purpose. It states that they consider the statement of accounts "thoroughly satisfactory." After writing of depreciations, the balance standing to credit of profit and loss is £14,135. 10s. 7d.; out of this a dividend at the rate of 10 per cent. per annum, less tax, is to be paid, £5,000 placed to reserve (bringing it to £15,000), and the balance is carried forward.

TYPEWRITING TELEGRAPH CORPORATION (LTD.)—This week subscriptions have been invited to an issue of 53,334 ordinary shares in this corporation, of £1 each, which has been formed to acquire letters patent in respect of certain improvements in telegraph recording instruments invented by Mr. W. S. Steljes, the business connected with the same as a going concern, and a number of contracts. Reference was made to these instruments on page 39 of *The Electrician* for May 4, and elsewhere in this issue a technical illustrated description will be found. The prospectus under review states "that all necessary agreements with the Postmaster-General have been entered into," and sets out particulars of important agreements with the National Telephone Co. for the use of Steljes' apparatus on the company's lines, and with the Exchange Telegraph Co. Reports accompany the prospectus from Mr. C. E. Spagnoletti, who is a director of the company; the late Mr. W. Johnson, of Sheffield; Messrs. Fell and James, patent agents; and Mr. W. R. Bousfield, Q.C., M.P., as to the utility of the apparatus and the security of the patent rights. The prospectus contains full particulars of the contracts entered into, and contains no waiver clause. The purchase price is £55,000, payable as to £28,334 in cash and £22,666 in shares. It is estimated that £25,000 will be provided out of the present issue for working capital, and that £15,000 will be sufficient working capital as a minimum, below which latter sum the directors will not proceed to allotment. The list closed yesterday (Thursday).

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	June 23	4,562	+ 381	24	105,739	+ 6,347
Blackpool Corporation...	„ 21	762	+ 249	12	6,588	+ 1,321
Blackpool and Fleetwood	„ 23	683	+ 72	25	9,401	+ 80
Bolton Corporation	„ 21	1,261	...	12	17,294	...
Bradford Corporation...	„ 24	458	+ 84	12	5,956	+ 1,286
Brisbane Trams	May 9	1,858	+ 511	6	10,890	+ 2,803
*Bristol Trams & Carriage	June 22	3,201	+ 179	25	71,839	+ 2,887
*Buenos Ayres & Belgrano	May 27	2,555	− 32	21	48,272	+ 4,952
City & South London Ry.	June 24	1,500	+ 567	25	32,234	+ 6,320
Dover Corporation	„ 23	216	+ 14	12	2,419	+ 244
Dublin United	„ 22	3,731	+ 242	25	83,344	+13,691
Dublin Southern Dist...	„ 22	956	− 129	25	20,547	
*Glasgow Corporation ...	„ 23	9,774	+ 680	...	...	...
Hull Corporation	„ 23	1,347	...	51	40,018	...
*Liverpool Corporation...	„ 16	8,043	+ 601	24	172,751	+20,985
Liverpool Overhead Rly	„ 21	1,605	+ 167	25	35,820	+ 1,090
*Sheffield Tramways	„ 24	2,330	+ 956	25	50,722	+16,226
*South Staffs. Trams.....	„ 22	714	+ 58	25	16,916	+ 1,090

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 20.	Price Wednesday, June 27.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 27. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July.....	...	...
35,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£322,720	Stock	15/0	Anglo-American	60 63	60 63	5 17 0	Feb., May, Aug., Nov.	...	...
£3,088,640	Stock	20/0	Do. Preferred	114 115	113½ 114½	5 5 9	„ „	114⅝	114
£3,088,640	Stock	27/0	Do. Deferred	12¾ 13½	17½ 13	10 7 9	„ „	13	1 ⅜
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	103 104	3 17 0	„ „	103½	102½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	6 1 8	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	9⅜	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11⅛ 12	11⅛ 12	5 16 8	Jan., Apr., July, Oct.	...	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100 103	101 103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	148 153	4 12 5	Jan., Apr., July, Oct.	151	149
£1,826,888	Stock	3½%	Do. 3½ per Cent. Preference Stock	97 100	97 100	3 10 3	„ „	97½	—
£1,482,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	6/6	Eastern Extension	14½ 15	14¾ 15¼	4 11 10	Jan., Apr., July, Oct.	15¼	15
£330,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 117	113 117	3 9 2	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.) ...	100 103	100 103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	103⅞ 103⅞	103⅞ 103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11⅝	1⅜
180,042	10	3/0	Do. 6 per Cent. Preference	15 15⅛	15 15⅛	3 17 5	„ „	15⅛	15⅛
150,000	10	15/0	Great Northern of Copenhagen	33 34	32 34	3 13 6	January and July.....	...	...
£96,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	100 103	100 103	4 8 0	June and December ...	...	...
17,000	25	37/6	Indo-European	53 57	53 57	4 7 9	May and November ...	54½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1911 ...	105 108	105 103	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's	7⅛ 8⅛	7⅛ 8⅛	4 14 1	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2⅛ 3⅛	2⅛ 3⅛	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
20,000	2½	...	West Coast of America.....	⅛ 1	⅛ 1	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 17 7	January and July.....	...	...
88,321	10	1/0	West India and Panama	⅝ ⅞	⅝ ⅞	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	7½	6⅜
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£30,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	...	...	3 17 4	June and December ...	...	...
207,920	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15	14¾ 15¼	4 11 10	Mar., June, Oct., Dec.	15⅛	14⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	105 108	105 108	4 13 10	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2⅜ 3⅜	2⅜ 3⅜	4 5 9	August	...	...
224,850	10/0	1¼d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜ ½	⅜ ½	5 0 0	November	...	...
96,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„ „	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	12 14	13 15	4 5 9	„ „	14	13½
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5½	5 5½	4 15 3	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	98 101	3 10 3	June and December ...	100½	99½
171,504	1	0/3	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	2/6	United River Plate	4¾ 5¼	4¾ 5¼	8 1 11	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	5 5¼	4 10 11	June and December ...	...	...
£179,917	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	105 108	4 14 9	„ „	107½	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, June 20.	Price Wednesday, June 27.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 27. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ekh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...			
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅛ 12⅛	11⅛ 12⅛	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	9	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6⅞ 7⅞	6⅞ 7⅞	...	...	7	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9 10	9½ 10½	4 5 9	February and August	10	9⅛
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅞ 6	5⅞ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7⅛	6½ 7⅛	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107 110	107 110	4 1 8	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8½ 9½	8½ 9½	4 4 3	February and August	9⅜	9
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½ 13½	12⅝ 13⅝	4 8 11	January and July	12⅝	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124 129	124 129	3 18 11	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9 10	9 10	4 0 0	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½ 12½	11½ 12½	4 16 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	110 113	110 113	4 1 1	...	111	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	7 7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1⅛	1 1⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4 4⅛	4 4⅛	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98 100	98 100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½ 14½	13½ 14½	3 9 0	April and October	14⅜	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	113 116	113 116	3 18 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 99	97 99	3 11 6	...	97½	...
6,452	10	8/0	Notting Hill Electric Ordinary	16 17	16 17	4 2 4	March	...	..
10,000	5	5/0	Oxford Electric Ordinary	6 6½	6 6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	⅝ ¾	⅝ ¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'st'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14 15	4 16 8	February and August	14⅜	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	,, ,,	9	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3¾ 4¼	3¾ 4¼	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	11 12	11 12	5 8 4	March and September	11½	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅝ ¾	⅝ ¾	8 0 0	March and September	⅝	...
85,000	1	...	British Electric Works Co. Ordinary	⅝ 1	⅝ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16 1/8	1/16 1/8	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	...	...
100,000	5	1/6¼	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,060	2	1/2⅝	Brush Electrical Engineering	1⅝ 2	1⅝ 1⅞	4 5 4	September	1⅝	...
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cum.	2 2⅛	2 2⅛	5 6 8	,,	2 1/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 114	109 114	3 19 10	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 5 9	June and December	...	...
20,000	5	10/0	Callender's Cable Construction Ord.	13½ 14½	13½ 14½	5 3 5	,, ,,	13⅝	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	,, ,,	5⅝	5⅝
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 116	112 116	3 18 5	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	3 1/16	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 19 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	2	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4½ 5	4½ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101 104	101 104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2⅛	2 2⅛	5 6 8	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3 3⅛	3 3⅛	4 0 0	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 108	103 103	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13 14	13 14	6 15 9	February and August	13⅛	13⅜
30,000	5	1/6	Do. 4½ per Cent. Preference	5½ 5⅝	5½ 5⅝	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	21 1/16	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	35 39	35 39	4 12 4	March and July	37⅜	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	10⅜	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	11 12	10½ 11½	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7½	6½ 7½	4 2 9	,, ,,	6½	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½ 18½	17½ 18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102 104	103 104	4 16 2	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½ 23½	22½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully paid) x1	8⅜ 8⅝	10⅜ 10⅝	...	...	10⅝	10⅜
£100,000	Stock	4%	Do. 4 per Cent. Debentures x1	118 120	118 120	3 6 1	February and August	120	118
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10⅝	10½ 10⅝	4 13 0	May and November	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	15 17	16 17	3 10 7	...	16⅞	16½
15,000	10	...	Do. (Nos. 60,001 to 75,000)	16 17	16 17	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12½ 13½	12½ 13½	4 8 11	February and August	13⅛	12⅝
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	120 123	120 123	...	...	...	...
40,000	5	2/8 3/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5 5½	5 5½	5 14 4	...	...	...
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	4½	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	101 104	101 104	4 16 2	...	103½	103½
£120,000	Stock	13/0	Do. 5% 2nd Deb. Stk Prov. Certs (£57½% to be p.)	37 40	38 41	...	...	...	...
206,297	10	3/0	Central London Ordinary	10 10½	10¼ 10⅜	2 15 10	June and December	10⅝	10½
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	65 68	65 68	2 15 2	February and August	68⅛	66
370,500	10	1/5 3/10	Do. (Nos. 22,501 to 60,000)	6 7	6 7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	,, ,,	...	...
£200,000	Stock	5%	Do. (1898)	132 137	132 137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123 123	123 123	3 2 6	May and November	...	...
20,000	10	8½	†Imperial Tramways Ordinary	22½ 23½	22½ 23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture x1	113 115	113 115	3 17 11	January and July	115	1 3
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	⅛ 3/16	⅛ 3/16	32 0 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	3/16 ¼	3/16 ¼	24 0 0	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'st'n 5% Pref.	9½ 10½	9½ 10	5 0 0	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9½ 9⅝	8⅝ 8⅝	4 5 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13⅝	13½ 13½	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3¾	...	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5½	4½ 5½	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	...	16 18	...	February and August	...	...
4,000	10	6/0	Do. 5 per Cent. Preference	...	10⅜ 10⅝	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100 103	100 103	2 18 10	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,155. [No. 11, Vol. XLV.] FRIDAY, JULY 6, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 20fr., or 7Qpf.

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NOTES.

MANY of our readers will learn with regret that the Dublin Electric Lighting Bill was thrown out on the motion for the third reading last Monday. After running the gauntlet of keen opposition at the hands of the Corporation of Dublin, and passing through the report stage with a majority of 13 votes, this bill, which is being promoted by the Dublin Electric Lighting Co., has met with this unhappy fate. The result is, however, to be regarded rather as a curiosity in Irish politics than as any important development in sober electrical engineering. In a leading article on April 13th we commented on the rival schemes for electric supply at Dublin, viz., the combined electric lighting and tramway scheme of the company and the polyphase scheme for electric lighting alone brought forward by the Corporation. The result of the rejection of this bill, we presume, will be that Dublin will be supplied with electric light from a municipal polyphase station, while its extensive system of tramways will be run by the company from an independent power house. Considering that this result has been brought about by municipal opposition, the local authorities who have made combined electric lighting and tramway undertakings their principal argument in favour of municipal electricity works must feel somewhat disconcerted.

WE are told, however, that the rejection of the company's bill was necessitated in the interests of all local authorities owning electricity works. There is no precedent, it is said, for introducing company competition against a local authority already running electricity works. This, however, overlooks two important facts; firstly, that neither to local authorities nor to companies do the Electric Lighting Acts grant a monopoly—the terms of the acts state emphatically to the contrary; and, secondly, that the company proposed to do what the Dublin Corporation has long had an opportunity of itself doing had it so wished. Surely where, as in the case of Dublin, the municipal owners of a provisional order fail to develop the order to its fullest reasonable extent, it is only right that the Board of Trade should grant a competitive order to any responsible company prepared to undertake the work. This, indeed, is the situation at Dublin in a nutshell. It remains to be seen whether the Dublin Corporation, now that its prospective competitor is defeated, will carry out the big scheme of electrical supply it has displayed as its pretext for opposition.

INDUSTRIAL economists will watch with considerable interest the development of an experiment which is about to be made in the neighbourhood of Budapest, Hungary, in supplying electricity for motive power for industrial purposes in cottages and small homesteads. The feasability of this as an alternative to the existing factory system has more than once been advanced by prominent economists in this country. Lord SALISBURY, for example, has on several occasions expressed the opinion that the advent of electric power would revolutionise industrial methods, decentralising industry from the factory to the home. On the other hand, it has been shown that the factor of cheap power is not the sole consideration, nor indeed the principal consideration, in determining whether an industry should be carried on in a factory or in a number of isolated homesteads. Other considerations, such as the distribution of the raw material and the collection of the finished products enormously affect the question. It will be interesting, therefore, to see what degree of success is effected with the Hungarian experiment, which appears about to be made conjointly by the Ungarische Elektricitäts Allgemeine Gesellschaft and the Budapester Allgemeine Elektricitäts Gesellschaft.

THE strong centre of attraction afforded by the Paris Exhibition has brought a large number of American and Colonial engineers to this country on their way to Paris. It was in the fitness of things, therefore, that the 32nd Annual Convention of the American Society of Civil Engineers should be held in London. The convention opened on Monday last, at the Institute of Civil Engineers in Westminster, and was

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brought to a close last night by a reception by the Institution of Civil Engineers at the Guildhall. The proceedings commenced with an address of welcome to the visitors from Sir DOUGLAS FOX, the President. In this address he referred to the competition in this country on the part of American engineers, and said we were ready for competition, and nothing was to be feared therefrom. He hoped that the visit of our American cousins would teach us how to meet this competition, and he extended a hearty welcome to these engineers who were meeting their English hosts on intimate terms of friendship and amity.

THE Papers dealt with during the convention were not of an electrical nature, and therefore call for little comment. Electrical engineers, however, may feel some interest in Mr. R. W. HUNT'S Paper on "Iron and Steel Rails," read on Tuesday last. The Paper considers the subject mainly from the American point of view, and deals mostly with American practice. In a historical summary, the author calls attention to the enormous production of American rails at the present time, one mill alone having turned out no less than 58,103 tons in a month. The question of standardisation of rail sections was dealt with, but the author would probably admit that we have brought standardisation to a higher pitch in this country than have the American ironmasters. The Paper included some account of the McKenna process for renewing old rails. The worn rails are re-heated to a temperature of about 1,500°F., and passed through re-forming rolls. They are then sawn hot and straightened cold. No less than 100,000 tons of rails thus treated are in use, which tends to prove the satisfactoriness of the process. Indeed, so much better do the rails appear to be after renewing that the author puts forward the somewhat paradoxical statement that "no rail ought to be used at all until it has been renewed," which reminds us of the Irishman who declared he could never put on a new boot until he had worn it a month.

A LETTER which we reprint from *Nature* this week announces the encouraging fact that the execution of the important work of bringing out an international catalogue of scientific literature is now practically assured. Whatever doubts there may have been prior to the recent conference as to the feasibility of this gigantic scheme appear to have been completely dissolved, and instead of meeting with almost insuperable obstacles and objections, the proposals of the English scientists were cordially accepted by their foreign *confrères*. All true lovers of science will wish that success may crown the efforts of the International Committee, but in order that these efforts may be successful the catalogue must meet with commercial as well as scientific patronage. The catalogue is to be published annually in 17 volumes, and is to include both an authors' and a subject index. It is admitted that if 300 sets or the equivalent are sold annually, the expenses of publication will be met. We hope that, for their credit's sake, the collective interest of civilised nations of the world in a great and complete compilation of scientific literature is capable of supporting an edition of 300 copies annually.

THE following report on the subject of gutta-percha extracted by what is known here as the Serullas process from the leaves of the *Isonandra Gutta* has been made by the French Administration of Posts and Telegraphs:—

A cable conductor, made with gutta-percha obtained from this source, had been kept from July, 1897, until March, 1898, at the Paris central depôt; it was then sent to the Seine cable factory, and was under observation until May 15, 1899, without variation of its insulation or various physical properties.

At this date it was covered with an armouring, and the cable thus constituted was submerged in the Seine dock. This cable, after being submerged for seven months, did not show any fall of insulation. It was picked up at the end of December, 1899, and placed under water in one of the tanks of the factory. This operation does not appear to have caused deterioration, and it still shows satisfactory insulation. Up to the present it has been admitted that gutta extracted from leaves gives a very high insulation, but that it is not stable and soon cracks. The tests referred to above, extending over two years, would seem to show that the preservation of this gutta is greater than was supposed. The period is, nevertheless, not sufficiently long to permit of definite conclusions. Gutta extracted from leaves presents, moreover, the inconvenience of being less fusible than ordinary percha, and much more difficult to work. Recent tests with joints of conductors thus constituted have, however, been made, and have given satisfactory results. In consequence of these various experiments, the Administration is about to order, using gutta extracted from leaves, a short cable which will be laid near the shore and employed in the service during the summer. It is unnecessary to say that, so far as submarine cables are concerned, the study of innovations must be made with the greatest caution, and that experiments should only be undertaken progressively.

In the report of the Commission formed to consider the question of the establishment of a system of French submarine telegraph lines, it is recommended that the new gutta-percha should be used for one at least of the short cables included in their programme, provided that those who supply the material guarantee it. It is added that the price of "leaf" gutta-percha would be considerably lower than that of the ordinary variety, say, 14fr. or 15fr., instead of 20fr. to 25fr. for the same quality. Nothing is said as to the quantity likely to be available.

AT the recent annual general meeting of the Incorporated Gas Institute, Mr. W. H. Y. WEBBER gave an interesting lecture under the somewhat misleading title, "The New Gas." Mr. WEBBER referred to the old proposal of supplying a fuel gas for heating purposes, and suggested that with the Welsbach burner such a gas could now be used in place of the present highly-carburetted gas. He cited some experiments made in Germany of supplying gas obtained directly from Westphalian coal, without enrichment. The illuminating power, when the gas was burnt in ordinary burners was, of course, much less than the present legal standard in this country, while the calorific value was not greatly altered. If the proposal were carried into effect, the ordinary gas burner would be even less economical than it is at present; and although the competition of the incandescent gas burner with the incandescent electric lamp might be keener, the electric light would then, without a doubt, be "the poor man's light."

Opening of the Swansea Tramways.—The mayor of Swansea performed the opening ceremony of these new tramways on Saturday last. The chairman and directors of the British Electric Traction Co. were present.

Personal.—We regret to learn that, owing to ill-health, Mr. Julius H. West has been compelled to resign the editorship of the *Elektrotechnische Zeitschrift*. We trust that Mr. West will speedily recover his health.

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Electrical Engineers (R.E.) Volunteers in South Africa.—Sapper F. C Weakley is reported to have died of enteric fever at Viljoen's Drift on June 27. The death is also announced of Pte. E C. Short from enteric fever at Kroonstad.

American Electro-Therapeutic Association.—The tenth annual meeting of this Association will be held from Sept. 25 to 27, at the Academy of Medicine, New York City. The programme includes the following two items: (1) Electricity in Gynecology and the present reluctance of gynecologists to use Electricity, (2) Electricity in Tuberculosis and the present modes of Treatment. Further information may be obtained from the secretary, G. E. Bill, M.D., 255, North-street, Harrisburg, Pa.

American Electric Railway Statistics.—From a table of "Street and Elevated Railway Mileage, Cars and Capitalisation in United States and Canada, 1899," given in the June issue of the *Street Railway Journal* of America, we extract the following figures relating to electric railways:—

	Track mileage.		Motor cars.		Trail cars	
	1898.	1899.	1898.	1899.	1898.	1899.
United States	15,942	17,969	36,616	39,360	9,933	11,298
Canada	634	720	1,242	1,543	200	395

Cable Interruptions:—

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Gibraltar—Tangiers	June 28, 1900
Hong Kong—Macao	June 28, 1900

Honorary Degrees at Victoria University.—Last Saturday was degree day at Victoria University, and the Chancellor, Earl Spencer, conferred the honorary degree of Doctor of Science on Sir William Huggins, Sir W. C. Roberts-Austen, Sir William Abney, Dr. T. E. Thorpe, Profs. J. Dewar, A. R. Forsyth, E. Pickering, J. J. Thomson, A. Michelson, and H. A. Rowland, Lord Rayleigh, Mr. R. T. Glazebrook, and Mr. Henry Wilde. In addition, the honorary degree of D.Lit. was conferred on Mr. Sydney Lee.

Institution of Junior Engineers.—On Saturday the 14th inst., members of this Institution will visit Lord Rothschild's estate at Tring to inspect the electrical installation and other matters of interest. The train leaves Euston at 1:45 p.m. On Friday last the members visited the works of Messrs. Caird & Raynor, of Limehouse. This firm are well-known manufacturers of evaporators, condensers, feed heaters, pumps, &c. The motive power throughout the works is electrical, current being generated on the premises by a dynamo driven by a gas engine.

Institution of Mechanical Engineers.—As a surprise item not down on the official programme, the members of the Institution of Mechanical Engineers, on Thursday of last week, were treated to the reading of a Paper of peculiar interest at the present moment, entitled "Notes on the Construction of Long Cecil, a 4·1in. Rifled Breech-Loading Gun, in Kimberley during the Siege 1899-1900," by Mr. Edward Goffe, of Kimberley. The printed Paper is accompanied by an admirable photographic view of the gun, as well as a number of well-executed scale drawings of details.

Electrical Equipment of the New York Elevated Railways.—It is expected that the electrical equipment of these railways will be completed by Feb. 1, 1901. The committee, acting on the advice of their experts, have decided on the adoption of trains with a motor car at each end, each motor car being equipped with four motors and capable of hauling six coaches. Each motor will be of 100 H.P., thus giving 800 H.P. per train. The contract for the generating plant has been placed with the Westinghouse Company, and for the engines with the Allis Company. There are to be eight engines of 8,000 H.P. each capable, however, of working up to 12,000 H.P. on emergency. The boilers will be supplied by the Babcock & Wilcox Company. Up to the present the contracts entered into involve about £1,000,000.

Report of American Institute of Electrical Engineers, Committee on Electrical Units and Standards.—At the last Philadelphia meeting of the American Institute of Electrical Engineers, the Committee of Units and Standards, which had been formed on March 28th last, submitted their report. The reference to this Committee included the consideration of (1) Names of absolute units in electrostatic and electromagnetic systems; (2) the use of prefixes to denote multiples of these units; (3) the rationalisation of the present system by making the absolute unit of magnetism equal to the present magnetic line, and the absolute unit of magnetic potential-difference as equal to the present absolute unit of current-turn; and (4) the advisability of discussing these subjects at the Paris Congress. The Committee's report on these references were as follows:—(i.) Names for the absolute units are needed, as also suitable prefixes for decimal multiples and sub-multiples of these units; (ii.) the International Congress at Paris should be urged to decide on such names and prefixes; (iii.) rationalisation of units is urgently necessary, and the Congress be requested to consider the subject; and (iv.) the whole subject be discussed at the approaching general meeting of the Institute in Philadelphia.

Electric Power at the Westinghouse Air-Brake Works.—The American works of the Westinghouse Air-Brake Co. are now driven entirely by electric power. According to the *Electrical World*, a large central station has been erected at the works, and has been equipped with the most modern generating apparatus for this purpose. The plant consists of boilers of 2,000 H.P. capacity, which furnish steam for three Westinghouse-Parsons steam turbines. Each one of these turbines is direct connected to a bipolar, alternating-current generator, manufactured by the Westinghouse Electric & Manufacturing Co. The generators run at 3,600 revs. at a pressure of 400 volts. There are also two exciter units, the air pumps and condensers for the turbines, driven by a 50 H.P. motor, and two air compressors driven by 100 H.P. motors. The exciters deliver current at 110 volts. All the motors are of the Westinghouse induction type, placed in the most convenient situations, and belted to the original line shafts, which run at 112 revs. to 175 revs., an increase of about 12 per cent. in speed. Countershafts are largely dispensed with. In the machine shops there are motors aggregating 435 H.P.; in the boiler house, three motors, 60 H.P.; blacksmith shop, two motors, 50 H.P.; brass foundry, three motors, 35 H.P.; iron foundry, 13 motors, 185 H.P.; leather room, two motors, 25 H.P. Total motors 48, aggregating 790 H.P. There are 2,500 incandescent and 60 arc lamps of 100 hours' capacity, all taking current at 110 volts.

Utilisation of Energy Lost in Resistances.—A writer in the *Elektrotechnischer Anzeiger* of June 14, considers the question whether the energy lost in the regulating resistances of motors, and the steadying resistances of arc lamps cannot be usefully employed. In the case of resistances such as those in series with fan motors which are often kept running for a considerable period at less than their full speed, he suggests that low voltage lamps might take the place of the resistance coils, these lamps being in situations where momentary extinctions would not be of great importance. At the points where these lamps are, he proposes to place a second lamp fed by the full pressure of the mains, and the regulating switch of the motor is to be so arranged that as soon as the low voltage lamps (serving as resistance) were switched out, the ordinary voltage lamps would be switched in, the contacts of this switch being placed so that the two lamps could not be alight at once. In the case of arc lamps, he suggests the use of cooking or heating apparatus having the same resistance as the steadying resistance which could be switched on in place of the latter when required for use. He also proposes that fan motors and similar motors might be used in the same way. Arc lamp circuits and even incandescent lamps might be used for the same purpose where an unsteady light is permissible. This latter suggestion, however, hardly appears practicable, as the life of the lamps would be considerably shortened by the over-running occasioned by the carbons of the arc coming too near together, for even a relay to put in a substitutional resistance would hardly work to prevent this. Diagrams of the various connections are given in the article.

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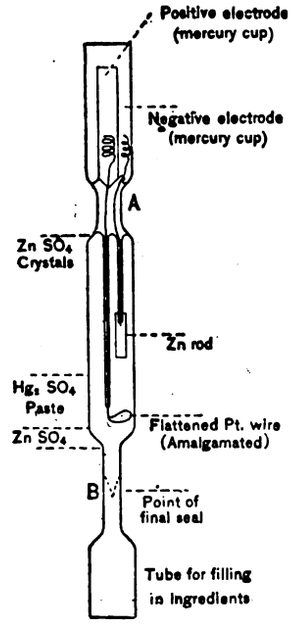
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Uranium Radiation.—Two different kinds of Becquerel rays have up to the present been discovered. One kind has practically all the characteristics of cathode rays, and is deflected by both magnetic and electric forces. The other kind is not deflected by either, and shows various degrees of absorption by metals and other opaque substances. Radium emits both kinds of rays. Polonium only emits the second kind, while Debierne's "actinium" only emits cathode rays. H. Becquerel has done some work in order to determine the exact nature of the rays emitted by uranium, the first substance which was found to emit the rays named after him. The difficulty of operating with uranium lies in the feebleness of its radiation. He found, however, that the rays emitted were deflected to about the same extent as the most penetrating radium rays. That might be explained by the supposition that uranium contains an admixture of radium, and that the true uranium rays are feebler. But the author believes that these deflected rays are due to actinium. They can be removed by treating the uranium chloride with barium chloride. Radio-active barium sulphate is produced, and a purified uranium salt remains. Further purification makes no difference, and hence it is probable that uranium has a definite though feeble radiation of its own. [H. Becquerel, *Comptes Rendus*, June 11, 1900].

Hermetically-sealed Clark Cell.—H. T. Barnes gives particulars of the construction of Clark cells completely closed by glass fusion. The arrangement of the cell is shown in the diagram. The positive electrode is a platinum wire flattened



at one end and amalgamated. The wire is enclosed in a glass capillary drawn from a small glass tube, shown in the figure, as the positive mercury cup. The negative electrode is a small zinc rod cast round a platinum wire and its enclosing glass capillary. This wire passes through the constriction A and ends in the outer or negative mercury cup. As soon as the ingredients of the cell have been filled in through the open end, the final sealing of the cell is accomplished by quickly fusing the glass in the narrow neck B. For making connections with terminals a small quantity of mercury is put into the cups. It can be at once removed when the cells have to be packed or sent away. The cell may be kept in any position. It may be immersed in a thermostat up to the neck A, and it still remains insulated thermally from the outside electrodes by the thick glass of the neck. The arrangement of the inner electrodes prevents the creeping of the amalgam, which almost invariably splits the tube at the point where the negative terminal is fused through the glass. [H. T. Barnes, *Phys. Review*, May-June, 1900.]

Viscosity of Liquids in an Electric Field.—It is still a debatable question whether the viscosity of a liquid is altered by immersing it in an electrostatic field. Fifteen years ago, König came to a negative conclusion. Duff in 1896 and Quincke in 1897 found that a number of alcohols, oils, and ethers show an increase of viscosity in an electric field. In addition, Duff observed a decrease in the case of heavy paraffin oil. The methods used by both the authors have been objected to, and G. Pacher and L. Finazzi have therefore made further experiments. They allowed various liquids to trickle through a set of tubes each of which formed a liquid condenser, and contained a central tube filled with mercury. Any change of viscosity consequent upon charging the condensers would have been indicated by a difference in the rate of fall of the meniscus. No change, however, was observed, although the liquids included such various kinds as water, alcohol, ether, benzol, turpentine, and carbon bisulphide. If there was a difference, it must have been less than 0·01 per cent., and the results obtained therefore make out a strong case for a negative reply to the question stated.

[Pacher and Finazzi, *Nuovo Cimento*, April, 1900.]

Heat Due to Cathode Rays.—The heating up of the cathode, which invariably accompanies the formation of cathode rays, has some practical bearings apart from the ordinary vacuum tube phenomena. It is well known that in continuous-current incandescent lamps the negative end of the carbon disintegrates more rapidly than the positive end, and in favourable circumstances a violet aureole can be seen to play around the cathode end. The latter rapidly loses its gloss, and probably contributes most material to the formation of the age-coating. P. Villard points out that the filament of a lamp can be made incandescent by means of an induction coil, if it is made into a cathode, and another filament is mounted as an anode in the same tube. The phenomenon may be produced at pressures up to one atmosphere by using metallic instead of carbon filaments. Care must be taken to have the current impulses in one direction only, and not to have the period of interruption the same as the period of elastic vibration of the filament. The difference of potential required to produce incandescence by the cathode effect is much higher than that required by the Joule effect, but the current required is much less. Tesla's incandescence phenomena are probably due to cathode heat.

[P. Villard, *Comptes Rendus*, June 11, 1900.]

Magnetic Field due to a Moving Electric Charge.—According to Maxwell's theory, a body carrying an electrostatic charge of surface density σ, moving with a velocity v, should produce a magnetic field equivalent to that of a conduction current. The intensity of the equivalent conduction current is given by the formula

$$di = ds\sigma \frac{v}{V}$$

where ds is the surface element of the charged body, and V the ratio of the electromagnetic to the electrostatic unit of quantity. In 1876 and in 1889, Rowland made some experiments which seemed to confirm this prediction. Such experiments, however, are very difficult to perform satisfactorily, as the forces to be measured are excessively small. Lippmann pointed out, as a logical consequence of Maxwell's view, that electrified bodies would be moved by every change in the intensity of the surrounding magnetic field, and he failed to discover any such motion. V. Crémien has accordingly conducted some new experiments on the same subject. Instead of watching the effect of a moving charge on a suspended magnetic needle, he made a charged disc rotate in the centre of a large coil and in the same plane. The charging of the disc would be equivalent to the establishment of a circular current, and should therefore produce an induced current in the coil. But no such effect was produced, whether the disc was left bare, or lacquered, or cut into three independent and insulated sections. It remains to square this fact with Maxwell's theory.

[V. Crémien, *Comptes Rendus*, June 5, 1900.]

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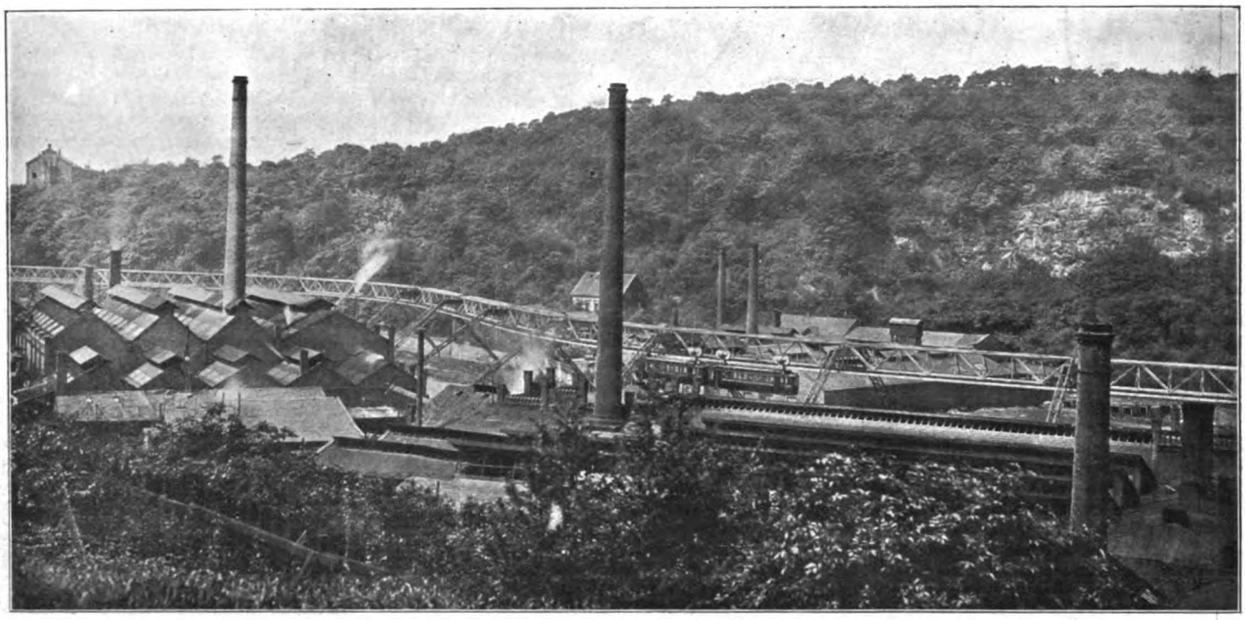
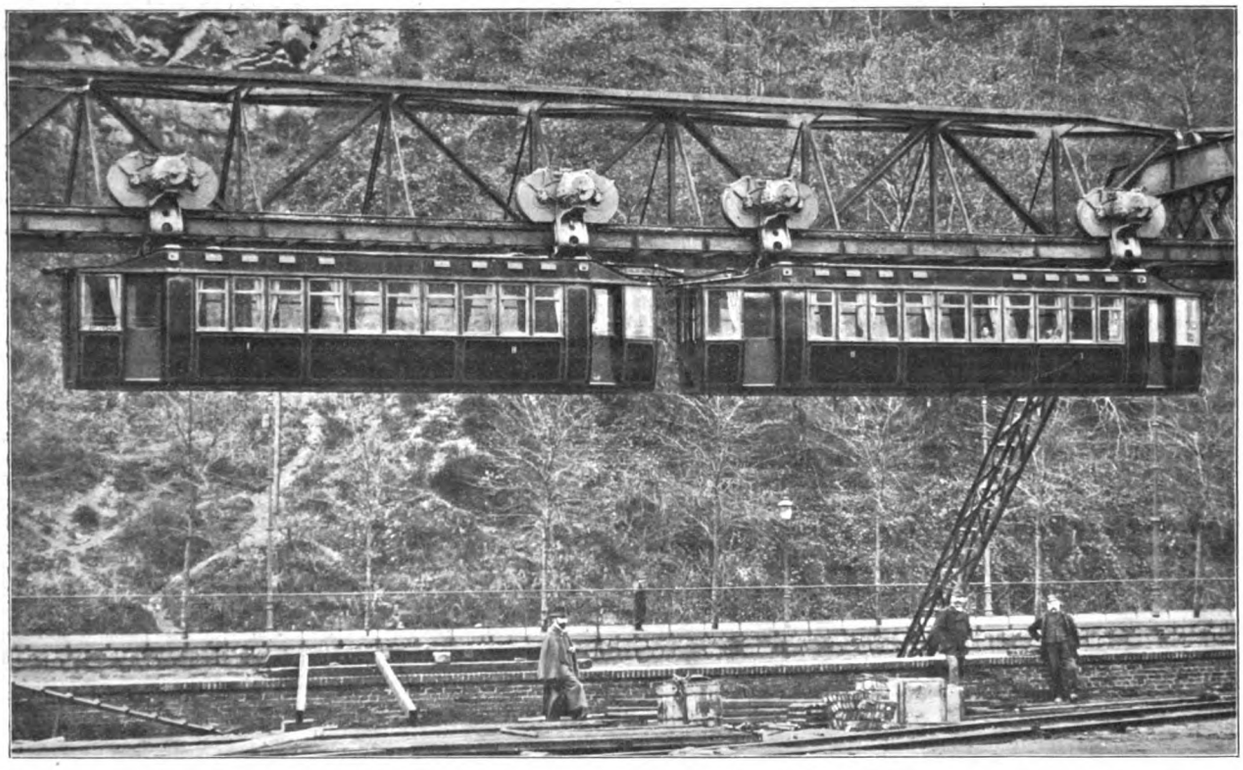
THE BARMEN-ELBERFELD MONO-RAIL OVERHEAD RAILWAY.

In a recent number of *The Electrician* (Vol. XLIV., p. 885), we announced the completion of a novel form of overhead electric railway between Barmen and Elberfeld, in Germany. Electric Co. we are enabled to present our readers with some illustrations of the German line, which has been constructed and equipped by the Continentale Gesellschaft für Elektrische



General View of the Barmen-Elberfeld Railway.

In view of the attempt to introduce a mono-rail system for an express railway between Liverpool and Manchester, the successful completion of the Barmen Elberfeld line possesses special interest at the present moment. Although the Liver- Untermehmungen, of Nurnberg. These illustrations clearly show the general construction of the railway, and doubtless will convey to our readers a correct sense of the combined lightness and safety which this type of railway construction



Barmen-Elberfeld Mono-rail Railway Train.

pool-Manchester scheme was rejected by the Parliamentary Committee, it doubtless will not be long before an attempt to introduce the mono-rail system between these two cities is again made. Through the courtesy of the British Schuckert introduces. The Barmen line cannot be called a high-speed line, as the normal speed is under 30 miles an hour. Moreover, many of the curves are too sharp to allow of a high speed. The railway abundantly demonstrates, however, the

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feasibility of running a suburban or inter-urban service of light electric trains on the mono-rail system. The particular mono-rail system which has been adopted for the Barmen-Elberfeld line is that invented by, and associated with the

CURVE CONSTRUCTION OVER THE RIVER WUPPER.

name of, Eugen Langen. Unlike the Lartigue system, selected for the proposed Manchester-Liverpool line, the trains on the Langen system are suspended beneath the track rails, while the motors are carried on bicycle bogies above these

VIEW OF STREET CONSTRUCTION.

rails in the manner shown in the illustrations. There are four motors on each train, the train consisting of two coaches; each motor running at 500 volts and capable of developing 86 H.P. The carrying capacity of the train is 50 passengers. The motors are constructed for very rapid acceleration necessitated by the large number of intermediate railway stations, there being altogether 18 stations on a total length of only about 8¾ miles of line. The acceleration admits of full speed being attained in from 10sec. to 15sec. The trains are provided with four kinds of brakes, viz., the Westinghouse air brake, which is also controlled by a hand brake worked either by the conductor or driver, an electric brake and an emergency electric brake.

Several different forms of overhead construction have been adopted as the line passes for a considerable part of its length over the River Wupper, and also for some part over the streets of Barmen. Our illustrations show the manner of adapting the construction to these different conditions.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.*

In view of the proceedings at the recent third International Conference, there can be little doubt that the ultimate execution of this important enterprise is now assured. Prior to the meeting some of us, perhaps, vaguely feared that the foreign delegates would come prepared to suggest all sorts of difficulties, if not to announce the unwillingness of the countries they represented to take any part in the work; but nothing of the kind occurred. All came bent on securing success; not a word was uttered in depreciation of any of the proposals brought under consideration; and all present may be said to have taken an enthusiastic interest in carrying the proceedings to a satisfactory issue. Everyone was of opinion that if a fair beginning can once be made—the importance of the work is so great, it will be of such use to scientific workers at large—that it will rapidly grow in favour, and soon secure that wide support which is not yet given to it, simply because its character and value are but imperfectly understood. Therefore, all were anxious that a beginning should be made.

It has been estimated that if 300 sets or the equivalent are sold the expenses of publication will be fully met. As the purchase of more than half this number was guaranteed by France, Germany, Italy, Norway, Switzerland and the United Kingdom, the conference came

* From *Nature*.

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to the conclusion that the number likely to be taken by other countries would be such that the subscriptions necessary to cover the cost of the catalogue would be obtained. The resolution arrived at after this opinion had been formed, "That the catalogue include both an author's and a subject index, according to the schemes of the Provisional International Committee," must, in fact, be read as a resolution to establish the catalogue.

Of the countries represented at the various conferences, excepting Belgium, not one has expressed any unwillingness eventually to co-operate in the work. Unfortunately, neither the United States nor Russia was officially represented on the present occasion. The attempts that have been made to induce the Government in the United States to directly subsidise the catalogue have not been successful: but that the United States will contribute its fair share, both of material and of pecuniary support, cannot be doubted. There, as here, private or corporate enterprise must undertake much that is done under Government auspices in Europe. As to Russia, the organisation of scientific workers there has been so little developed that it is very difficult to secure their attention, and probably our Russian colleagues are as yet but very imperfectly aware of what is proposed. The importance of Russian scientific work is so great, however, that it stands to reason that it must be fully considered; and it may be supposed that Russia will join when she becomes acquainted with what is proposed and what is required of her.

A provisional international committee has been appointed, which will take the steps now necessary to secure the adhesion and co-operation of countries not yet pledged to support the scheme. Originally it was proposed to issue a card as well as a book-catalogue, but on account of the great additional expense this would involve, and as the Americans in particular had not expressed themselves in favour of a card issue, it is resolved to publish the catalogue, for the present, only in the form of annual volumes.

From the outset great stress has been laid on the preparation of subject indexes, which go behind the titles of Papers, and give fairly full information as to the nature of their contents. Both at the first and the second International Conference this view met with the fullest approval. Meanwhile, the action of the German Government has made it necessary to somewhat modify the original plan. In Germany a regional bureau will be established, supported by a Government subvention, and it is intended that the whole of the German scientific literature shall be catalogued in this office; no assistance will be asked from authors or editors or corporate bodies. In such an office it will for the present be impossible to go behind titles; consequently, only the titles of German Papers will be quoted in the catalogue. In the first instance, some other countries may prefer to adopt this course on the ground of economy. But in this country, at least, the attempt will be made to deal fully with the literature, and the co-operation of authors and editors will be specially invited. An author may not always be best able to judge which are the most important points in his Paper to be noted in an index, but the experience gained in the Royal Society during several years past has shown that authors furnish most valuable information, and that their suggestions are easily reduced into shape. A full code of instructions for the use of the regional bureaux is now being prepared under the auspices of the Provisional International committee.

The catalogue is to be published annually in 17 distinct volumes. The collection of material is to commence from Jan. 1, 1901. As it will be impossible to print and issue so many volumes at once, it is proposed to publish them in sets of four or five at quarterly intervals. During the first year, parts covering shorter periods will be prepared, so as to make the subsequent regular issue possible of volumes in which the literature published during a previous period of 12 months is catalogued. Valuable opportunity will thus be given from the outset of gaining experience both in the preparation and use of the catalogue. That many difficulties will be encountered in carrying the work out cannot be doubted; but if scientific workers generally will but reflect on the inestimable value of accurate classified subject indexes, they cannot but see that it will be to their great advantage to do all in their power to further the enterprise. If the attempt fail, it will only be because those on whose behalf it is undertaken are blind to their own interests. H. E. A.

Revival of Telpherage.—The Consolidated Telpherage Co., of New York, has considerably developed and perfected on modern lines the system of telpherage originated by Prof. Fleeming Jenkin some years ago. The American telpher, however, differs considerably in detail from that of Prof. Jenkin. It consists of a truck or bucket supported from a motor vehicle riding on a single cable or wire. A short distance over this cable there is an ordinary trolley wire, current being collected from this by a small trolley wheel similar to that used on tramways, but much smaller. The system is designed for use both overhead and in tunnels.

THE NEW PHYSICAL LABORATORY AT OWENS COLLEGE.*

BY PROF. ARTHUR SCHUSTER.

The physical laboratory which is to be opened to-day* by Lord Rayleigh will form an important addition to the buildings of Owens College. The general public has often a little difficulty in understanding the nature of the work done in a physical laboratory, owing to the association of the word "physics" with quite different matters, such as "physical exercise" or "physic." To trace the origin of the word in its various meanings would be an interesting undertaking. But at present it will be sufficient to recall the fact that Aristotle's book on "Physics" dealt chiefly with the idea of movement, and in that sense "physics" was used a good deal in the Middle Ages. But in a work entitled "Physica," by Melchior Verdries, the third edition of which was published in 1735, a much wider meaning was given to the word and "physics" was defined as including the following: (1) Cosmology (2) stoicheiology, or the doctrine of the elements, (3) uranology, (4) geology, (5) meteorology, (6) mineralogy, (7) phytology (botany), (8) zoology, and (9) anthropology. This pretty well covers the range of human knowledge so far as the material universe is concerned, and if the word was generally used in so wide a sense a man who knew physics must have been a wise man. Probably, therefore, originally "physician," like the word "doctor," only indicated a learned man, and the only learning appreciated by the public being that capable of dealing with the pains of the flesh, it is obvious how both "doctor" and "physician" came to have their special meaning. Without wishing to trace the further varieties in the meaning of "physics" as a science which occur in different writings and in different countries, it is sufficient to say that at present by general consent the word indicates that branch of human knowledge which deals more especially with sound, light, heat, magnetism, and electricity, and the general constitution of the material world. A laboratory in which all these branches of science are studied experimentally must therefore be provided with a considerable outfit of appliances of the most varied character.

Attention may be drawn to a few of these. The properties of bodies have to be studied at various temperatures, and it is important to be able to pass quickly from the temperature of freezing to that of boiling water. This can be done partly with the help of ice on one side and of steam on the other. Ice is easily obtained, and, to save time and trouble, steam in our new laboratory will be available in most of the rooms. For this purpose special pipes are laid from a small boiler into the different rooms. If a wider range of temperature is required, we have recourse to the electric furnace or the cooling action of liquid air. In the electric furnace the heat is supplied by electric currents, and the temperature may be raised to over 6,000°F. But a very considerable power is absorbed in the process. Moissan, at Paris, uses as much as 50 H.P. in some of his work, but half that power is sufficient for most purposes, and will be available by means of a gas engine presented by Mr. W. J. Crossley and dynamo machinery constructed by Messrs. Mather & Platt and the Electric Construction Corporation. Air can be liquefied and a temperature of 300deg. below zero reached by means of a pump which compresses the air to 200 atmospheres. This air is then forced through very narrow openings, when a cooling of a few degrees takes place. The air thus cooled serves to lower the temperature of the compressed air before it passes the opening, which is cooled down another step, and gradually the air becomes colder and colder until it falls down in the form of rain. The liquid air is collected, and can be drained off like water. The plant, the most expensive portion of which consists of a Whitehead compressing pump absorbing 4 H.P., has been presented to the laboratory by Sir Henry E. Roscoe. A high pressure of 200 atmospheres will of course be useful for many other purposes, but, independently of this, the laboratory is supplied with air compressed to four atmospheres, a pressure of that amount or less being often required for different objects. The pump used for this purpose is attached to a small steam engine placed in the boiler-house, and iron pipes diverge from here to the different rooms of the laboratory.

The knowledge of accurate time intervals, which is important in many investigations, renders the possession of accurate clocks, expensive as they are, absolutely imperative. The clock to be placed in the basement of our new laboratory will probably be the most perfect clock in the country. It is made by Dr. Riefler, of Munich, and has in its original form been tested in many observatories, and found to keep more perfect time than the older types of clock. But a further improvement has been recently introduced, for it is found that a very slight disturbance in the rate of the clock is due to the difference in the retardation due to air resistance which takes place according to the height of the barometer. A pendulum clock which keeps accurate time when the barometer is exceptionally high would gain about a second a week when the barometric

* From the *Manchester Guardian*, June 29th.

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pressure is exceptionally low. It is a sign of the perfection of Dr. Riefler's clocks that he has found it worth while to correct and compensate so trifling an error. So valuable a timepiece must of course be kept locked up in a room, and will not be generally accessible, but time is supplied to the different parts of the laboratory by electric transmission from a second clock. The lecture rooms and the larger rooms of the laboratory will all contain dials showing time correct to within a few seconds.

Special attention has been paid to the optical outfit of the laboratory. One of its features will be a room on the top floor which contains the so-called Rowland's diffraction grating. The object of the grating is to split up light into its various components in the same way as is done by a prism, the whole apparatus acting like a spectroscope. These gratings are made of speculum metal, on a plate of which a space of 6in. is covered by lines ruled very close together with a diamond point, the total number of lines being over 100,000. The ruling of these lines, which must be accurately spaced, is extremely difficult, although done by a ruling machine. An idea of the difficulty experienced may be obtained from the fact that it occasionally takes three or four years before a satisfactory grating is manufactured. The one supplied to the college has been certified by Prof. Rowland as exceptionally good, and carries an inscription stating that it has been specially selected for the professor of physics at Owens College. The mounting of the granting is peculiar, and takes up a good deal of space. Two iron beams over 20ft. long, stretching across the room, are placed exactly at right angles to each other. Each beam carries two rails, and small carriages can roll along these rails. One of these carriages carries the grating, while the other carries the photographic camera or the eyepiece which serves for observation of the spectrum. The two carriages are connected by an iron girder over 21ft. long, and this girder has to be specially steady so as not to be subject to vibration. This construction of the girders and their supports has been specially designed by Sir Howard Grubb, and it is hoped the mounting will be a considerable improvement on that used in the three or four places where these gratings are at present to be found. The room in which this apparatus is situated has of course to be kept dark, but there must be some means of obtaining a beam of sunlight or a beam of an electric arc when required. For this purpose a balcony has been built. This runs along the west side of the building, and sunlight may be thrown by means of inclined mirrors through openings in the wall.

The photographic laboratory is in the basement. The observatory, placed on the top of the building, contains the 10in. telescope presented by Sir Thomas S. Bazley. There was some difficulty in providing a sufficiently steady foundation for the telescope, but it is hoped that this has been successfully overcome. The electro-technical laboratory, built and equipped in memory of Dr. John Hopkinson, has been provided, as far as the means at the disposal of the college have allowed, with the most modern form of machinery. Considerable space has been assigned to an electro-chemical laboratory, and as a special lecturer has been appointed in that subject it is hoped that Owens College will take a leading part in its development.

As regards the general arrangements of the laboratory, it may be said that the walls are lined almost entirely with glazed bricks, which are easily kept clean. The question of ventilation has received careful consideration. For a number of reasons the so-called plenum system was found unsuitable for a physical laboratory, and some process of natural ventilation was adopted. Air is admitted through openings in the wall, and passes over a surface of oil, which frees it from dust. This is an invention of Mr. Kenneth Teale. The arrangements for heating, which is done by low-pressure steam, and for drawing off the vitiated air have been devised by Mr. E. Hatton. An electric lift connects the different floors, and will serve principally to convey delicate apparatus from one part of the building to another. There will be a small but well-equipped workshop in which instruments can be repaired or even made. The large lecture-room holds, under ordinary circumstances, 210 students. It has a skylight as well as windows looking to the east, and rapidly moving shutters allow the room to be quickly darkened. The small lecture-room serves for advanced lectures, and rooms are provided for storing the ordinary apparatus and also some historical instruments, as, for instance, Joule's valuable apparatus, some of which have been presented to the college. In a modern laboratory it is essential that the electric current should be available in every room for experimental purposes. This current is supplied from 60 storage cells, which are connected through a large switchboard over 15ft. long. Thirty circuits diverge from this switchboard into the various rooms, the circuits consisting of aluminium or copper wire, stretched principally under the ceiling of each room and passing through specially perforated bricks in the walls. Uncovered wires have been chosen for the purpose, as the expense is reduced, and much stronger currents can be sent through the same thickness of wire; there is also gain in the neatness of appearance. The research-rooms are placed principally in the basement and on the ground floor of the building, where the greatest steadiness and freedom from disturbance can be obtained, and it is hoped that the unusual facilities which in future will be given at Owens College for original research in physics will attract many students. There is also every reason to hope that the John Hopkinson electro-technical laboratory, with its adjunct, the electro-chemical laboratory, will soon make itself felt in the education of electrical engineers, who will be trained to carry out the highest technical work they may be called upon to perform.

THE LIGHTING OF SMALL TOWNS.*

BY G. M. HARRIS,
(Electrical Engineer, Bray, Ireland.)

The lighting of small towns is a problem requiring very careful consideration, not by reason of any engineering difficulties, but by reason of the difficulty of making such an undertaking pay. On account of the profits being necessarily small, the lighting of small towns will continue to receive little attention from private companies, except they be very plucky ones. The matter will, therefore, be left for the consideration of the local authority, who will be content, or at all events should be, if at a reasonable cost they are enabled to carry out the public lighting of the town, and at the same time place a supply of electricity at the disposal of its inhabitants. The measure of the success of such an undertaking should then be judged, not by actual return made in the shape of profit shown, but upon truly municipal lines, *i.e.*, by the efficiency and cost of the public lighting and the rate at which a supply of electricity is obtainable for private use. Small towns mean small consumers and usually a scattered area. The distributing charges will be heavy, so that if there is to be any hope of success the generating charges must be light, which means that the site for a generating station must have very special natural advantages, such as good water power or facilities for cheap fuel, or a combination of the two. Where there are no such advantages there appears to be no alternative but to wait for the great power companies to pick up such small areas as may be within their reach or upon the direct line of route of their mains to larger ones. Assuming that the conditions are favourable for generating or obtaining a supply at a low cost—at the commencement, the public lighting should be provided for and taken over, and provision only made for private consumers where such are certain to come on in a reasonable time. The policy of laying the mains for private use well in advance of the demand, though justified in wealthy areas, would not be so in small towns where the conditions are different. The prospect of profit in supplying small and scattered consumers being very small, there is no room for speculation, and it is of the utmost importance that the capital expenditure be kept as low as possible, and that no capital should be unproductive. It therefore follows that the system of distribution should possess the maximum of flexibility at the minimum of cost. Now that distribution up to 200 volts has been successfully established, there are, of course, many towns where direct current would be feasible and no doubt preferable, but in the majority of cases high pressure alternating current with transformers in street pits and occasionally in houses would be better; where the area comprises a number of private houses and mansions, standing in their own grounds and of necessity widely scattered but nevertheless desirable to reach, the alternating system is the only one commercially possible. This question, however, will, of course, be governed by the circumstances in any particular district, but the question of the actual cost of mains will always remain—a serious item telling against economical distribution on a small scale.

It is therefore the object of this Paper to deal with the matter of cheap mains and main laying, that being, I consider, the most important point—the one which lies nearest towards a solution of the problem under consideration. I therefore propose to bring to the notice of this Association two cheap and effective methods of main laying, of which I have had experience at Bray. First, as to the mains in operation at Bray—there have been over 6 miles of high and 27 miles of low tension laid direct in the ground since 1892, and during that time we have never had a fault on the main line of cables themselves, except where mechanical injury had caused it, and this has very seldom happened. Any trouble we have had has been due to defects in the filling material of the jointing boxes, now overcome, so that this system of laying may claim to have been well tried. In fact, I think the Bray mains are the oldest paper-insulated cables in the Kingdom, other than those from Deptford. The cables are concentric lead-covered and unarmoured—they are taped, but this is, in my opinion, a disadvantage. In laying, the bottom of the trench was covered with about 3in. of puddle clay, well wrought, the cables laid in and covered with another 3in. of puddle clay, evenly put on, and a 7in. by 1in. board placed on top, the trench being then filled. Latterly, the timber used for mechanical protection has been larch—being simply the small larch trees, 7in. thick in the butt, sawn in half. This timber stands well in the ground, requiring no special treatment to preserve it, is cheaper than deal

* Paper read before the Municipal Electrical Association, at Huddersfield, June 20.

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The following are Particulars of the Insulation Resistance of the High-tension Mains.

No. of main.	Size.	Year laid.	Length in miles.	No. of underground joints.	Insulation resistance.					
					No. of loops to pits.	Outer to earth.	Inner to earth.	Inner to outer.	With transformers connected.	Equiv. per mile, transformers connected.
1	0·0229	1892	0·3	17	7	0·176	1·37	1·69	0·18	0·059
2	0·0229 0·0128	1892 1893	1·58	41	13	0·133	0·133	0·173	0·66	1·04
3	0·0229	1892	0·875	28	8	0·4	0·8	1·04	0·40	0·35
4 (arc circuit)	0·0128	1892	2·17	50	4	0·44	0·314	1·10	0·20	0·434
5	0·0072	1892	0·54	14	6	0·338	0·758	0·846	0·285	0·15
6	0·0356 0·0128	1898	1·16	7	6	1·8	3·42	2·66	1·81	2·09

boards, and more effective, being thicker. The effect of the puddle clay, impervious to moisture, is to protect the lead covering from any contact with acids or salts in the soil which would attack it, and it has proved so effective that when the cable is now, after eight years, exposed, the lead is absolutely unattacked. The braiding of the cables has rotted, proving to have been an unnecessary expense; it might prove a source of danger if it allowed the passage of water charged with matter which would attack lead, the life of a lead-covered cable being practically the life of the lead. As to the jointing, no clips are used, the inners are married and soldered in the usual way, the outer wires are drawn to one side and soldered together forming a loop, all soldering being done well clear of the cable insulation. The joint is contained in a cast-iron joint box divided longitudinally on the line of two bottle necks for entrance and exit of cable and having on the top side a large hole for filling (not less than 1in.) and a smaller hole as air vent, closed by screwed plugs. The cables are served with spun-yarn up to the diameter of the bottle necks and no other packing of the glands is found necessary. The joints having been made and the box screwed up, molten pitch is poured in; the outer side of the bottle necks, beyond the spun-yarn serving, is also filled in with pitch, hollows being formed in the clay for the purpose, and here fine clay mixed with the pitch forms a cement which effectually seals up the bottle necks and protects the cable from injury where they enter and leave the box. Such a joint is cheaply made and fulfils every requirement. It demands only care, and requires absolutely no special skill, a very important matter in a small town. This, and the fact that it is both electrically and mechanically sound, gives a joint so made advantages which no form of joint made with clips, which the writer has seen, can claim. Where any transformer pits lie on the route all cables are brought into the pits and are joined there, inners and outers, with loops of rubber-covered single cables; disconnection of any length of cable for tracing a fault is done by snipping these loops, and this works well under our conditions. Of course in a large scheme where the expense was no object disconnecting boxes would be preferable, but when used they should certainly be placed in pillars above ground and so above the reach of flooding, and not in water tight boxes under ground.

As far as the writer is aware, the insulation resistance of mains in operation is not usually easily obtainable, but he has reason to believe that the above are more than ordinarily low. This, however, in no way reflects on the cables; it is partly due to the fact that originally oil was used in the joint boxes, but was soon abandoned, not, however, before the cable ends had suffered, due to water mixing with the oil—the repairing of these ends accounts for the large number of joints. The main cause of the low insulation is due to the large number of joint boxes, which still contain a mixture of tar and pitch (the tar having been added as a precaution against cracking of the pitch). This mixture is inferior in every way to the pitch alone, which is now always used. The fact that the resistance from the inner to the outer is in the majority of cases greater than that to the earth is no doubt accounted for at the joints, where the resistance of the pitch has been weakened in the manner indicated, and the surface of the outer is small in comparison to the surrounding box. Their condition, however, causes no anxiety at Bray, as the tests are practically identical with those taken in 1893; the cables have been perfectly steady all along, and have lived to see much of the more elaborate and costly drawn-in system placed on the scrap heap. The cost of laying the cable described was under 1s. per yard of trench, made up as follows: Opening and filling trench 20in. deep, including mixing of puddle clay, from 3d. to 6d. per yard. Puddle clay at 2s. 6d. per ton, sufficient for three cables, 3d. per yard. 7in. by 1in. board for mechanical protection, 2d. per yard.

The average cost of a joint being under 10s., as follows:—

	s.	d.
Joint box, complete	4	6
Pitch, solder, fire, &c., say	2	6
Labour	2	6
	9	6

Sufficient has been said perhaps to show that such a system of laying and jointing mains is cheap and reliable, in any case in which no danger from electrolytic action is feared—as where, for instance, a tram line passed through a town. In such a case the lead would need protection, and recourse to some solid system seems inevitable; but a small town cannot afford the luxury of lead-covered cables laid in this way, and the lead seems to me quite unnecessary, serving no purposes which would not be equally served by any cheap covering which would protect the insulation from damp up to the time of being laid, after which it requires no such protection. If the cables are concentric the outer insulation can be reduced to that thickness which, with the filling, suffices for the voltage carried; if the cables are not concentric then the covering of each may be reduced to that thickness which, with the filling, is good enough. The question is, how much the insulation, other than that of the filling compound, may be reduced? My impression is that, driven by consideration of cost, we shall see this extra insulation year by year reduced in amount, till, for low voltage, we come to the bare conductor laid on insulators in the solid filling, and for higher voltage, conductors laid on the same system with very slight extra insulation, relying mainly upon the filling compound. The inevitable result of this will be that we shall, for the conductors, use iron or other metal, or alloy, cheaper than copper, since the prohibitive cost of the increased insulation, due to bigger cross-section for the same conductivity for such metals, will not have to be faced. At Bray we tested some years ago 80 yards of bare copper mains laid on the solid system, and although roughly laid and badly insulated, the filling compound being a mixture of bitumen, tar and sawdust, this nevertheless stood 1,000 volts for twelve months, and 100 volts for two years afterwards, and was then only taken up on account of building extensions. From that experiment and subsequent experience I believe it is perfectly possible, even now, for voltage, say up to 500, covering all low tension distribution for light and traction, to use wires covered with, say, a few layers of paper and a light braiding varnished, and the whole laid in troughing filled in with plain pitch at 10s. per ton, which, for all sizes of copper above, say, 0·25in. sectional area, would be cheaper than any cable in the market. Whatever be the nature of the solid system, the compound for filling both joints and troughing should be ordinary pitch, which has the advantage that it can with ease be chipped out, and is cheap. In most small towns, for the public lighting of outlying country roads, overhead bare wiring might be employed, for doubtless the sanction of the Board of Trade for their use, at all events for the first years, might be obtained. On the whole, however, the regulation preventing the use of overhead wires does not press very hard upon small towns, where usually labour is cheap and the roads easily opened.

Returning to the general question, it may safely be said that where gas has been well established, the outlook for a private consumption of electricity will be in inverse proportion to the price charged for gas, for, where a high price prevails, the inhabitants will be found educated to the closest economy in its use, and it is surprising how far this can be carried.

BATTERIES FOR AUTOMOBILES.

Dr. Sieg, discussing the subject of portable batteries in No. 10 of the *Centralblatt für Accumulatoren und Elementenkunde*, says that there is still considerable divergence of opinion concerning their usefulness, and that the breakdowns which have occurred on the Berlin tram lines have given a fresh handle to those who oppose their employment. He does not concern himself with these breakdowns or with their causes, but passes on at once to the general consideration of the employment of batteries for the propulsion of ordinary road vehicles. In stationary batteries it is only the chemical processes involved in the storage of the current which act injuriously on the plates, and as there is no necessity to keep down the weight or size of the batteries, heavy electrodes may be employed, spaced far apart, and a good depth may be left below the bottom of the plates, so as to reduce the risk of damage from short circuits and buckling to a minimum. The work required of the battery is also known accurately beforehand, so that damage due to overstrain can

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be avoided. But in the case of batteries propelling automobiles the conditions are very different. Weight and size have to be restricted as much as possible in order that the vehicle may not be too heavy, for weight not only increases the working cost of the vehicle, but also reduces its handiness. The amount of current used, and therefore the demand on the battery, varies with the conditions of working and the state of the roads. Wet roads, sandy soil, stones, &c., increase the demand enormously, so that not only the normal current, but also the normal capacity, may be far exceeded. The batteries are also constantly subjected to severe jolting, which seriously affects their life. Dr. Sieg then proceeds to the consideration of the properties which are required in an automobile battery, and as a preliminary lays down certain requirements which must be fulfilled.

The weight of the empty carriage ought to be from one-half to three-fourths of the weight to be carried by it according to the method of construction employed, and the speed to be attained. For the conveyance of passengers, two-thirds of the total weight may be allowed. This total weight is made up as follows: The motors, which for a passenger car for a speed of 15km. to 18km. per hour amount to one-tenth of the total weight of the occupied car (W), the battery (B), and the passenger weight which may be taken at 0·3 tons (four persons at 75 kg. each). It follows from this that

$$W = 0{\cdot}6 + 2B.$$

As carriages exceeding 2 tons in total weight cannot be safely steered at a higher speed than 15km. to 18km. per hour, it follows that the battery weight must not exceed 700 kg.

Taking the commercial efficiency of the motor as 70 per cent., and assuming a traction coefficient of 25, which is rather too low than too high on a good road, the consumption of energy by the carriage in 18 kilometre-hours, or 5 metre-seconds, works out to $1{,}750 \times W$ watts. Assuming that the carriage will require to run at least three hours on one charge, that is somewhat over 50km., which corresponds to the daily service of a taxameter cab, the battery will require a capacity of 5,250 watt-hours, *i.e.*, in order that the working generally may be possible, the battery must yield at least 10·5 watt-hours per kilogramme weight, or be capable of yielding 5·5 ampere-hours at a 3-hour discharge at a potential of 1·9 volts.

As it will seldom happen that a carriage will be called on to give its whole yield without some stoppage, it will as a rule be sufficient when the battery gives 8 ampere-hours per kilogramme with a 5-hour to 6-hour discharge. Or when the battery has a higher capacity per kilogramme weight, a smaller battery weight than 700 kg. will suffice; but if the battery has a lower capacity, it will not maintain the daily work of 50km.

For stationary batteries the capacity per kilogramme varies between 3 ampere-hours to 5 ampere-hours, so it is evident that to fulfil the conditions required by an automobile the battery must have only about half the weight of a stationary battery, or else have double the ordinary capacity. Weight may be reduced by making the cells themselves lighter, which can be done by employing vulcanite in their construction instead of glass, &c. The weight of the acid may also be diminished by reducing the distance between the plates, and the space allotted to them, but since the production of an ampere-hour always requires the consumption of a definite quantity of pure sulphuric acid, the diminution of the quantity of the electrolyte must be compensated for by an increase in its density, which at once has the injurious effect of raising the working potential of the cell. The reduction of the distance between the plates is further attended with the risk of short circuit from a very small amount of buckling, which is best obviated by the employment of perforated and corrugated distance plates of vulcanite, such as those manufactured by the Hagen Accumulator Works at Cologne. This construction is also employed by other leading manufacturers of automobile cells, such as the Société Fulmen of Paris, who adopted it after making trial of other methods. They found that flat separators spaced by rods of insulating material, gave unsatisfactory results because the circulation of the electrolyte was interferred with, as also was the descent to the bottom of the cell of the material dislodged from the surface of the plates. All gelatinous electrolytes have been failures, and all attempts to absorb the fluid electrolyte by dry fillings have had a similar fate, since a rapid circulation of the electrolyte through them is impossible. With a quick discharge they have a very high internal resistance, and they lower the capacity of the cell, while the gas bubbles soon form little hollow spaces and channels in the material in which the active material dislodged from the plates collects, and this occasions short circuits. The cost of these corrugated vulcanite separators is certainly very high, and therefore any cheaper method for satisfactorily attaining the same end would be welcomed.

But a decrease in the weight of the acid and of the boxes is not sufficient alone to raise the specific yield of automobile cells to about double that which is obtained from stationary cells, for the weight of the electrodes in the latter is about 50 per cent. to 60 per cent. of that of the total weight of the cell. Thus a considerable reduction is also required in the weight of the cells themselves, which can only be effected at the expense of their durability. The same durability, therefore, must not be expected from automobile cells as is required from those which are stationary, especially as the diminution in weight entails thinner plates, from which more chemical activity is expected, and greater current-carrying capacity, while mechanically they are subjected to the strains involved by perpetual jolting.

Of the three types of accumulator at present in use, *i.e.*, the large surface plates, the grid plates, and the block, the second is alone suitable for automobile batteries, because with the first-named the requisite yield of 8 ampere-hours per kilogramme cannot be obtained, and in the block plates the distribution of the current is not uniform, so that whole blocks lose contact with the supporting frames and drop out. The requisite specific yield combined with a reasonable durability can be obtained from the grid type if care is taken in the filling in of the plates that there is no break in the continuity, either of the lead salt, or between it and the supporting grid. Either a light double grid, riveted together, such as is employed in the Fulmen cells, or an E.P.S. grid, or any other of similar type, give good results if due care is bestowed on the filling in of the active material, and in placing the separators so that their corrugations press against the plates. As the result of experiments which have extended over two years at the Cologne works, Dr. Sieg has arrived at a method of construction which gives good results. For both positive and negative plates, hardened lead grids are employed having a thickness of 3mm. and whose mesh is 15mm. square. The plates are 130mm. wide, 200mm. high, and are mounted about 3mm. apart. The negatives stand on the bottom of the cell on legs 25mm. high, while the positives are suspended above them from vulcanite rods, so that they have room for downward expansion. By the employment of a specially prepared paste Dr. Sieg succeeded in fixing it securely in the grid, and in obtaining a yield of 10 ampere hours per kilogramme, with a 5-hour discharge. Between the plates are placed hard rubber separators half a millimetre thick, and the plates of like sign are united to each other by burning.

The first of these batteries was delivered to the Cologne Elektricitätsgesellschaft in March, 1899, and since that time has propelled a vehicle which has been used partly for business purposes and partly for the personal needs of the directors. The carriage weighs about 1,200kg., and has an 80km.-hour range. At the end of April, 1900, the cells, which had hitherto required no repairs, were cleaned, and it was found that the negative plates were still faultless, whilst the positive plates, although they had lost some material, were apparently capable of carrying on the work for some time longer. Before the battery was cleaned, the carriage had travelled with one charge over 60km. over somewhat soft roads, and the battery still had its initial capacity of about 120 ampere-hours, with a 5-hour discharge rate. These favourable results determined the Cologne Elektricitätsgesellschaft to give the Hagen works a commission for 19 batteries for employment on the cab service they were about to start in Cologne and Düsseldorf, and some of them have lately come into use.

Since the spring of 1899 experiments have also been conducted in the carriage building works of Heinrich Scheele in Cologne. He tried types of conveyance ranging from the lightest high speed vehicle to a heavy goods waggon capable of carrying 5 tons, and hitherto the batteries have given no cause for complaint. In the laboratories the batteries had yielded about 300 discharges at a 2-hour rate before a change of plates was necessary, and one may therefore reckon on at least 150 discharges being obtained without any repair being required when the batteries are employed for automobile traffic. Since those portions of the cell whose first cost is highest, *i.e.*, the vulcanite cases and the separators, suffer but little deterioration in use, it is quite sufficient to allow 30 per cent. of the initial cost of the batteries for their maintenance, and on these terms the makers are willing to undertake the maintenance of batteries in any towns in which they have agents.

Still more information concerning the durability of the batteries, and their behaviour under all conditions of work, should be gained as the result of the experiments being carried out in Berlin by the "Automobilkonkurrenz."

One circumstance may be mentioned which is of special interest to manufacturers, and that is that out of 40 batteries which the Hagen Company have already delivered, three did not maintain when in work the capacity which they had before being sent out from the factory, and on examination it was found that there was loss of contact between the active material and the grid in the negative plates occasioned by their having been exposed to frost before formation, and with this exception, the faulty plates differed in no respect in weight or construction from those which gave good results. Experimental batteries have been supplied to the tramway service in Bremerhaven which weigh about 2,000 kg, and will run cars weighing 11 tons for an uninterrupted journey of about 140 kilometres. The batteries have been in work since December, 1899, and have gone without stoppage through the heaviest snow without a change of plates being necessary. It remains to be seen how long these batteries will retain their efficiency, but if they only require to be renewed once in six months a satisfactory return will be obtained from them.

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IMPROVEMENTS IN ELECTRIC SUPPLY PLANT.

The accompanying illustrations show some of the latest patterns of electric supply station and transformer plant and apparatus manufactured by Messrs. John Fowler & Co. (Leeds) (Ltd.). From the early days of electric lighting this firm has been steadily and

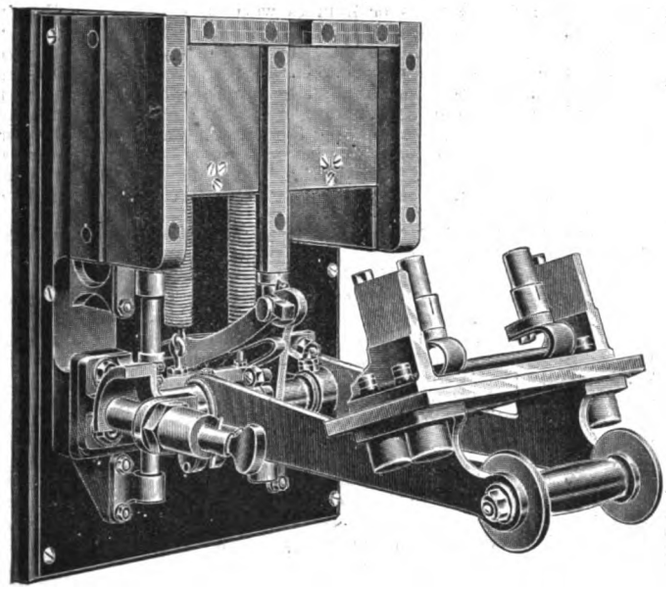

FIG. 1.—Switch open.

extensively connected with the development of the electric supply industry in this country as well as abroad, and it is one of the features of their manufactures that they are always being carefully brought up to range with the latest and best practice. Figs. 1 and 2 show a form of single-pole lever-type shutter switch, designed to

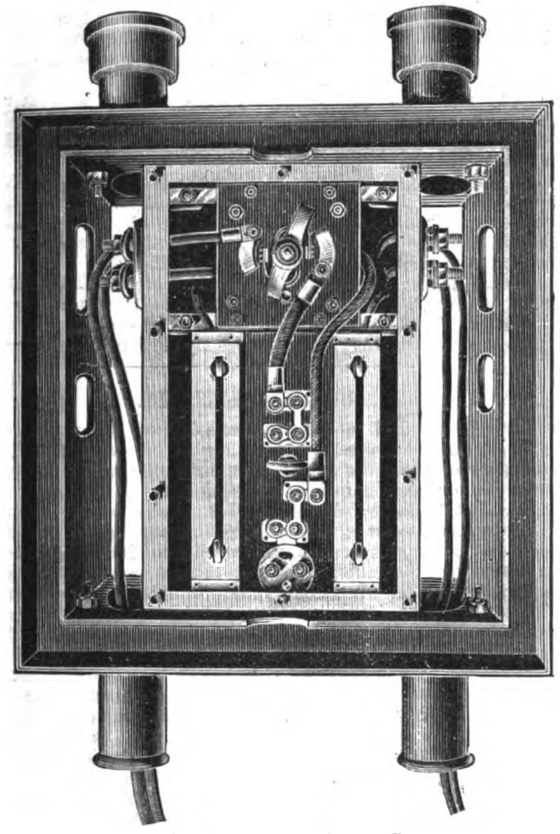

FIG. 3.—Plan of Transformer Box.

work in connection with large currents at high voltage. The illustrations show the switch both open and closed.

The base is of enamelled slate and carries two socket terminals which are mounted on heavy porcelain insulators, and are provided at the back with cable thimbles and nuts, and at the front are fitted with spring jaws and spring-pressed carbons. The base also carries brackets for the lever centres, the brackets for the shutter guide rods, and the guard slates. The lever portion of the switch consists of two brass levers held at their lower ends by a spindle, and at their upper ends by the handle and insulated bridge contact fitted with carbons. The shutters (one arranged for each contact) are mounted on

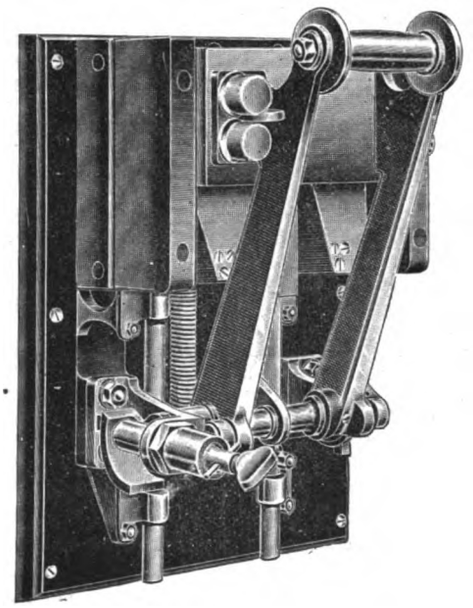

FIG. 2.—Switch closed.

brackets and guide rods; the rods are joined together by a cross-piece. Two springs hold the shutters firmly against the top guard. When the switch is in the "off" position jar or undue knocking is prevented by the rubber buffers. The shutters are further guarded by the guard slates, which are suitably grooved to effect this. The lever spindle is fitted with a spring-pressed lever which engages a cross-piece, and thus operates the shutter automatically.

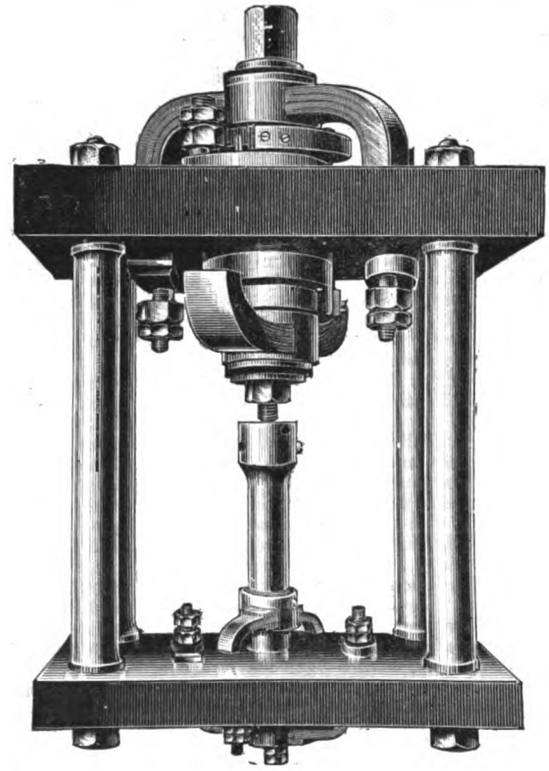

FIG. 4.—Underground Transformer Switch for High and Low-Pressure Circuits.

The switch is operated by pulling the handle fixed on the lever. During the travel the metal contacts will first break, leaving the carbons still pressing together until the holder of the spring-pressed carbon, which telescopes into a tube, comes to its limit of travel, when

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the final break takes place between the two carbons, and immediately following this the shutter, which at that moment is released, flies up, and effectually breaks any arc that may be forming, and at the same time completely closes in the live parts of the switch; the contact plugs in the "off" position being entirely disconnected and therefore harmless. In closing the switch the spring-pressed lever engages with the shutter and causes the same to travel downward against the action of the shutter springs, and in this way uncovering the contact jaws to receive the plugs. Just before the lever has completed its travel, the spring-pressed lever is disengaged by its motion automatically, the shutter then moves upward to the underside of the plugs, and is thus ready to fly up when the switch is opened as already described.

The lever shutter switch is already in use on the main switchboards at Coventry, Newport, and Dublin, at a working pressure of 2,000 volts alternating. It is also in use at the Leeds Corporation tramways, working at a pressure of 500 volts to 600 volts, and a continuous current up to 1,500 amperes.

Fig. 3 shows a plan of the top of the underground transformer box made and recommended by this firm for use in distribution systems supplying power over a scattered area, or where the demand is not likely to be very heavy at any given point. The illustration shows the box with the cover and watertight lid removed. These boxes are made in two sizes, viz., a small size to receive transformers up to 9kw., and a larger size for transformers up to 22·5kw.

Fig. 4 is an elevation of an underground key switch for connecting or disconnecting transformers. This illustration explains itself. The switch breaks both high and low-pressure circuits simultaneously on both poles with a double break and when the transformers are working with the full load there is practically no sparking. The high-pressure contacts are mounted on ebonite and the low pressure on enamelled slate.

PARLIAMENTARY INTELLIGENCE.

MUNICIPAL TRADING.

The Joint Committee of Lords and Commons on Municipal Trading met again on Friday last, Viscount Peel presiding.

Mr. E. O. SMITH, town clerk of Birmingham, stated that his Corporation owned the gas, water, and electric supply undertakings of the city, besides the markets, the public baths, the tramways and the cemetery. At present the tramways were leased to companies, but as soon as the leases expired the Corporation intended to obtain Parliamentary powers to work them themselves. The Town Council had carried out large operations under the Artisans' and Labourers' Dwellings Acts, thus making very great sanitary as well as town improvements. They also owned a large amount of land in Wales in connection with their water undertaking, and the total capital invested in their eight undertakings was approximately £10,000,000. He regarded the carrying on of gas, water and electrical undertakings as municipal trading, and placed tramways in the same category if a corporation run them themselves. A profit of about £30,000 a year was made by Birmingham on the gas undertaking, and this went to the reduction of price and to the improvement rate. He did not believe that if the various undertakings had been worked by companies in competition with other companies, the consuming public would have secured the same advantages. It was, no doubt, a danger for a municipality to have in its employment a vast number of workpeople, but it was one that must be faced. He should like to see all corporation officials disfranchised, but he was afraid that was a policy which could not be carried out. In Birmingham no disadvantages had at present been experienced through having a large number of Corporation workmen who were also municipal voters.

On Tuesday (Lord Crewe presiding) the Committee resumed.

Sir T. HUGHES, alderman of the Liverpool Council and a member of the Liverpool Chamber of Commerce, expressed the opinion that a good many undertakings could be better carried on by corporations than by private individuals. Local authorities could obtain their capital at a lower rate of interest than private persons, and they paid no dividends, while his experience was that there were many men who devoted their lives to corporate undertakings instead of concerning themselves with private work. Liverpool Corporation managed the city tramways, the electric lighting, the water supply, the markets, public baths, workmen's dwellings, and open spaces. The Council consisted of 116 members, and was divided into 14 standing committees, no member of the Council being allowed to serve on more than one of these committees. The Liverpool tramway undertaking dated back to an experimental line in 1860, and came into the possession of the Corporation in 1897, being bought for £567,375, which he looked on as a most unreasonable sum. The Corporation were now reconstructing the tramways and adapting them to electric traction. Directly the Corporation came into possession they began to reconstruct the lines so as to adapt them to electric haulage. Already 63 miles of line had been constructed out of a total of 114 miles. In spite of the large sums they had had to spend, the Corporation had found it possible to reduce the fares by nearly one-half, to concede increased wages and better conditions to their employés, and to increase the speed of the cars. The result of the last-named improvement had been to improve the conditions under which the working classes lived. During the last years of the company's tenure (1896) the passengers carried on the trams numbered 36,704,379, while three years later the number increased to 63,771,450. The receipts increased from £278,446 in 1896 to £359,929 in 1899. As to the overhead electric railway, witness said that was under the special control of the Dock Board, and had no connection with the Corporation tramway system. The Liverpool tramways were on the overhead trolley system, and as the telegraph and telephone wires throughout the city had been laid underground, the appearance of the streets was little, or not at all, interfered with. They looked for great improvements when the whole electric system was completed. At present they had only done about one-half. It paid the Corporation better to take a penny fare for 1½ miles or 2 miles with electric traction than to charge 2d. for the same distance by horse traction. They had been able to pay interest upon the amount paid to the company for the undertaking, and also upon the cost of construction, besides providing the necessary sinking funds. He was of opinion that no municipality ought to look to assisting its rates out of undertakings of this kind until they were on a thoroughly sound basis, and Liverpool Corporation were debarred by their act from taking any portion of their profits for the relief of the general rates till the expiration of the year 1912. There ought not to be too much temptation to create undertakings in order to make profits for the relief of the rates.

The CHAIRMAN asked for some information as to the Corporation's electric undertaking.—Witness said that the electric lighting undertaking was acquired in 1896, £400,000 being paid for what had cost the company £250,000. The charges for current by the company had been 7½d. per unit for lighting and 5d. for power. These charges had been reduced by the Corporation to 4d. for small customers and 3d. for public buildings for lighting, while large consumers for power were charged only 2d. per unit. It had been found possible to work the tramways and the electrical undertaking together, with the result that the charge made to the tramway undertaking for power was less than 1d. per unit. The Corporation's profit in 1896 on the company's charges was £11,000. Last year, after the charges had been twice reduced, the profit remained the same. None of this profit had been allocated to the relief of the rates. Under no circumstances could more that 5 per cent. of the profits be taken for this purpose, because when a larger profit was shown the price had to be reduced. Witness went on to say that he recognised the danger arising from the growth of the number of municipal employés who had votes, and he did not see that any great hardship would result if, on a man becoming an employé of a corporation, he ceased to have a voice in the choice of his masters.

By the CHAIRMAN: Where a local authority got an electric lighting or tramway order they should be called upon to exercise it within a reasonable period, or forego it. If the order was merely obtained as a block it should be set aside.

Ald. SOUTHERN, of the Manchester City Council, said he had served on both the Waterworks and the Gas committees of the Corporation, and was a representative of the City Council on the Manchester Ship Canal Board. Last year the great expenditure incurred in connection with the Thirlmere water scheme had all been wiped out, and it was found possible to reduce the water charges to consumers by £35,000 per annum. With regard to gas, the Corporation made an annual average gross profit of £105,572, which was devoted to the reduction of the city rate. As something had been said by a former witness respecting the ability of corporations to manage gas undertakings, he might say that during the last 50 years the consumers of gas in Liverpool, where the supply was provided by a company, had paid 3d. per 1,000 more for their gas than consumers in Manchester, where the gas supply had been in the hands of the Corporation since 1843. The ratepayers in Manchester, so far from having sustained losses by reason of having their gas cheaper had paid over out of the gas account towards City improvements a profit of £788,317, besides writing off £631,494.

The CHAIRMAN: If you devoted the whole of your £100,000 profits to reduction in price, what would be the effect?—Witness: One penny in the £ is equal to £12,000, so that it would make a difference of about 8d.

The Committee again adjourned till to-day (Friday).

HULL TRAMWAYS.

On June 28 the bill for the confirmation of the provisional order obtained by Hull Corporation with regard to owning and working tramways came before the Select Committee of the House of Lords, of which the Duke of Northumberland is chairman.

Mr. BALFOUR BROWNE, Q.C., said this was an order authorising the Hull Corporation to construct additional tramways in the city. The Corporation having purchased the Drypool and Marfleet steam tramway, which was a single line, applied for a provisional order giving them power to reconstruct the line as a double line throughout and working it electrically on the overhead trolley system. The line ran along the north side of Alexandra Dock, so that the line was a very important one. There were trams in all the main thoroughfares of Hull, and they crossed in about a dozen places the lines of the North-Eastern Railway on the level. All that was now proposed at the level crossing in Heddon-street was to double the line and to work it by electricity. A single line ran over the railway line there already, yet the North-Eastern Railway Co., because they had an easement to run their trains across the road on the level, instead of by some other means, objected. The Drypool and Marfleet Company was a very small and insignificant concern compared with the North-Eastern Railway Co., and so, when getting power to cross the railway—conceded as the price of the withdrawal of the railway company's opposition—very strong clauses indeed for the protection of the company were inserted. These clauses included such things as that the goods traffic from the railway company's dock should have precedence of traffic on the tramway company's own road—a monstrous provision; that the railway company were not to be obstructed; and that the railway company should have power to make their own byelaws for their own protection on the

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tramways. These provisions were to be taken over by the Corporation, and while counsel did not dispute them he did say that they should get no further protection. The railway company, as an answer to the present application, in their petition referred to sec. 25 of the Act of 1893 under which, if Hull found it essential there should be a bridge at this level crossing in order to carry the road over the railway, then the railway company should contribute two-thirds and the Corporation one-third of the cost. They said that clause should be enforced. The reason the Corporation did not use that power was that they held there was no danger whatever at the crossing. There were no passengers carried over the line, which only ran to the docks ; and if there were danger then the railway company themselves were bound at their own expense, by the Act of 1852, to build the bridge. A bridge in that position would be very inconvenient, because all the traffic on the road was very heavy, and the gradient which the bridge would cause would necessitate the putting on an extra power and cause serious blocking of the traffic. The electric tram could easily run up such a gradient as would be involved—1 in 40 ; but the Corporation objected because of the general inconvenience to the public. It would be said that the Hull Corporation drivers had in one or two cases touched the gates at the level crossings with their cars. This was admitted, but in every case where there was a gate the Corporation had now marked in the street the distance from the gate at which the car was to be stopped. That was found to be perfectly efficacious, no damage having resulted except in one slight case.

Mr. LAVERACK, town clerk of Hull, said when this line had been purchased all the trams in Hull would be in the hands of the Corporation and be worked electrically. The Corporation opposed the abolition of the level crossing because it would add largely to the cost of haulage, and alter that which governed the amount of load which could be carried generally through Hull. It would be an advantage to the road traffic to get rid of the level crossing ; no one could deny that level crossings *per se* were most objectionable. Catch points had been introduced, the effect of which was that if a tram overran the point where it ought to stop it would run off the line. The Corporation thought that was reasonable, the Board of Trade having assented to it. They could just as well bring up the tramcar before a catch point as before a railway. There had been two or three cases in which cars had overrun the catch points and run off the line owing to the carelessness of the drivers. Electric cars were under such great control that drivers over-estimated what it was possible to do with them.

Mr. W. H. WELLSTED, C.E., said he was engineer to the Drypool and Marfleet line. As to the crossing in dispute, traffic had been regularly carried on since its erection without interference or hindrance to the railway company's traffic. The gates at the crossing were closed entirely during shunting operations. The weight of a steam engine and car was greater than that of the electric cars the Corporation were running, and the brake power of a steam train was not nearly as efficient as that of a steam car.

Mr. STEPHEN SELLON said he had been professionally associated with a large number of tramway companies which worked over level crossings, and he knew of no accident due to working over a level crossing. It was common for tramways to cross tramways at right angles, but not very common for trams to cross trainlines belonging to other companies.

Is there any danger to the public by the use of electric traction over this crossing ?—None at all, under proper control.

Is there any danger to the public by substituting a double line for a single line ?—No, it is much more satisfactory in all systems of electric traction, and much safer where a frequent service is intended. An electric car had far more braking capacity than any other modern tramway car.

So far as electric trams cross railways—which was the best ground of complaint, if any ground of complaint there be ?—I have never yet been able to understand what the railways really complain about. The railway company has the whole control of the level crossing while the gates are across the road and, as far as my experience goes, the tramway companies rather want a clause for their own protection to prevent them being unnecessarily stopped at crossings where railway companies use those crossings illegally for the purposes of shunting. He had had many cases in which level crossings were sanctioned by Parliament. He had never seen such a clause as that which existed for the protection of the North Eastern Company—he called it monstrous. If there was any danger at all at level crossings it would be greater where there were only two or three trains passing daily than where there were many, because in the former case the men might be liable to forget the trains.

Mr. GOODYEAR, traffic manager to a very large number of tramway undertakings, worked by electric power, by steam, and by horses, said there were level crossings on those lines, some over railways, and they were worked satisfactorily and without accident.

Mr. A. E. WHITE, city engineer of Hull, and engineer to the present scheme, said at present the tramway line crossed the railway ; if a double line were carried across it would lessen the stoppage of cars at the crossing and thus facilitate road traffic, and prevent the danger of blocks on the railway. Electric cars were under much better control than steam cars. A road bridge would be most disastrous to the road traffic. There were three or four bridges in Hull at present, but they were dodged, and practically no heavy traffic passed over them. There would be almost as much objection to a tunnel as to a bridge. If the bridge had an incline of 1 in 40, about three times as much power would be required to mount it as would be required on the level, and great difficulty, if not danger, would be experienced in taking the vehicles down the incline, as, owing to the general flatness of Hull, vehicles were not generally fitted with brakes. For the past 12 years there had been no accident at this crossing. The lines at the crossing-place were largely used for shunting, which was an improper use of the public roads. There had been a number of small accidents at the level crossings in Hull, but they were due to carelessness and to the newness of the electrical scheme. As, however, the Corporation had gone on working they had made the regulations as stringent as was found desirable. Catch-points, if the railway company thought them desirable, would afford the railway company ample protection.

This closed the case for the promoters.

Mr. MOON, for the North Eastern Railway Co., said this question of the extra cost of cartage, owing to a bridge being provided, if there was anything in it, would affect the North Eastern Company more than anyone else, as they were the largest carters in Hull, so that the company could not be said to have any interest opposed to the interest of the witnesses who objected to the construction of a bridge. The level crossings at Hull had been the subject of constant complaint by the Corporation. The railway company were willing to provide two-thirds of the expense of constructing a bridge, which would obviate all the difficulties and delays and dangers (if dangers existed) at the crossings, and enable the Corporation to have a through run for their trams instead of being practically at the mercy of the railway traffic. Was the Committee satisfied there was no danger in allowing electrically-propelled cars to cross a railway on the level ? It might be safe, with proper precautions inserted by the Board of Trade, where there were few trains ; but in a case where there were 260 engines, with or without trucks behind them, passing daily, surely it was entirely different. There had been no accidents at Hull or at Stockton while the cars were run by steam ; but, whatever the cause, as soon as electric traction was introduced there were accidents. He asked the Committee to say the crossing should be got rid of, and that as the price of obtaining the power they sought the Hull Corporation should be obliged to contribute one-third of the cost of the necessary bridge.

Mr. GEORGE GIBB, general manager of the North Eastern Railway Co., explained that the clause in the Drypool and Marfleet Order for the protection of the North Eastern, which had been referred to as monstrous, was not suggested by the North Eastern Company, but was put in by the Board of Trade, following the precedent of the Wigan Order, at that time the most recent. In the former bill (which did not become law) a clause was agreed to by the Corporation for the erection of a bridge at this place with a gradient of 1 in 40, as was now proposed. Such a gradient was found in practice not to limit a load or prevent the regulation load of 2½ tons being drawn by one horse. The crossing in question was even more dangerous than it would be if passenger trains used it. Lines for passenger traffic were worked on the block system, so that the working was more regular, and the gates were closed when the train was still several hundred miles from danger. At the Hedon-road crossing the engines and trucks were being continually shunted backwards and forwards ; and often it was not the engine driver or his engine which crossed the points at the crossing but the trucks behind the engine, and so there was greater danger. Moreover, the gates here were so often closed that it would be impossible for the tramway to carry out their scheme of a three-minute service. The directors of the North Eastern Company had been seriously alarmed by the electric tramways. They had not objected to electricity being introduced in the Stockton case, but it was very curious that, whatever the reason, after electric traction was introduced accident after accident occurred there ; and the same result followed the introduction of electricity in connection with the trams at Hull. He proceeded to read a list of the cases in which accidents had occurred at both places. So serious and numerous were these that the directors of the railway company were afraid of the prospect. No railway would be permitted to cross another line of railway at the present time, and in cases where such an arrangement was continued the traffic was worked on the block system. Whatever the control a tramcar driver had over his machine, that control, as shown by the accidents, was often not sufficiently exercised ; and unless some system in regard to electric trams similar to the block system was established, he did not see how these accidents could be avoided.

From the experience you have had of the conduct of these cars in crossing your railway, are you strongly of opinion, as the responsible manager of the railway, that it is a very dangerous thing to allow it to be done ?—Yes. We have been seriously alarmed by these accidents. The railway company were willing to pay two-thirds of the cost of the bridge, so anxious were they in regard to this point. Two level crossings in Hull had been abolished on the same terms.

Further evidence was given by Mr. H. Copperthwaite, engineer of the southern district of the North Eastern Railway, and by Sir John Wolfe Barry, consulting engineer to the North Eastern Company.

The CHAIRMAN said : The Committee do not see their way to granting electricity or a double line at this particular crossing and do not see their way to pass so much of the bill. In their opinion some definite proposal should be made of a give-and-take kind as to raising the railway and lowering the road before Parliament should be called upon to give the powers asked for.

Mr. LLOYD, for the Corporation : I understand the Committee will neither sanction electricity nor a double line. Would a single line meet your objection ?—No.

On Monday, Mr. PEMBER said he hoped an agreement had been or would be come to between the parties which would enable the tramway to pass the railway, the suggestion being that the road should be lowered and the railway line raised, so as to allow a workable gradient. This agreement must be sanctioned by the Corporation, which did not meet till Thursday. If the agreement was sanctioned by the Corporation, he suggested that he (the Chairman of the Committee) personally should pass the requisite clause, it being understood that if the Corporation did not accept the agreement the whole order would be withdrawn.

The draft of the clause to be submitted to the Corporation was handed to the Chairman to be submitted to the Committee. This clause provided that tramway No. 2 (the one passing along Hedon-road) should not be laid, nor should electric power be employed on that part of Hedon-road where it crossed the railway unless and until the railway had been carried over the road by means of a bridge, such bridge and works in

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connection therewith to be constructed, unless otherwise agreed, in accordance with certain heads of arrangement. The level crossing at Hedon-road was to be abolished by raising the Victoria Dock branch railway at this point not less than 7ft., and carrying the same over the road by a bridge, and by lowering the roadway of Hedon-road so as to obtain a clear headway under the bridge of 16ft. 3in., the gradients for the road to be not steeper than 1 in 40, the footpaths to remain unaltered as far as reasonably practicable, and to be connected with the lowered roadway by steps, the entire width of the new road to be not less than 58ft. The railway company were to seek in the next Session of Parliament and use their best endeavours to obtain powers necessary for carrying out the said works, the Corporation to assist the company in such application to Parliament.

The Committee accepted the provisions.

The CHAIRMAN: It must be understood that the Corporation take the clause or leave it. I will not be responsible for any alteration.

Further proceedings were adjourned till to-day (Friday).

AIRDRIE AND COATBRIDGE TRAMWAYS BILL.

The Select Committee of the House of Lords, presided over by Lord Ribblesdale, on June 26, considered this bill.

Mr. FREEMAN, Q.C., for the promoters, said the Caledonian and North British Railway Companies had withdrawn their opposition, and the only opponents left were the Airdrie and Coatbridge Water Co. The original scheme included Coatbridge, but as the local authority had refused its consent that portion of the bill had been withdrawn, and the bill referred to Airdrie alone. The water company, he urged, were amply protected under the Tramways Act, 1870.

The CHAIRMAN said the Committee were of opinion that the water company had no *locus standi*, and the engineer of the scheme, Mr. I. E. Winslow, having proved the details, the Committee found the preamble proved. The bill was afterwards ordered to be reported.

LONDON TELEPHONE SERVICE.

In the House of Commons on Friday last Mr. HANBURY stated, in reply to a question, that the construction of the underground system of wires for the Post Office telephone service for the metropolis was proceeding as rapidly as possible. The subscription rates would be published as soon as the Postmaster-General was able to announce a definite date for the opening of the main exchange.

(Parliamentary Intelligence continued on page 411.)

ELECTRICITY WORKS ACCOUNTS.

Belfast Municipal Electric Supply Works.

Our summary of the accounts of the Belfast undertaking for 1899 clearly shows the difference wrought by the conversion from gas to steam working. The effect is less apparent from the accounts because during 1898 the supply was generated partly by gas and partly by steam—the steam station having been started in July of that year. An interesting comparison is therefore afforded by the annexed table.

It will be seen that although, as between 1897 and 1899, both the output and the load-factor have increased, yet the difference was quite inadequate to cause the alteration which has taken place in the costs—especially in the fuel item.

The results obtained last year are, without exception, excellent, not only as regards the expenditure figures but also in the marked advance in the business done. At 622,486 units sold the output was nearly 75 per cent. above that of 1898 while the equivalent lamp connections show a rise of nearly 34 per cent.

The following table furnishes some interesting figures relative to this undertaking:—

Year.	Units generated.	Units sold.	Maximum supply demanded. Kw.	No. of lamps connected. (Equiv. 8 c.p.)	Rev. per unit for current.	Works costs per unit sold.	Total costs per unit.	Plant capacity. Kw.
1895	95,126	82,771	159	10,500	6·32d.	3·47d.	5·43d.	283
1896	166,219	149,721	240	14,750	6·30d.	2·93d.	4·01d.	500
1897	235,972	201,832	360	21,000	6·04d.	2·63d.	3·54d.	500
1898	414,007	356,526	721	38,500	5·41d.	2·18d.	2·92d.	900
1899	742,590	622,486	956	51,500	4·36d.	1·52d.	2·22d.	2,080

The Hove Electric Lighting Co. (Ltd.).

We are glad to find from the Hove accounts for 1899 that the already flourishing state of the undertaking is being so well maintained. As a glance at our table on next page will show, a general reduction in the costs has been effected. The items of rents, rates and taxes, and fuel are exceptions, having risen slightly; but in view of the upward tendency of coal prices during the last two or three years, it is most satisfactory to find the fuel item exhibiting such a moderate figure as it does.

As largely contributing to the improvement in the costs attention is directed to the good advance made in the output, which rose from 350,354 units sold in 1898 to 444,499 units last year. The character of the load was also more favourable, as is shown by the load factor having risen from 9·85 per cent. in 1898 to 10·9 per cent. The lamp connections indicate an advance of over 31 per cent.

In view of this expansion of business, it is not surprising to find from the report of the directors that, although two additional steam dynamos of 350 H.P. and 250 H.P. respectively and a Babcock and Wilcox boiler have been installed, while another 250 H.P. steam dynamo is on order for delivery in the autumn, yet it has become necessary to seek for a site for a second generating station, as the present one has been enlarged to the fullest extent which the Corporation of Hove will permit.

The following figures furnish an idea of the progress which this concern has made since 1896:—

Year.	No. of consumers.	No. of lamps.	No. of units sold.	Max. supply demanded. Kw.	Total costs per unit.	Total revenue per unit.
1896	314	21,756	230,562	253	3·85d.	7·93d.
1897	397	27,777	268,243	310	2·93d.	6·51d.
1898	513	36,967	350,254	406	2·88d.	6·50d.
1899	671	41,824	444,499	465	2·60d.	6·52d.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 22, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	July 14, 1899	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, 1900	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 18, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, 1900	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 18, 1900
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Wokiog (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Woolwich (Company)	Jan. 18, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	June 9, 1899		

Year ended Dec. 31.	Costs per unit sold. Fuel.	Oil waste, &c.	Wages at station.	Repairs and maintenance at station.	Generating costs.	Works costs.	Total costs.	Load factor.	Units sold.	Per cent. of total output. Gas generated.
1897	1·30d.	0·15d.	0·78d.	0·19d.	2·42d.	2·63d.	3·54d.	6·4%	201,832	100%
1898	1·07d.	0·14d.	0·66d.	0·14d.	2·01d.	2·18d.	2·92d.	5·65%	356,525	54·7%
1899	0·68d.	0·09d.	0·44d.	0·14d.	1·35d.	1·52d.	2·22d.	7·44%	622,486	3·54%

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	BELFAST.		HOVE.	
Undertaking Worked by	Belfast Corporation.		The Hove Electric Lighting Co. (Limited).	
Date of Commencement of Supply	Jan. 1895. (Steam station started July, 1898.)		November, 1892.	
System of Supply	3-wire continuous-current.		3-wire continuous-current, with batteries.	
Chief Engineer	Victor A. H. McCowen.		C. B. Smith.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	414,007	742,590	415,332	520,967
„ **SOLD (TOTAL)**	356,526	622,486	350,354	444,499
„ sold to consumers	356,526[a]	616,294[j]	341,462	440,476
„ sold for public lighting, &c.	nil	6,192	8,892	4,023
„ used on works	15,900	33,076	9,040	21,486
UNITS SOLD PER 8 C.P. LAMP CAPACITY	12·7	9·58	16·75	13·6
Maximum supply demanded	721 kilowatts	955·7 kilowatts	406 kilowatts	455 kilowatts
Number of public lamps	—	60 glow	2 arc 9 glow	No arc, 20 8 c.p. glow
Number of consumers	350	505	513	671
Connections to mains in 8-c.p. lamps	38,500	51,500	36,967	44,892
CAPACITY OF PLANT IN 8-C.P. LAMPS	28,100	65,000	20 900	32,640
CAPACITY OF PLANT IN KILOWATTS	900	2,080	669	1,045
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowat capacity.
AUTHORISED (TOTAL)	£115,000 / £128	£190,000 / £91·3	£100,000 / £149·5	£150,000 / £144
Share	— / —	— / —	50,000 / 74·8	100,000 / 95·7
Loan (including Debenture charges)	115,000 / 128	190,000 / 91·3	50,000 / 74·8	50,000 / 47·9
RECEIVED (TOTAL)	65,907[b] / 73·2	117,039[k] / 56·2	69,910 / 104·5	84,362[g] / 80·7
Share	— / —	— / —	43,910 / 65·7	51,174 / 49·0
Loan (including Debenture charges)	65,370 / 72·6	116,360 / 56·0	26,000 / 38·9	25,000 / 23·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	49,630 / 55·1	73,640 / 35·4	30,090 / 45·0	73,826 / 70·7
Share (unissued)	— / —	— / —	5,000 / 7·48	45,000 / 43·1
Share (uncalled)	— / —	— / —	1,090 / 1·63	— / —
Loan (including Debentures)	49,630 / 55·1	73,640 / 35·4	24,000 / 35·9	25,000 / 23·9
REPAID (TOTAL)	— / —	250 / 0·12	— / —	— / —
RESERVE OR SINKING FUND	433 / 0·481	614 / 0·295	5,288 / 7·91	12,288 / 11·8
DEPRECIATION FUND	1,148 / 1·28	1,148 / 0·552	1,106 / 1·65	1,261 / 1·21
EXPENDED (TOTAL)	96,277 / 107	138,394 / 66·6	77,451 / 116	93,661 / 89·6
Lands and buildings	28,463 / 31·6	34,590 / 16·6	6,594 / 9·86	9,353 / 8·95
Plant	30,865[c] / 34·3	46,522 / 22·4	31,384 / 46·9	40,317 / 38·6
Mains	34,657 / 38·5	54,559 / 26·2	37,955 / 56·8	42,641 / 40·8
Miscellaneous	2,293 / 2·55	2,723 / 1·31	1,517 / 2·27	1,350 / 1·29
BALANCE OF CAPITAL ACCOUNT	−30,369[d] / −33·8	−21,355[d] / −10·3	−7,541[a] / −11·3	−9,299[a] / −8·90
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£8,225 / 5·540d.	£11,679 / 4·505d.	£9,481 / 6·498d.	£12,070 / 6·525d.
Revenue from supply	8,039 / 5·410d.	11,308 / 4·364d.	8,770 / 6·012d.	11,246 / 6·080d.
„ meters, &c.	171 / 0·115d.	316 / 0·122d.	530 / 0·363d.	684 / 0·369d.
„ public lighting	— / —	— / —	178 / 0·122d.	83 / 0·047d.
„ sale of lamps, &c.	15 / 0·010d.	56 / 0·022d.	— / —	— / —
„ miscellaneous sources	— / —	— / —	3 / 0·002d.	52 / 0·028d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,343 / 2·924d.	£5,744 / 2·215d.	£4,200 / 2·877d.	£4,816 / 2·600d.
WORKS COSTS	3,243 / 2·183d.	3,936 / 1·518d.	2,704 / 1·853d.	3,124 / 1·687d.
Generation of electricity	*2,993 / 2·014d.*	*3,490 / 1·346d.*	—[b] / —	—[b] / —
Fuel (including cartage, &c.)	1,583[e] / 1·066d.	1,755[l] / 0·677d.	1,239 / 0·883d.	1,641 / 0·886d.
Oil, waste, water, stores	213 / 0·143d.	247 / 0·095d.	179 / 0·123d.	103 / 0·056d.
Wages at station	983 / 0·662d.	1,135 / 0·438d.	827[b] / 0·567d.	936[b] / 0·505d.
Repairs and maintenance at station	214 / 0·144d.	353 / 0·136d.	409[b] / 0·280d.	444[b] / 0·240d.
Distribution of electricity	*250 / 0·168d.*	*428 / 0·165d.*	—[b] / —	—[b] / —
Wages, &c.	173 / 0·117d.	330 / 0·127d.	—[b] / —	—[b] / —
Repairs, renewals of mains, &c.	77 / 0·052d.	98 / 0·038d.	—[b] / —	—[b] / —
Public lighting	— / —	*18 / 0·007d.*	— / —	— / —
Attendance	— / —	12 / 0·005d.	— / —	— / —
Renewals	— / —	6 / 0·002d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,100 / 0·740d.	1,809 / 0·698d.	1,493 / 1·025d.	1,692 / 0·914d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*305 / 0·205d.*	*724 / 0·279d.*	*231 / 0·158d.*	*302 / 0·163d.*
Management	*795 / 0·535d.*	*1,085 / 0·419d.*	*1,265 / 0·867d.*	*1,390 / 0·750d.*
Salaries	383 / 0·259d.	504 / 0·194d.	872[h] / 0·598d.	942[h] / 0·509d.
Stationery, &c.	113 / 0·076d.	201 / 0·078d.	53 / 0·036d.	67 / 0·036d.
Establishment charges	156 / 0·105d.	235 / 0·091d.	180 / 0·123d.	220 / 0·119d.
Law charges, &c.	143[f] / 0·096d.	145[m] / 0·056d.	160[c] / 0·110d.	161[i] / 0·087d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,882 / 5·24%	£5,936 / 5·06%	£5,281 / 7·32%	£7,253 / 8·47%
Sum carried to Depreciation Fund	1,148[g] / 1·55%	— / —	191[d] / 0·365%	156[d] / 0·182%
Sum carried to Reserve or Sinking Fund	663 / 0·894%	976 / 0·832%	1,000 / 1·385%	2,000 / 2·34%
Net interest on loans (incl. Debenture charges)	2,302 / 3·105%	2,837 / 2·42%	1,005 / 1·392%	1,018 / 1·19%
BALANCE FROM LAST ACCOUNT	1,280 / 1·726%	533 / 0·454%	215 / 0·298%	376 / 0·439%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	533[h] / 0·719%	2,655 / 2·26%	3,052[e] / 4·23%	3,036[j] / 3·62%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	6½% / —	7½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	52·8%	49·2%	44·3%	39·9%
Expenditure per kilowatt capacity	£4. 16s. 6d.	£2. 15s. 2d.	£5. 5s. 7d.	£4. 12s. 2d.
REVENUE PER KILOWATT CAPACITY	£9. 2s. 9d.	£5 12s. 4d.	£14. 3s. 5d.	£11. 11s. 0d.
Expenditure per 8-c. lamp capacity	3s. 1d.	1s. 9½d.	4s. 0½d.	2s. 11½d.
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 10½d.	3s. 7d.	9s. 0½d.	7s. 4½d.
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 3½d.	4s. 6½d.	5s. 1½d.	5s. 4½d.
Price charged for lighting, per unit	7d. to 2d.[i]	7d. to 2d.	8d. to 4d.[f]	8d to 4d.[f]
Price charged for power, per unit	4d. to 1¾d.[i]	4d. to 1½d.	4d.	3d.
Price charged for public lighting	—	£2. 7s. 6d. per lamp	6d.	—

BELFAST.—REMARKS—*a* Being 256,998 units at 7d., 3,986 units at 5d., and 50,531 units at 2d. for lighting; 26,045 units at 4d., 14,069 units at 2¾d., and 4,760 units at 1¾d. for motors; also 137 units at 6d. for charging batteries. *b* Includes £225 for copper scrap and £513 from miscellaneous sources. *c* Inclusive of £52 on street arc lamps. *d* Over-expended. *e* Gas and coal. The gas to generate 195,000 units cost £992 or 1·22d. per unit and the coal to generate 161,526 units cost £592 or 0·879d. per unit. *f* Includes insurance £121. *g* Being amount contributed to renewals suspense account. *h* After deducting hire of gas engines returned £515. *i* On Wright system with 1½-hour scales. *j* Includes 278,515 units at 7d., 8,087 units at 5d., and 255,631 units at 2d. for lighting purposes; also 25,500 units at 4d., 20,289 units at 2¾d., and 28,152 units at 1¾d. per unit for motors; also 120 units at 6d. for charging batteries. *k* Includes £244 from sale of copper scrap and for work done. *l* Gas and coal. The gas to generate 22,000 units cost £277 or 3·02d. per unit and the coal to generate 600,486 units cost £1,478 or 0·557d. per unit. *m* Includes insurance £104. *n* On Wright system with one-hour scale.

HOVE.—REMARKS—*a* Over-expended. *b* Distribution wages and repairs and maintenance are included in the corresponding generating items. *c* Includes £11 to auditing and £149 to insurance. *d* Set aside under contract with the Hove Commissioners. *e* After deducting £248 written off preliminary expenses. *f* By the Wright system (one-hour scale). *g* Inclusive of premiums received £8,188. *h* Includes £450 directors' remuneration. *i* Includes £150 for insurance and £11 to auditing. *j* After deducting £262 written off preliminary expenses and £97 income tax.

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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THE ELECTRIC POWER BILLS.

IN our last issue we announced that the Select Committee of the House of Commons, presided over by Sir JAMES KITSON, had decided to pass the preambles of three of the four large electric power schemes, rejecting only the preamble of the Tyneside scheme. When making this announcement Sir JAMES KITSON further stated that so far as practicable uniform conditions would be inserted in the various bills. We have now to direct the attention of our readers to an additional statement on this matter, made by Sir JAMES KITSON on Tuesday last. The statement, so far as its direct bearing is concerned, was made in respect of the South Wales Electrical Power Distributing Co.'s scheme; but, having regard to the intended uniform treatment of all the schemes, its bearing will probably be found to be of a much wider and more general character. The statement is substantially as follows:—

I have to make a statement which is an expansion of the previous declaration of the Committee on the South Wales Electrical Power Distribution Bill. It is as follows: (1) The company to be authorised to supply electrical energy for power purposes anywhere within the area of supply, subject to the consent of the local authority in certain cases, as set out below. (2) The company to have no general lighting powers—*i.e.*, distribution to ordinary consumers within the area—except in pursuance of a provisional order obtained in the ordinary way. (3) Where a local authority is now authorised to supply electricity within the area, their consent is to be required for the supply of electricity by the company. The Board of Trade to be empowered to override the refusal of the local authority to give consent, if the authority are not prepared to provide the requisite supply on reasonable terms and within a reasonable time. (4) Any local authority which hereafter gets statutory powers for supplying electricity within the area to have, in ordinary cases, the option of taking over the company's supply in its local area on terms to be laid down by the provisional order or act by which the statutory powers are given. (5) A company having statutory powers, to be in the same position as a local authority now having statutory powers; a company to whom powers are hereafter granted, to be placed in the same position as a local authority to whom statutory powers are hereafter granted.

Provisionally we may assume that this statement expresses the conditions for all future power supply schemes, powers for which are not directly obtained under the Electric Lighting Acts (1882-8), *i.e.*, all schemes supplying power wholesale over an extensive area. Let us see what these conditions imply. Condition No. 1, taken by itself, seems at first glance satisfactory. The power company is to be allowed to supply electricity for power purposes, subject to certain consent

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from the local authority. Condition No. 2, however, narrows down the apparent privilege. Power *quâ* power may be supplied to a factory or other consumer; but the electric power so supplied is not to be used for electric lighting, unless the company has previously obtained a lighting order for this particular part of its area. A manufacturer taking motive power from the company may therefore be compelled to go to the local authority for lighting current, to be taken from an altogether different power station from the company's power station. But if a manufacturer may erect an electric motor and shafting to run his works, what is to prevent him from running a small dynamo from that same shafting and so lighting his own premises? The Board of Trade would be powerless to prevent this practice.

Coming to condition No. 8, we see that the Board of Trade is to be granted the power to overrule the obstruction of any local authority to the introduction of electric power by the company. This is a very wise and, indeed, a most necessary decision. The next condition (4) specifies that terms are to be introduced into the sectional orders—*i.e.*, the provisional orders for any section of the entire area—upon which terms the local authority may at any future time take over that part of the company's business which relates to electric supply within the area controlled by the local authority. The justice of this provision will depend on the precise nature of the terms introduced into each particular order; but the provision is almost certain to lead to friction between the company and the local authority in drawing up the terms referred to. It is conceivable, moreover, that where opportunity arises a local authority might succeed in introducing terms that would seriously hamper the ordinary business of the company. It would appear also that existing local companies holding lighting orders are to be put on the same footing in this respect as local authorities in the same position, and that a company which in future may obtain a lighting order is to be treated in the same way as a local authority thus obtaining an order. We presume this means that a local company is, like a local authority, to have power to take over the local business of the general power company on certain terms to be embodied in the provisional order. The effect of these complicated transferences of local sections of a business grown large and extensive cannot well be imagined.

THE NEW CABLE-REPAIRING STEAMER "JOHN PENDER."

The Eastern Telegraph Co.'s new cable-repairing steamer "John Pender" is now completed, and fully equipped and ready to proceed to sea. She will, in fact, start for a foreign station on Saturday. The launch of this steamer took place at Glasgow, on March 13 last, when the vessel was christened the "John Pender," the ship of that name formerly in the company's fleet having been disposed of. A description of the new steamer appeared in our issue for March 23 last, but since that date the equipment of the vessel has been completed, and some further particulars regarding her will interest our readers.

The "John Pender" is not only the newest but also the largest and most perfectly equipped of modern cable-repairing steamers. Her length all over is 333ft. 9in., and the length on the load line 300ft. The beam outside the plank is 41·2ft., the depth of the hold from the tonnage deck to the ceiling amidships is 25ft. 6in. The gross tonnage is no less than 2,836 tons, the registered net tonnage being 1,104 tons. She is splendidly engined with 3,500 I.H.P., capable of developing a speed of 14 knots at the ordinary working draught—an accomplishment which she readily made on the measured mile. The vessel, was built and engined by Messrs. Robert Napier & Sons, of Govan, Glasgow. It should be stated, however, that the owners are responsible for the design of the vessel, engines, &c., and of her complete equipment, the whole being the result of many years of thought, discussion and experience on the part of the company and its chief officials. The ruling principles in her design and construction have been (1) to do all the work of the Eastern and allied companies in all parts of the world either in deep or shallow water, which at present no one cable-repairing steamer can do, although many of them are of much smaller size than the "John Pender." (2) To embody all the collected and collateral experience of the company, extending over many years, in regard to their fleet of ships, with the addition of all known and tried improvements, bringing vessel and engines up to date, with the object that the cost of maintenance shall be kept at the lowest possible point. Nothing that would further this end has been spared in the capital outlay on the vessel. Coal endurance is a point which has been carefully regarded, the vessel having 15 days coal capacity at full speed, with cables and stores for ordinary repairing work. She is provided with five cable tanks, one being auxiliary, and is, therefore, capable of carrying a very large amount of cable—about 1,000 tons when on ordinary cable-laying and repairing work, and about 2,000 tons when engaged on special service. When using only two of her boilers she is capable of a 10 knot to 10½ knot sea speed. Many important points have been held in view in regard to (1) the main design of the vessel, (2) the equipment of her engines and auxiliary engines, (3) the cable laying, repairing, and testing departments, and, lastly, in regard to the hygienic and general sanitary conditions of health and comfort. In all these respects the arrangements on board could not be surpassed. The hospital and medical arrangements are specially complete, the hospital containing isolation cots of the best Admiralty pattern, besides other equipments necessary for the treatment of disease or surgical cases in tropical climates. The watertight compartments of the bunkers are arranged to be closed promptly by an ingenious mechanism.

The main engines were built by the builders of the ship, Messrs. Robert Napier & Sons. They consist of two triple-expansion marine engines, each driving a separate propeller. These propellers are of the Navy bronze type, supplied by Messrs. Stone, of Deptford, who also supplied the watertight doors and some portion of the sanitary fittings. The engine and boiler equipment includes two 12-ton evaporators by Messrs. Caird & Raynor, a feed-water heater by Messrs. Kirkcaldy & Co., centrifugal pumps by Messrs. Drysdale & Co., of Glasgow, main feed pumps by Messrs. G. & J. Weir, of Glasgow, each pump having the full capacity of the boilers, besides some auxiliary pumps by Mr. A. G. Mumford, of Colchester. The boilers are supplied with air by Howden's forced draught worked by a 90in. fan, and two compound high-pressure auxiliary engines. The electric lighting of the ship is as perfect as modern practice can make it, and has been carried out by Messrs. Clarke, Chapman & Co., of Gateshead-on-Tyne. This firm have also supplied the lifeboats, the sides of which are formed from one sheet of metal, experience having proved this to be the best type of boat. It will be remembered that the only boat saved from the ill-fated "Mohegan," wrecked on the Manacles, was a lifeboat of this pattern. The electric lighting sets consist of two continuous-currrent dynamos, each with its separate direct-connected vertical steam engine. Each set has a capacity of 250 lights. The powerful searchlight is also supplied by the same firm. This plant, together with the necessary main switchboard, &c., is placed in a separate machinery room between decks, thus isolating the dynamos from the heated main steam engine room. The refrigerating plant, which embodies all the latest improvements, has been supplied by Messrs. J. & E. Hall, of Dartford.

It is unnecessary to state that the steamer is perfectly equipped with cable-handling and testing apparatus. The engines for the cable gear were built by Messrs. Robey & Co., of Lincoln. The instruments and general equipment in the

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testing room are of the latest pattern Kelvin testing instruments by Messrs. James White, of Glasgow, this firm having also supplied the nautical instruments.

At the present moment the "John Pender" is berthed alongside the old cable steamer "Chiltern," in the South West India Dock. The spectacle is thus afforded of the oldest and the newest cable-repairing boats in the world lying side by side. The "John Pender," however, will not long remain in this berth, although it is only 10 days since she was brought round from the Clyde out of the hands of her builders, for, as already stated, she is commissioned to proceed to a foreign station next Saturday on work for the Eastern Extension Telegraph Co.

POWER SUPPLY BY SINGLE-PHASE MOTORS.*

BY T. P. WILMSHURST.
(Borough Electrical Engineer, Derby.)

The principal objections which are usually urged to the distribution of electricity by alternating currents are: (1) That alternating-current is less economical than direct-current working. (2) That alternating arc lamps are inferior to direct-current lamps. (3) That single-phase motor working is impracticable. While the writer is prepared to admit that in some instances objections (1) and (2) are valid, and (3) also in a modified degree, he holds the conviction that they originate rather from unsuitable arrangements or want of appreciation of the varied requirements of electrical supply on the part of the designers, than from any inherent unsuitability of alternating currents. He is led to this conclusion from a study of the cost's analysis of various towns, from which it appears that the following results have been achieved in A.C. stations: Full costs of 0·25d., 0·3d., and 0·32d., and works costs of 0·78d., 1·02d., and 1·16d., all on outputs of less than a million units per annum. As regards objection (2) the writer would only remark that those members of the Association who visited Cheltenham during the last Convention would hardly deny that the A.C. arc lighting there left little to be desired. Coming to objection (3) the object of the Paper is to show what is the present position of the S.P. motor in the struggle for existence.

In nearly every town, certainly in all manufacturing towns, there will in the future be an enormous demand for motors when the cost of supply is sufficiently low and the public appreciate the advantages of electric driving. Since the S.P. system has been adopted in nearly 100 towns in this country, the question arises, how is this demand to be met? (1) Shall we change over our whole system to D.C. as is proposed in one or two cases? (2) Shall we lay down D.C. plant and mains for the motor supply, leaving the A.C. plant to supply current for lighting? (3) Shall we supply S.P. motors from our ordinary A.C. plant and mains? (4) Shall we lay a special A.C. motor network supplied from the A.C. plant. (5) Shall we lay down multiphase plant for power supply? The writer has come to the conclusion that while cases do exist in which by reason of abnormal frequency, excessive armature drop in the generators, or other causes, the good working of A.C. motors is rendered difficult, in the majority of cases, under reasonably favourable conditions, the inferiority of the S.P. motor to the D.C. or three-phase motor is not sufficiently marked to justify the laying down of special plant. It is obvious that method (3) has the great merit of simplicity and low cost. It is a matter of common knowledge that at the present time, while the proportion of motor to lighting load on D.C. circuits is small, it is still less on A.C. circuits, and it is a matter of interest to study the causes of this. The two principal reasons appear to be the difficulty of successfully competing in cost with gas and steam engines, and the fear that the use of motors will injuriously affect the steadiness of the light. It is a self-evident truth that the more the day load can be increased the lower can the charges be made. An examination of the power charges in various towns reveals the curious fact that these charges vary from 8d. per unit down to 1d., and inasmuch as the cost of production can hardly vary within such wide limits, it would appear that the size of these charges is a measure of the appreciation by the engineer of the value of a motor load. In the case of a gas engine a brake horse-power can be obtained for about 1d. per hour; in the case of electric motors, therefore, it is necessary to bring the cost down to 1d. to 1½d. per unit before we can hope to enter into successful competition. The second point is of vital importance, and merits careful consideration.

The principal causes which are likely to disturb the supply voltage are: (*a*) Bad regulation in engines, alternators and transformers; (*b*) the use of small generating sets and transformers; (*c*) defective working of the motors themselves; (*d*) the adoption of a high frequency. The first is a prolific source of trouble. An armature drop of 20 per cent. to 30 per cent., even on non-inductive loads, is by no means uncommonly found in this country. Why these abnormal drops of pressure have been tolerated it is difficult to say. It is obvious that the starting of a large motor on mains supplied by such a machine must cause an instantaneous drop of pressure which no amount of switchboard manipulation can prevent. When one considers that in a D.C. station an armature drop of 6 per cent. is rarely exceeded, is it any wonder that A.C. motor working on such circuits has been discouraged? A similar abnormal drop may also be found in transformers which have been designed for a lighting load only. It is quite possible that a transformer with heavy magnetic leakage may have three or four times the terminal drop on a motor load which it would have on a lamp load. It is therefore obvious that all transformers before being sent out should be tested on an inductive load in addition to the non-inductive load test. The writer has adopted the practice in specifying for transformers that when tested on a non-inductive load the drop shall not exceed 2 per cent., and not more than 3 per cent. when tested on a load with a power factor of 0·75. (*b*) The question of the size of the day load sets is one which will right itself as the motor load increases, since the possibility of any single motor disturbing the supply will diminish as the number of motors increases, and this may therefore be classed as a temporary difficulty only. (*c*) The chief defects are heavy starting current and low power factors. The starting current in a S.P. motor need not necessarily be abnormal, though undoubtedly this often is the case, and it is surprising that A.C.

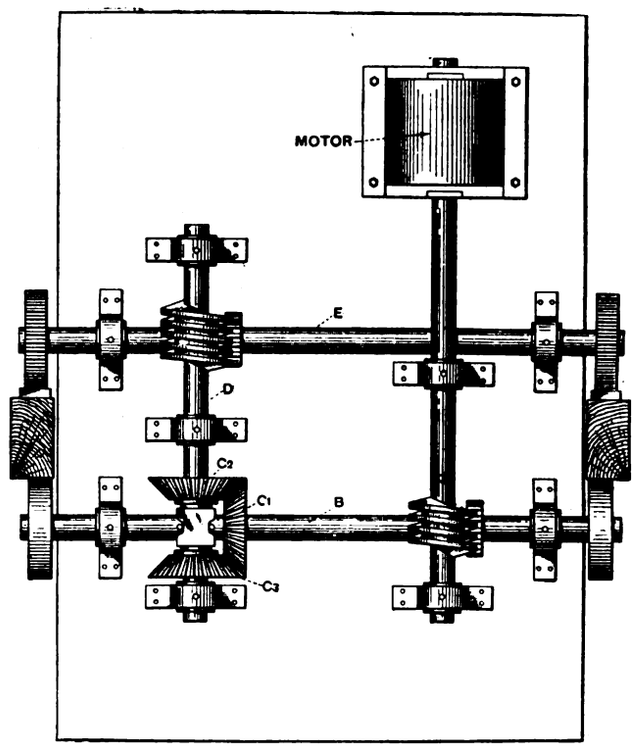

FIG. 1.

engineers do not more rigorously insist on the starting current of motors being kept down. It is purely a matter of what starting torque is required, and it can be brought as low as two-thirds of full load current or less by suitable arrangements. (*d*) A high frequency was adopted in the early days when it was common practice to instal small transformers in houses, with a view of keeping down the iron losses, the designers losing sight of the objection to a high frequency in view of motor working. It is well known that with a low frequency, a motor has the advantage of higher efficiency, higher power factor and smaller starting current.

The writer trusts that he has shown that the prejudice against the single-phase motor has its root not in any inherent defect in the motor but in the unsuitable nature of the appliances used. It will be seen that direct-current engineers would have equal cause to complain of their motors if they tolerated the defects in their systems which alternating-current engineers accept as inevitable. Imagine a D.C. engineer being first hampered with a 25 per cent. drop in his armature, then a drop in his feeders and distributors corresponding to the drop in the feeders, distributors and transformers (the latter wound for non-inductive loads only), allowing motors to be started from rest by means of a resistance so imperfect as to pass double or treble the full load current, and we should not be surprised at his complaining of the disturbance caused by his motors. Consider now the A.C. engineer with the added

* Paper read before the Municipal Electrical Association, at Huddersfield, June 21.

NOTE.—In this Paper the abbreviations D.C., A.C., S.P., refer to direct current, alternating current, and single phase respectively.

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losses caused by a power-factor less than 90 and we see his difficulties in the face of unsuitable plant. The writer believes that it would be well worth while to go to the expense of re-winding alternators with these abnormal drops, to use only transformers rated on a power basis and in extreme cases to bring down the frequency to a reasonable value. Exception has been taken to the S.P. motor owing to its alleged inability to start against a load. This allegation is quite unfounded, as this condition can be complied with, but at the expense, of course, of starting current. It appears to the writer that this point has been laboured too much, as there are few cases in which a fast and loose pulley cannot be arranged. Moreover this defect has not prevented the enormous use of gas engines, which, so far from being able to start against a load, have actually to be pulled round by hand before they will start at all! Even in the case of lifts

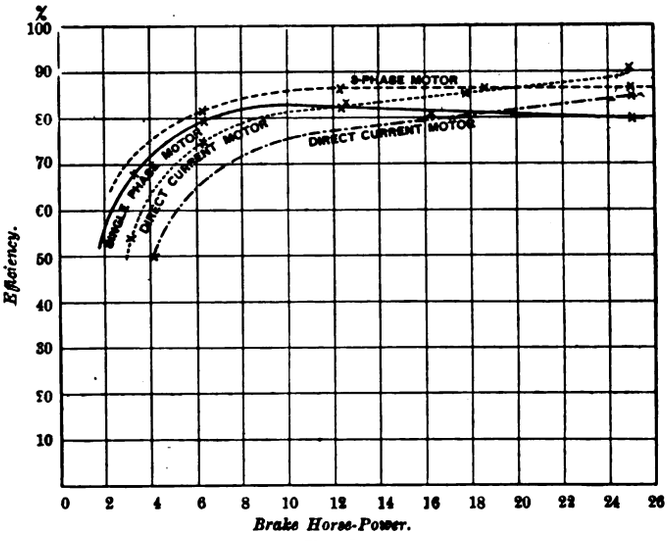

FIG. 2.

there is a wide sphere of utility for S.P. motors. The writer has a lift worked by a S.P. motor on the Derby mains which is perfectly satisfactory. Although the motor starts light, the lift is working at full speed within 7 sec. of the motor being switched on. A short description may be of interest. Fig. 1 is a plan of the cage; the motor and gearing are fixed on the top of the cage and move with it. The motor, a 4 B.H.P. Langdon-Davies, is switched on inside the cage and quickly runs up to speed, simply driving its own spindle and spindle B, and also the bevel wheels C_1, C_2, C_3; the two latter are at present loose on their spindle. The starting lever inside the cage when pulled over brings a friction cone to bear on the inner surface of the shoulder on bevel wheels C_2 and C_3. This throws shafts D and E into gear and causes the lift to rise or fall at will.

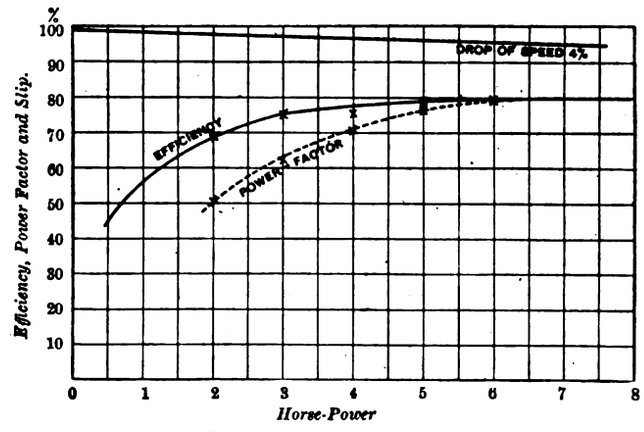

FIG. 3.—6 B.H.P. Single-Phase Motor.

The time necssary to start the lift, i.e., 7sec., is sufficiently small to justify the contention that the S.P. motor can be used for lift purposes in a great variety of cases.

A few notes as to what is actually being done on supply systems with S.P. motors may not be out of place. For purposes of comparison, it is a matter of interest to note what is being done in a city where the D.C. motor business is vigorously pushed. In Bradford the low charges and easy terms of hire have resulted in a considerable motor load being obtained. Up to the end of June, 1899, there were 307 motors connected to the mains, and the proportion of units sold for power to total units sold was about 17 per cent. It is doubtful if this result has been equalled in any other town in the country. It will perhaps be somewhat of a surprise to some members of the Association to find that on the Continent the above results have been far eclipsed by the use of S.P. motors. In the City of Frankfort, on March 31, 1899, there were single-phase motors of an aggregate of no less than 4,532 B.H.P. connected to the mains, while the proportion of power units sold to total units sold was no less than 58 per cent., the figures being, for power 1,851,268 units and for light 1.342,399 units, total 3,193,667 units sold. The largest motors are of 750 B.H.P., of which there are three. They are of the synchronous type and are coupled to D.C. generators, and are used for driving the trams. With the exception of these all the motors are of the induction type, the largest of which are of 90 B.H.P. The larger motors are run from separate transformers fed from the nearest feeders, while the smaller sizes are taken direct from the low-tension network, while the steadiness of the light leaves nothing to be desired. The generating sets are as follows: Two of 1,500 I.H.P. and four of 750 I.H.P. The frequency is 45 periods and the armature drop 6 per cent. The charges for power are equivalent to 2d. per unit with discounts up to 25 per cent. The Corporation of Derby have within the last few months commenced letting out S.P. motors on hire with gratifying results. At the present time motors equivalent to about 200 B.H.P. have been connected, of various sizes up to 30 B.H.P., and the units sold for power during the year have amounted to about 12 per cent. of the total units sold. The charges vary from 3d. to 1d. per unit according to the length of time the motor is used.

A few words may now be said on the chief characteristics of the modern S.P. motor. The only practical motors on the market are of the synchronous and the induction type. The sychronous motor requires its field to be excited by a direct current. It is not usually self-starting, and this defect precludes its adoption for any but large sizes. It has an extremely high efficiency and power factor, and it runs at a synchronous speed. The induction motor, which is almost exclusively used, has been greatly improved in recent years. A few years ago the maximum efficiency was not expected to be more than 60 per cent. to 65 per cent. with a power factor of about the same value, while the starting current, even when the motor started light, was often two or three times the full current. Thanks, however, to the good work of Tesla, Brown, Langdon-Davies, and others, very marked improvements have been effected within the last two or three years.

The following table gives a good idea of the efficiencies of modern single-phase motors, as compared with direct-current and three-phase motors. All the tests are made from motors actually at work, the S.P. motors being on the Derby mains. The motors were all made by leading firms, and though the figures do not necessarily represent the highest attainable results, they are a fair sample of good modern practice :—

Type of motor.	Brakes, H.P.	Efficiency. Full load.	Half load.	Quarter load.	Eighth load.
		Per cent.	Per cent.	Per cent.	Per cent.
Direct current	4	78	68	53	...
Ditto	3	84	77	59	35
Single phase	2	78	76	62	...
Ditto	6	80	76	62	46
Three phase	10	83·5	82	72	55
Single phase	12	75	78	68	54
Ditto	25	80	83	80	68
Three phase	25	87	86	82	72
Direct current	25	91	83	75	54
Ditto	25	86	78	66	...

Diagram (2) shows the efficiencies of the above-mentioned four motors of 25 B.H.P. plotted together for ease of comparison. The interesting fact to be noted in both the diagram and the tables is that, while the efficiency at full load in the D.C. motors is the higher, the S.P. motors have the advantage at low loads, and it is probable that where the work to be done by a motor varies considerably, as, for instance, in a machine shop, the average efficiency of the S.P. motor is quite as high as, if not higher than, in the D.C. motor. Diagram (3) of the power factor and efficiency of the above 6 H.P. motor shows that while there is still room for considerable improvement in the power factors, the modern motors exhibits considerable advancement during recent years.

In conclusion, the writer would urge that while the S.P. motor still leaves much to be desired in the matter of power factor, starting current, starting torque, and facility of running at variable speeds, yet the absence of commutators with their attendant troubles giving such simplicity in working, together with the high average efficiency, render it eminently suitable for general distribution work. As is shown in the Table the polyphase motor outstrips both its competitors in point of efficiency. The writer would suggest that should a transformer or other appliance be placed on the market which without moving parts would convert a single-phase into a polyphase current, in the same manner that a two-phase can be converted into a three-phase current, in this direction may lie the solu-

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tion of the motor problem. With the increase in size of our stations, the engineers of direct-current works are more and more realising the advantages of alternating currents for generation and transmission. The improvements in modern A.C. motors have gone a long way to lessen the force of the objection to alternating currents for distribution purposes as well, and the writer's experience justifies him in the opinion that the A.C. motor (either single or polyphase) is quite capable of satisfying all ordinary demands for power from the mains of public supply undertakings.

LIGHT RAILWAY SCHEMES.

In our issue of June 15th we gave a list of the applications lodged with the Light Railway Commissioners during the month of May, and we are now able to give further particulars of the projects in which electric traction is specified. Though the total number of applications shows a considerable falling off compared with November and May of 1899 (when the numbers were 43 and 40 respectively), the proportion of electrical projects is maintained. On the present occasion the promoters of 17 of the schemes propose to employ electric traction, the figures for the two previous occasions being 32 and 21 respectively. Five of the present applications are for powers to make extensions of light (electric) railways already authorised. The Bath and Swansea schemes have been revived. In the first case there is a joint application by the Bath Corporation and a private syndicate, and we trust it may meet with a better fate than the two rival applications did last year. The Swansea Corporation seek to obtain the powers which the Swansea Tramways Co. unsuccessfully applied for in 1899. The statistics of the total applications, together with the proportion of electrical schemes which have been lodged with the Commissioners since the passing of the light Railways Act will be of interest, and are as follows:—

	1900.	1899.		1898.		1897.		1896.
	May.	Nov.	May.	Nov.	May.	Nov.	May.	Nov.
Total applications	24	43	40	54	35	30	28	28
Electric schemes.....	17	32	21	32	18	16	10	14

These figures would seem to indicate that, notwithstanding the absence of any onerous purchase clause, promoters of light railway and tramway schemes are becoming less inclined to adopt procedure under the Light Railways Act, as, unless an agreement has been previously arrived at with the road authorities, the application has small chance of being approved by the Commissioners. In addition, the Commissioners have no power to authorise the compulsory acquisition of land, and in all cases there is an appeal to the Board of Trade against their order—a right which is freely exercised by the opposing municipalities and railway companies. As, however, the Light Railways Act is only an experimental one, and will shortly expire, Parliament may be disposed to consider the advisability of amending and improving the procedure in this and other respects.

CORRESPONDENCE.

STELJES' TYPEWRITING TELEGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of June 29th you were good enough to give a description of the above system of telegraphy (page 359) and as reference is made to the speed of the working of this instrument, which as therein given may be somewhat prejudicial to the system, I feel sure you will allow me to say that the rate of speed of the transmission of a message by an unskilled operator varies from 14 to 18 words per minute. An enterprising office boy was ambitious to try his prowess in this line and accomplished 18 words per minute, and other inexperienced workers came out at from 14 to 18 words per minute. With very little practice 25 is easily obtained.

The alternations of this instrument are rapid. The Wheatstone transmitter we use is of a modified form, and of a pattern I understand the Post Office is now adopting.—Yours, &c.,

C. E. SPAGNOLETTI.

Ealing, W., July 3.

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the paragraph in your current issue dealing with our material at the above exhibition, we beg leave to point out that your description of the manner in which our single-phase (Heyland) motors are started is incorrect. These motors do not employ a choking coil at starting, as stated, the starting coils and running coils being switched in parallel directly across the line, there being no auxiliary apparatus whatever. Under these circumstances the motors for 40, 50 and 60 cycle circuits start with full load torque, with a current consumption not exceeding twice the full load current.

We are sorry that your representative, when visiting our stand, apparently missed seeing the specialities in traction work we are showing. We refer more particularly to our light railway truck, standard car controller, scotch for hilly districts, new hand brake, &c., which we venture to think are the chief novelties in the Exhibition.—Yours &c.,

WITTING BROS., LTD. (Electricite et Hydraulique),
S. C. WITTING, Managing Director.

49, Cannon street, London, E.C., July 4.

List of Applications to the Light Railway Commissioners in May, 1900.

Title.	Promoters.	Engineer.	Mileage.	Gauge. Ft.	in.	Agents.
Barnsley & District (extension) No. 2	British Electric Traction Co.	S. Sellon	4¼	3	6	Sydney Morse.
Bath and District	Bath Corporation, Sir J. Sivewright and Leopold Hirsh	G. Hopkins & Son	13½	4	8½	Brash, Wheeler & Co.
Blackburn, Whalley and Burnley	Auxiliary & Light Railways & Tramways Co	C. Chadwell	14¼	4	0	Tahourdins & Hitchcock.
Durham and District	British Electric Traction Co.	S. Sellon	2¾	4	8½	Sydney Morse.
Hayling Island	E. Belfield, T. Pollock, and J. P. Bedson	Knowles & Russell	3¼	4	8½	Angrove, Bromwich & Yeo.
Hyde and Dukinfield	Hyde Corporation and Dukinfield Corporation	J. Mitchell & S. Hague	9¾	4	8½	Baker, Lees & Co.
Jarrow and South Shields	British Electric Traction Co.	S. Sellon	3¼	4	8½	Sydney Morse.
Kidderminster and Bewdley	Kidderminster and District Electric Lighting & Traction Co.	S. Sellon	4½	3	6	Sydney Morse.
Kingston, Surbiton and District (extension)	British Electric Traction Co.	S. Sellon	7	4	8½	Sydney Morse.
Mansfield and District (extension)	J. Fell, J. Lewis, and W. J. Kershaw	C. H. Gadsby	4½	3	6	Wm. Webb & Co.
Pwllheli and Nevin	North Wales and District Light Railway & Electric Power Synd.	Bennett & Ward-Thomas	6½	3	0	G. H. Hoyle.
Rhyl and Prestatyn (extension)	Rhyl and Prestatyn Light Railway Co.	A. Dickinson & Co.	2	3	6	Warwick Webb.
Swansea and District	Swansea Corporation	Kincaid, Waller & Manville	8	4	8½	Sharpe, Parker & Co.
Sheerness and District	British Electric Traction Co.	S. Sellon	2½	3	6	Sydney Morse.
Staines and Egham	Staines and Egham Light Railway Co.	V. B. D. Cooper	3½	3	6	Booth & Smee.
Warrington & Northwich (extension)	A. Anderson and A. Brown	R. H. Scotter	9¼	4	8½	Baker, Lees & Co.
Warrington and Runcorn	International Electric Traction & Power Synd.	Bennett & Ward-Thomas, Knowles & Russell	8	4	8½	Sherwood & Co.
	Total	miles of electric line ...	101¾			

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PARLIAMENTARY INTELLIGENCE.

(*Continued from page 404*)

THE ELECTRIC POWER BILLS.

The House of Commons Committee on the Electric Power bills held another sitting on Tuesday, Sir J. Kitson presiding.

The CHAIRMAN said that before any further progress had been made the Committee would make a declaration. Subsequently he said: The statement I have to make now is an expansion of the declaration of the Committee which has already been given to you on the South Wales bill. It is as follows:—

1. The company to be authorised to supply electrical energy for power purposes anywhere within the area of supply subject to the consent of the local authority in certain cases as set out below.
2. The company to have no general lighting powers, *i.e.*, distribution to ordinary consumers within the area, except in pursuance of a provisional order obtained in the ordinary way.
3. Where a local authority is now authorised to supply electricity within the area their consent is to be required for the supply of electricity by the company, the Board of Trade to be empowered to override the refusal of the local authority to give consent if the authority are not prepared to provide the requisite supply on reasonable terms and within a reasonable time.
4. Any local authority who hereafter gets statutory powers for supplying electricity within the area to have in ordinary cases the option of taking over the company's supply in its local area on terms to be laid down by the provisional order or act by which the statutory powers are given.
5. A company having statutory powers to be in the same position as a local authority now having statutory powers; a company to whom powers are hereafter granted to be placed in the same position as a local authority to whom statutory powers are hereafter granted.

That is the decision of the Committee, and it is suggested that the Government draughtsman, Mr. Thring, should meet the agents and go through the clauses.

The Agent for the Lancashire bill said he did not think there was anything in the Committee's declaration which would apply to the Lancashire bill.

The CHAIRMAN: We have made no declaration on the Lancashire bill because it is not affected by these provisions.

On Wednesday considerable discussion took place respecting the wording of a clause drafted by the Board of Trade for the purpose of carrying out the Committee's declarations on the South Wales Bill. Eventually the clause was adopted by the Committee in the following form:—

The powers of the company for the supply of electricity under this act shall be subject to the following provisions:—

1. Electricity shall be supplied under this act only (*a*) for supply in bulk to authorised distributors; and (*b*) for the purpose of providing power and for the lighting by any person to whom it is so supplied for power of any premises in any part of which the power is utilized.
2. Electricity shall not be supplied under this act by the company in any area being at the passing of this act the area of supply of any authorised distributors, except with the consent of those distributors, but the consent shall not be unreasonably withheld. If any question arises whether that consent is unreasonably withheld or not, that question shall be determined by the Board of Trade. The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and in considering what are reasonable terms and what is a reasonable time, the Board of Trade shall, amongst other things, have regard to the terms upon which, and the time within which the company are willing and in a position to give the supply.
3. If at any time after the passing of this act any local authority or company become authorised distributors in any area within the area of supply under this act, the company shall be subject to any provisions which may be made by the act or provisional order under which the distributors became authorised as to the taking over of any supply then given to the company for use exclusively within the area of supply of the distributors.
4. Nothing herein contained shall prevent a company from applying for provisional orders under the Electric Lighting Acts of 1882 and 1888.
5. Nothing in this section shall authorise a company to supply electricity for lighting, other than the lighting specially mentioned in this section.

In this section the expression "authorised distributors" means any local authority, company, body, or person authorised by Act of Parliament, or provisional order confirmed by Parliament to supply electricity within the area of supply.

Yesterday, Mr. H. LLOYD, on behalf of Barry Council, asked the Committee to re-consider sub-section 2 of the clause drafted (as above), respecting the conditions under which the supply of electricity was to be given, and to insert a proviso that distributing mains should not be laid by the company in the area of supply of any authorised distributors except with the consent of those distributors.

The Committee declined to insert such a proviso, whereon Mr. Lloyd said his clients regarded the question as one of principle, and therefore he should take no further part in the proceedings—indicating that the bill would be fought in the House of Lords.

Mr. FITZGERALD, representing local authorities in the Rhondda Valley, brought up a sliding scale and proposed its insertion. After some discussion,

The CHAIRMAN said the Committee had decided that the dividend payable by the company should be limited to 8 per cent. instead of to 10 per cent. as proposed in the bill, and that there should be a clause giving the Board of Trade power of revision after 10 years.

The Durham County Bill was then considered, and Mr. BALFOUR BROWNE, Q.C., on behalf of the promoters, asked for powers of supply within the authorised area of supply of other companies.

The Committee reserved their consideration on this point.

The question of the application to the Durham and Lancashire bills of the limitation of dividends to 8 per cent. was next dealt with.

Mr. MOON, for the promoters of the Durham bill, said it was a matter for serious consideration whether the promoters would accept the measure with a dividend limited to 8 per cent.

Mr. RAM, Q.C., for the South Wales promoters, remarked that his clients believed that it would be absolutely impossible to get money if they were to be restricted to a hard and fast dividend of 8 per cent. without a sliding scale. There would be no inducement, if such a dividend were fixed, to lower the price to consumers.

The Committee, recognising the importance of the question, decided to hear arguments on the question of dividend, but declined to hear evidence. Counsel having spoken on the point, the Committee deliberated.

The CHAIRMAN said: The Committee adhere to the decision they have come to, that the standard dividend should be fixed at 8 per cent., but having heard the arguments of counsel, they are willing that a sliding scale should be adopted, the principle of the sliding scale being 5 per cent. discount on the amount charged on the raising of the dividend by 1 per cent. The Lancashire and Durham schedules as amended will be the standard price for Durham and Lancashire. The standard price for South Wales will be 2½d., the sliding scale and the standard price charged being subject to revision in 10 years.

The Committee then adjourned till to-day (Friday).

SHANNON WATER AND ELECTRIC POWER BILL.

The Select Committee of the House of Commons, presided over by Sir Frederick Godson, on Tuesday commenced the consideration of this bill, by which it is sought to incorporate a company with capital powers of £300,000, and borrowing powers of £150,000, with power to use the water of the Shannon for generating electricity to be sold in bulk to the city of Limerick and other local authorities in the county of Clare.

Mr. BUSHE, Q.C., for the bill, quoted the remarks of Sir James Kitson, from whose Committee the present bill had been transferred, with reference to the provision of electric power. Sir James said he felt that the value of electrical energy had been amply demonstrated. Its importance to industries was admitted, and the Committee were accordingly advised that it was to the public advantage to facilitate measures for the supply of electrical energy to all consumers who wished to avail themselves of the economy and efficiency of electric power. Sir J. Kitson's Committee also accepted the recommendations contained in the report of the joint committee of 1898, especially as regarded that part providing compulsory powers for acquiring lands for generating stations, easements, &c. The manufacturers of Ireland were in a torpid state, and so long as they depended on coal as a motive power they could not flourish. The company asking to be incorporated by the Bill desired to use the water power of the river Shannon for the purpose of generating electric energy in order to serve Limerick and the district round for some 30 miles. The area of the water proposed to be utilised was 30,000 acres, with an average depth of 30ft, and consisted of the drainage of some 4,000 or 5,000 sq. miles. The average flow of the Shannon at Killaloe was about 330,000 cubic ft. per minute. In regard to the works proposed by the company, there was an already existing canal leaving the Shannon about 6 miles from Killaloe and running to the south. They proposed at that point to make an intake nearly parallel with that canal and to return the water to the river lower down. They proposed to have their generating centre at Cloonlara, some 2½ miles from the intake. At that place there was a fall in the river of 40ft., and there they proposed to place turbines capable of producing energy up to 8,000 H.P. The works, however, would be capable of development. It was estimated that 5,000 H.P. would at first be necessary. From Cloonlara down to Plassy Lock a race would be constructed to carry the water back to the Shannon; the only effect, therefore, upon the river would be that water would be borrowed from it and afterwards returned to it some miles lower down the stream. The scheme had the unanimous support of the local authorities concerned. In order to meet the case of droughts, it had been agreed with the Board of Works of Ireland, who were the Navigation Commissioners of the Shannon, that a minimum fixed flow of water should be left in the river. That minimum had been fixed at 90,000 cubic ft. per minute of water going down the river, and when the flow fell to that limit the intakes of the company would remain closed. The Limerick Corporation were the electric lighting authority for their city, and although they desired to save their rights in regard to electric lighting and water they did not see their way to generating electrical energy themselves, but rather looked to the promoters as the wholesale dealers who would bring the electricity to the city in bulk. The Corporation, therefore, were watching their interests before the Committee in a friendly spirit.

Mr. TAYLOR, Q.C., for Limerick Corporation, said the Corporation only desired protection for the city water works and electric lighting; beyond that they would not trouble the Committee.

Mr. FRASER, C.E., engineer to the project, said he had carried out works to the value of £2,000,000 in Ireland. The present proposal was to use the waters of the Shannon, now running to waste, for the purpose of generating electric energy for supplying Limerick and places around. The proposed works consisted of two parts, the first being simply a great canal cut down to Cloonlara, where the power station would be situated, and there, over a distance of about 2½ miles, they got a fall of 40ft. The second part of the works was a gigantic tail race, the water being taken from the river above, and returned lower down, there being no interference with the river whatever. The scheme merely meant a big cutting, the bottom of which was concrete. The electric power

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would be transmitted to Limerick 4 miles or 5 miles away, and to various other points, as the small towns in the neighbourhood were most anxious to get both light and power—light because gas cost them 6s. 6s. per 1,000 cubic ft., and power because it would enable them to retrieve their industrial position. The radius of supply would be 30 miles. In Italy, where there was little coal, they were rapidly utilising their water powers for the production of electricity, and so Italy was becoming a manufacturing country. The experience in Italy, Switzerland, and in the neighbourhood of the Niagara Falls, had shown that electricity as a motive power for machinery conduced both to an economy of money and space. The Corporation of Limerick had granted a concession for some 7 miles of electric tramways and the Tramways Company would take their motive power from the promoters. The cost of the works proposed would be great (£300,000) in the first instance, but after that only a small sum would be necessary for upkeep. The prices to be charged were the same as those adopted in the three great power bills passed during the present session, namely, for any quantity not exceeding 200 hours of supply at the maximum power, 5d. per unit; not exceeding 400 hours, 3d. per unit; above that amount 2d. per unit. When the river fell below the minimum flow steam power would be used to produce current.

Mr. J. CLARKE, an American electrician, gave evidence in support of the scheme. He said that these schemes of working with auxiliary steam power were highly successful in America.

Mr. RICHARD HAZARD, C.E., joint engineer to the scheme, gave corroborative evidence, and evidence having been taken to show that no injury would be done to the fisheries on the Shannon, the promoters case was closed.

Mr. BALFOUR BROWNE, Q.C., for the Limerick Fishery District Conservators, said he would be able to show that great damage would be done to the riparian proprietors by the proposals of the bill, as they would be deprived of the water necessary for the salmon fisheries in times of flood, and no compensation water would be supplied in times of drought. The Shannon salmon fisheries were worth £40,000 a year, and they ought not to be injured without adequate compensation. Counsel quoted statistics that show that according to the rainfall of previous years the promoters would not be able to obtain on a considerable number of days in each year the power they proposed to supply. Under the bill the promoters would be unable to carry out the scheme before they had come to Parliament for powers to construct the weir necessary on the Shannon, and he, therefore, asked the Committee to reject what was really a piecemeal scheme.

Mr. BUSHE, Q.C., said that sec. 12 of the Waterworks Clauses Act of 1847 which was included in the bill, and which dealt with the case of persons whose water was diverted, would give to the riparian owners all possible protection in regard to compensation for damage to their fisheries.

Mr. MACASSEY said the case for the fisheries was that they would be, if not destroyed, so seriously injured as to be worth nothing if the works under the bill were carried out. They, therefore, asked for the rejection of the measure.

The CHAIRMAN said, if anything stronger than the clause in the bill was asked for, the Committee were willing to consider the matter, and, if necessary, fix the amount beyond which compensation should not go. In regard to finance it was so much a matter for the promoters that, if the Committee were given, as they had been, a fair justification for considering that the £300,000 necessary would be raised, they would not go into the question as to whether £30,000 or so more might be required. No company ever did what it said it would do with its first capital. As to whether the company would have to come to Parliament again for authorisation to construct a weir, that was not before the Committee.

Mr. BALFOUR BROWNE said if the Committee were inclined to insert a provision for money compensation he would retire. He had yet two chances against the proposers of the bill—one in the Lords and the other when the bill authorising the weir came before Parliament—and his clients were meanwhile protected. The promoters could not touch a drop of water in the Shannon until the other bill was passed.

The CHAIRMAN: Supposing, Mr. Browne, those whom you represent wished to get money compensation afterwards, would the clause in the bill protect them? Will you produce a clause?—No, I will not. Much would depend on the character of the weir proposed to be constructed. It might do much or little damage. If the Committee thought that money compensation would meet his clients' case, despite the large body of evidence he could produce to the contrary, he would prefer to go to a tribunal that would hear him. The Committee had sufficiently indicated its view, and with the concurrence of his clients he proposed not to take any further part in connection with the bill.

Counsel then withdrew, reserving their opposition for the Upper House.

On behalf of the Corporation of Limerick, Mr. TAYLOR, Q.C., intimated that clauses having been agreed between parties, they were now supporters of the bill.

The Committee passed the preamble, and the bill was ordered to be reported as amended.

DUBLIN ELECTRIC LIGHTING BILL.

In the House of Commons on Monday, on the order for the third reading of this bill, Mr. CAREW moved that it be read a third time that day three months. The measure, he said, was against the tendency of the age, which was that undertakings for the supply of electric lighting should be in the hands of local authorities.

Mr. FIELD having seconded the motion,

Mr. A. BROWN, as chairman of the Committee appointed by the House of Commons which passed the bill, explained the reasons which had influenced the Committee in their decision. The Dublin Corporation had done little or nothing to carry out the powers it possessed under its provisional order to supply electrical energy, and the Committee therefore considered that the application of a private company asking to be authorised to give the city of Dublin and some of the out-townships a supply of electric light should be granted. The opponents of the present bill had taken the most unusual course of opposing it on the report and on the present stage. He looked to the House to uphold the decision of the Committee.

Mr. T. W. RUSSELL supported the motion. He said the Corporation of Dublin had failed to give a proper supply of electric light, only because they had been occupied with great schemes of main drainage and artisans' dwellings. The Corporation had much to contend against, as Dublin was a city in which the very poor were a great factor. As a citizen and ratepayer of Dublin he saw that the city's revenue would have to be spent in a few years' time in buying out the proposed electric lighting company.

Mr. RITCHIE could not bring himself to believe that the Corporation of Dublin could not obtain money to carry out their obligations as regards electric lighting as well as perform their ordinary duties as a municipal body. From the consumers' point of view there was no doubt the bill should be passed by that House, and its Committee's decision thereby upheld.

Mr. BLAKE held that the passing of the bill would be a positive calamity to Dublin and a distinct infringement of the rights of municipal corporations generally. As to the allegation of incapacity on the part of the Corporation, if it was Dublin that erred it was Dublin that suffered, and if it kept going wrong the ratepayers would most assuredly make the municipal authority do its duty. The Corporation had now obtained the necessary moneys and were ready to proceed.

Mr. T. M. HEALY said a great injustice would be done to the ratepayers of Dublin if the bill were rejected. For ten years the Dublin Corporation had possessed full statutory powers to provide an efficient system of electric lighting; had spent £100,000; and yet out of the 250,000 people in their area, only 250 were supplied with electric current. He pleaded for free trade in electricity supply. The third reading was ultimately lost by 6 votes—174 to 168.

MARYLEBONE (LONDON) PROVISIONAL LIGHTING ORDER.

In the House of Commons on Tuesday, on the motion for the second reading of the Electric Lighting Provisional Order (No. 2.) Bill, Capt. NORTON moved that the bill be read a second time that day three months. He said that he had taken that step at the special request of the Marylebone Vestry and other local authorities. This showed that the question was no narrow issue between Marylebone parish and an electric lighting company, but a matter that affected important parishes in the county of London. The bill was inopportune, and if it were passed the new Marylebone Council would either have to give up all idea of undertaking the electric lighting of their area or be driven to buy out two companies at enormous cost. In 1889 the Marylebone Vestry consented to the Metropolitan Electric Supply Co. providing the parish with electric current. The demand for current for lighting became so great that the company was unable to meet it, and thus did not give complete satisfaction. Harassed by complaints of inhabitants the Vestry made two unsuccessful attempts to obtain electric lighting powers. In view of the fact that they were to be soon constituted a borough council they had decided to apply again for an order, and they had entered into a provisional agreement with the Metropolitan Company for the purchase of so much of the undertaking of that company as lay within their area. Now the Marylebone Electric Lighting Co., which was identical with the St. James's & Pall Mall Electric Light Co.—one of the best electric lighting companies in London, he admitted—was trying, by promoting the present bill, to obtain a footing in Marylebone. He thought it would be admitted that to allow a new company to come into the parish would greatly handicap the new Borough Council at the beginning of their career.

Gen. LAURIE having seconded the motion,

Mr. RITCHIE (President of the Board of Trade) explained the position in regard to the present bill. He said that the supply of electric current in Marylebone had been extremely bad for some years past and had been greatly complained of. It was therefore necessary that something should be done to remedy that state of things. Two years ago the Marylebone Vestry applied for a provisional order to enable them to give a competitive supply. The House of Commons agreed to read the bill a second time, but it was rejected in Committee. Subsequently a deputation waited on the Board of Trade to complain of the quality of the electric light supplied by the Metropolitan Company. The Board was practically powerless, and the only remedy for a grievance of that kind was competition. In order to meet the difficulty he now proposed an instruction to the Committee (if the bill was read a second time) that it should consider the expediency of inserting a clause in the order providing that the order should not come into operation until a date to be decided upon by the Committee, and should not then come into operation if the undertaking authorised by the Metropolitan Electric Supply Co. (West London Order, 1889), should have been purchased by the Marylebone Vestry or its successors. He hoped the House would send the bill to a Committee to consider all the questions which would come before it.

After Mr. CRIPPS had spoken in opposition and Mr. LYTTELTON in support of the bill, the second reading was lost by 28 votes—147 to 119.

NORTH METROPOLITAN ELECTRIC SUPPLY BILL.

The Committee of the House of Commons on the North Metropolitan Electric Supply Bill, presided over by Mr. A. H. Brown, met again yesterday, when it was expected they would give their decision as to the conditions under which the powers conferred by the bill should be exercised; but after sitting for an hour with closed doors, the chairman proceeded to the room in which the Special Committee on Electric Power schemes is sitting, and, after conferring with Sir James Kitson, announced that the decision in the North Metropolitan case would not be given until Monday.

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ELECTRIC LIGHTING ORDERS.

A Select Committee of the House of Commons, presided over by Sir. F. Godson, considered the bill to confirm the Electric Lighting Provisional Orders (No. 10) granted by the Board of Trade to Battersea, Limehouse, Mile End Old Town, and St. George's-in-the-East. The Battersea order was not opposed.

Mr. Shiress Will, Q.C., and Mr. John M. Stone appeared for St. George's-in-the-East; Mr. Claude Baggallay, Q.C., and Mr. Lambert for Mile End Old Town; and Mr. Worsley Taylor, Q.C., and Mr. Ackworth for Limehouse. All three orders were opposed by the County of London & Brush Provincial Electric Lighting Co., who were represented by Mr. Pember, Q.C., Mr. E. Moon, and Mr. Shaw.

Mr. SHIRESS WILL for the St. George's-in-the-East order, said the points were substantially the same in all three cases. These places, in conjunction with Whitechapel, were about to be made into one municipality, under the Government of London Act of last year. Whitechapel already had the electric supply in its own hands, and the other three local bodies applied to join so that the supply should be in the hands of the new municipality. There was at present a company, the County of London & Brush Provincial Co., authorised to supply within the area, who were opposing the orders. But the fact was that that company had done nothing towards supplying any electricity under their order; and shortly after the act forming the new municipality was passed a meeting of delegates from the four districts was held and it was determined to apply for provisional orders. In the result the Board of Trade made the orders which the Committee were now asked to confirm. The scheme was that the whole of the four undertakings shall become one undertaking and be in one hand. The works of the Whitechapel Vestry, which were sanctioned under a provisional order of 1892, were capable of being made sufficient for all four places, and they were thus able to supply energy more cheaply and economically than if each district had been obliged to make a separate generating station. As to the position of the County of London Company they obtained a provisional order in 1897, but nothing was done till 1899, when the local authority received notice that the company intended to proceed. They said this was because they had received obstruction from the local authority. But the reason was very different. The company had a generating station in the north of London (at St. Luke's, Cerkenwell) and instead of putting in a generating station at the East End they wished to supply from St. Luke's station. Last year they tried to obtain powers to lay mains from this generating station to the East End. That bill was rejected, and again this year they had introduced a bill for the same purpose and again failed. Their object was, by agreement with the Regent's Canal Co., to carry a main from St. Luke's down the banks of the canal to the edge of Mile End Old Town and so escape all parliamentary and local control. He ventured to submit that as a general principle where a local authority gave consent to a company obtaining powers to light the district, where that company did its duty Parliament would not be disposed to allow the local authority to compete. But in this case the company had not done its duty—it had not laid a yard of mains or turned a spade of earth, and had not spent any capital at all. The policy of the electric lighting acts was to enable the local authority within some limited period to purchase the undertakings of the companies; but in this case the authority would only be able to buy the mains and lines and posts in their own district, and would have no power to purchase the generating station at St. Luke's.

Mr. HORATIO THOMPSON, vestry clerk of St. George's-in-the-East, said the parish had a population of 47,500, and an area of 244 acres, a considerable portion being occupied by the London Docks. In 1896 they were approached by the County of London Company, and gave their consent to the company's applying for a provisional order, but the first notice of their intention to commence work was in September, 1899, two years after their powers commenced.

Mr. W. C. PARSONS TAPPER, resident electrical engineer of the Whitechapel District Electrical Department, said Whitechapel had got a provisional order of their own, and had supplied electricity for about six months. The demand was rapidly increasing, and they were already extending their works. These works were capable of extension, and if necessary, when the new borough was formed, they could put another station at the river side. There was a growing demand for motive power. The average price for current was 3d. per unit, both for lighting and power; but during the six summer months they charged at the rate of 1d. per unit. They had already laid 7 miles of mains at Whitechapel. The installation was made with a view of supplying Whitechapel only, but they had a large area on the present site for extensions. Their system was the low-pressure direct-current. By this system there was a considerable loss in transmission in large areas.

Mr. PEMBER, in reply to the Chairman, said the average charge per unit of the County of London Company was 4d. or 4½d.; it, in fact, varied from 7d. down to 3d.

The CHAIRMAN suggested that if necessary the promoters could by consent erect further works on the river.

Mr. PEMBER said in that case they would be liable to actions for nuisance.

Mr. BAGGALLAY remarked that in all cases of provisional orders for supplying electricity provision was inserted that the undertaking should not be exonerated from any action or proceedings for nuisance. That provision was in each of the orders and in the general act of last year.

Mr. MOON said the orders had it, but the acts had not. If they got compulsory powers by an act they would only be liable if their works were carried on negligently. That was the distinction which had been made, following the report of the Joint Committee of both Houses.

Major CARDEW said having regard to the formation of the new borough he considered Stepney would make a very fair area for an electric supply and it ought to be successful. He had inspected the works at Whitechapel. They had a very considerable area on which they had started the construction of a station which could be extended to contain 15,000 H.P., which would serve for a time the whole district. As soon as that station was full up they could secure another site by the river, where they would be able to get coal and cart away the dust with greater facility and get water for condensation. For the kind of motive power used in the district, he considered the continuous-current system which was given from the Whitechapel station would be more suitable than the alternating current from the Clerkenwell station. He agreed that up to moderate limits the larger the station and the more business you could do from it, the cheaper would be the rate at which you could supply electric current.

This was all the evidence for the promoters of the St. George's order, and the Committee agreed to reserve their decision and to hear the opposition at the end of the promoters' case for the three orders, which must stand or fall together.

Mr. MILLNER JUTSUM, vestry clerk of Mile End Old Town, examined by Mr. Claude Baggallay, for Mile End, said the City of London Company had asked the consent of the Vestry to the provisional order, but that consent had been refused.

Mr. J. M. KNIGHT, surveyor and engineer, stated that in the negotiations with the company in 1897 it was distinctly contemplated that the generating station should be in the district they proposed to supply.

Mr. BAGGALLAY said if the company had intended in 1897 to supply electricity from St. Luke's station that should have been put into their order. It was not unfair that the local authorities should seek to supply themselves, because the company had never done a stroke of work in the district, and if there should be competition it would be because the company with their eyes open came in and established works in competition with the local authority.

Mr. S. G. RATCLIFFE, clerk to the Limehouse Board of Works (speaking to the Limehouse order), said the Board were strongly in favour of the order promoted.

Mr. C. P. SPARKES, chief engineer of the County of London Company, in support of the company's petition, detailed the steps the company had taken to get a main into the district. In consequence of the opposition of the local authorities they had arranged to carry it along the Regent's canal. The provision they had made would be sufficient to supply in the first instance 500kw. and at a later period 1,500kw., which was amply sufficient for the immediate wants of the district. They had capacity for the needs of the district at their City-road station, which was very favourably situated. Their price began at 7½d. and went down to 3d. for lighting, and for power purposes 2½d. per unit. If they could secure a considerable demand for power, they could reduce very largely the cost of current for lighting. Their rates compared favourably with those in the London district. The lowest rate in London at present was 2½d., but at Manchester and Edinburgh, where there was a large demand for current for power, the price had been reduced to 1½d.

Mr. SYDNEY MORSE gave the history of the company and its various orders. The reason the company had never supplied in the East End district was that they desired to save the expense of providing a generating station, and the local authorities had declined to allow them to put a main from St. Luke's to the East End.

Mr. MOON then addressed the Committee, contending that unless the company could be proved to have neglected its duty, Parliament should not allow the competition of a local authority. Within four months the company could supply the district. They had their plans sanctioned, and had spare capacity at their generating station.

The CHAIRMAN said the Committee would confirm all the orders. The preamble of the bill was then considered and agreed to, and the bill was ordered to be reported.

EAST HAM TRAMWAYS BILL.

On June 29 the Select Committee of the House of Lords, presided over by the Duke of Northumberland, commenced consideration of the bill to confirm the provisional order obtained by the East Ham District Council with regard to tramways.

Mr. HUTCHINSON said the bill would enable the East Ham Council to construct certain tramways within their district. The only opposition arose from the Great Eastern Railway Co. with regard to the crossing of their line on the level by the tramways, which were to be worked by electricity. The railway company alleged that the crossing would be attended with serious danger to the safe working of their line, and asked that it should not be allowed. The Council, on the contrary, held that there was no danger in the crossing, and that it should be allowed.

Mr. CAMPBELL, engineer and surveyor to the Council, gave evidence as to the great need for this line. With regard to the level crossing he pointed out that the trains passed along that line at intervals of about two hours, and the Council held that if the present tramway was authorised the danger attaching to the crossing would not be added to. The trams would run about every 20 minutes, and both trams and trains would run at less frequent intervals as the district further developed.

Mr. STEPHEN SELLON, consulting railway engineer to the Council, drew a number of distinctions between this case and that of Hull. At Hull the crossing was over a line used for goods only, whereas here the line was used for passenger traffic. On a passenger line there was much more protection by signalling on the block system than on a goods line. At the East Ham crossing, therefore, the gates would be under the control of the signalman, and no tram would be able to enter them unless the signal was given that the line was clear. Then, whereas, at Hull there were some 260 trains passing daily (that was a few trains magnified into 260 by shunting backwards and forwards), here there was no shunting, and only seven or eight trains daily. In Hull a three-minute service was talked of; here it would be every 15 minutes or 20 minutes. Further, in the case of Hull, the line was double; in the present case the line would be single.

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Mr. GOODAY, the general manager of the Great Eastern Railway Co, said they objected to the crossing of their line by the tramway on the level. The district was rapidly developing, and the company might have to run a quarter-hour service and a service of night trains. For the reasons stated in the Hull case he held that the crossing was objectionable, and also because of the danger and interference with the regularity of the trains which it might involve. He agreed that there was more danger in irregular working of goods traffic, but it was more serious if accidents occurred on a passenger line. There was, he also agreed, more danger with a double than with a single line of trams.

Mr. JOHN WILSON, engineer of the Great Eastern Railway Co., said a level crossing would always be a source of danger and trouble, especially when, as was likely in this case, the railway line would have to be doubled. From an engineering point of view, there was great difficulty in a light railway, as this was, crossing a heavy railway line, because you could not weld a 25lb. rail up to an 85lb. rail. It would be impracticable to cut a groove in the large rail to take the smaller rail. He objected to a light rail, no matter what it was to carry, over a level crossing.

Mr. HUTCHINSON, in answer to the chairman, said the order provided that the level crossing should only be made with the sanction, in writing, of the Board of Trade. He would prefer to have the provision as to the sanction of the Board of Trade struck out.

The Committee eventually passed the order as it stood, with the Board of Trade provision.

HAMILTON, MOTHERWELL, AND WISHAW TRAMWAYS BILL.

This bill was heard before the Select Committee of the House of Lords, presided over by Lord Ribblesdale, on June 22. The promoters of the bill are the British Thomson-Houston Co. The only opponents were the two railway companies in the district—the Caledonian and the North British.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said the tramways commenced at Blantyre, passing through Hamilton and Motherwell to the centre of Wishaw. The length of line was 8½ miles—5¼ double and 3¼ single line. The tramway would be worked by electricity on the overhead system. The district was a poplous one, and there were from end to end of the line collieries and manufactories. A branch to Larkhall had been originally proposed but had been withdrawn, as in all probability this would be provided by the Caledonian Railway. They were now asking only for the main line from Blantyre to Wishaw, and this application was supported by all the local authorities, the traders, and the employers of labour in the district. It had been proved in Glasgow that by the facilities given by the tramways the population had been carried 171 times in the year—a total of 120,000,000 people—more than was carried yearly by all the railways in Scotland and Ireland. The reason for the railway companies' opposition was simply competition, but competition was really a reason for passing a rival railway and not a reason for rejecting it.

Local evidence having been given at considerable length,

The CHAIRMAN said they had had a great deal of evidence to show that the tramway would perform services which they could hardly expect the Caledonian Railway to perform.

Mr. JAMES STUART, C.E., said his estimate of the cost was £102,820, exclusive of the electrical equipment. The gauge would be 4ft. 8½in., which was the same as in Glasgow. They had agreed to pay to the Hamilton Corporation £11,500 for the purpose of street improvements.

Mr. R. W. HOGARTH (Messrs. Mathew Buchan & Hogarth) said there were no engineering difficulties. He considered the promoters' estimate was sufficient to admit of the constructional work being carried out in a thorough substantial manner in accordance with the best modern practice. The estimate for the electrical equipment was £85,000, which included the generating station, the overhead equipment, and the rolling stock. He had allowed for 20 motor cars, and a number of trail cars, which were attached at certain hours of the day only.

Mr. A. R. MONKS, managing director of the British Thomson-Houston Co., gave evidence as to the financial capacity of the company.

In support of the petition of the Caledonian Railway Co. Mr. PATRICK, general manager, said he did not know any district more fully developed by railways. The Caledonian Company was promoting a loop-line joining the Hamilton and Motherwell branch to their main line near Flemington, which would enable passengers from Blantyre to get to Hamilton, Motherwell, and Wishaw directly. They had had no application for extra trains, and no complaints as to the efficiency of their service. The proposed line was called a tramway, but it was a competing railway made on the public road—a condition which would give the promoters a tremendous advantage. The promoters were entirely foreign to the district, whilst the Caledonian had for many years contributed to the local taxation. They would, in his opinion, lose their money and do the Caledonian Company damage at the same time.

Local evidence was given to show that there was no popular demand for the scheme, and that there was not sufficient traffic to justify the construction of the tramway. After hearing counsel,

The CHAIRMAN intimated that the Committee were of opinion that the preamble was proved. The clauses having been adjusted the bill was ordered to be reported.

LINCOLN CORPORATION TRAMWAYS BILL.

The bill of the Lincoln Corporation to construct additional tramways came as an unopposed measure on Monday before Mr. J. W. Lowther, the chairman of Ways and Means, at the House of Commons. The preamble having been proved, the bill was ordered to proceed to third reading. The bill has already passed through all its stages in the House of Lords.

WESTON-SUPER-MARE TRAMWAYS BILL.

On Friday last the Select Committee of the House of Commons, presided over by Mr. de Tatton Egerton, gave their decision on the last bill confirming the provisional order granted by the Board of Trade to the Weston-super-Mare and District Electric Supply Co. (Ltd.) for the construction of electric tramways at Weston on the overhead trolley system. The Commercial Cable Co. strongly opposed the bill, contending that, as the delicate telegraph instruments at their cable station at Weston would be disturbed by electric leakage currents from the tramway, the tramway company should be obliged to bear any expense incurred in remedying such disturbance.

The CHAIRMAN said: The Committee has taken time to consider the question raised because it is one of grave importance. The question arose as to whether a precedent ought to be established either for or against the report of the Joint Committee of 1893 in connection with the working of tramways. The Committee have decided to pass the preamble of the bill subject to the insertion of a clause as follows:—

"This Act shall not be construed so as to prejudice or interfere with "any rights which the Commercial Cable Co. may by any court of "law having jurisdiction on the matter be held to possess under the "common law, either statute or otherwise, in regard to the uninter- "rupted user or enjoyment of their submarine telegraph cable now "running under the Bristol Channel to Weston, provided always that "the recommendations in the report of the Committee of 1893 in "respect to telephone companies' lines be carried out so far as they are "applicable to submarine telegraph cables."

In reply to Mr. Balfour Browne, Q.C., for the tramways company, the CHAIRMAN said: The Committee felt that they could not create a precedent either for or against the cable company, or alter or vary in any shape the 1893 report, and yet they felt that if they passed the preamble of this provisional order without any reference whatever the cable company in any action that might be taken would be seriously prejudiced by not having something recorded that contained the views of the Committee, therefore the Committee drafted the above clause. They wished to leave the cable company in the possession of every right which they now possessed, and it was not for the Committee to say whether they came within or without the provisions of the clause of 1893.

Mr. BALFOUR BROWNE: If they do come within you want the report to stand?—Yes.

Mr. BALFOUR BROWNE said the promoters accepted the clause suggested by the Committee.

The CHAIRMAN said the only alteration the Committee desired was to strike out the reference to the report of the Joint Committee.

Mr. BALFOUR BROWNE thought the alteration was important, as otherwise a court of law might say the whole report was thrown at it.

The CHAIRMAN said the Committee could not say whether the Commercial Company were or were not under the provisions of the recommendations of the Committee of 1893. They therefore desired, in the event of litigation, that the tramway company should not be able to plead statutory powers. The Committee proposed to embody in their report to the House the following:—

"In the course of the proceedings the attention of the Committee "was called to the position of cable companies in relation to other "electric undertakings, and it was sought to affirm that they were "under the provisions of the model clause based on the report of the "Joint Committee of the House of Lords and the House of Commons "on Electric Powers (Protective Clauses) issued in July, 1893. The "Committee declined to give a decision upon a point involving such "great national interests, and recommend that it should, with "other matters involving electrical interests, be again considered "by a similarly constituted Committee as has already adjudicated on "the subject."

The clause suggested by the Committee for the protection of the legal rights of the Commercial Cable Co. was, with the omission of the reference to the report of the Joint Committee on Electric Powers, added to the bill, which was ordered to be reported as amended.

WARRINGTON TRAMWAYS BILL.

The bill to confirm the order obtained by the Corporation of Warrington with reference to tramways came before the Select Committee of the House of Lords, of which the Duke of Northumberland is chairman, on Tuesday.

Mr. RAM said the object of the order was to enable the Corporation to construct tramways to be worked electrically. Of late much had been done in the borough in the way of street widening to render feasible a system of tramways. Several attempts had already been made to establish tramways, but without success, and the Corporation, therefore, were decided to move. Tramway No. 10 was the most important section, and at one place it crossed on the level of the line of the London & North Western Railway Co. That company objected to the crossing, alleging that it would be a constant source of danger, most prejudicial to the working of the traffic on the railway, and that the tramway was unnecessary, and not required in the public interest.

Major CARDEW (Messrs. Preece and Cardew) said the original scheme had been modified by the Board of Trade, particularly as regarded tramway No. 10. The board required, as a condition of power being taken, to construct a crossing on the level that their consent in writing should be first obtained. Speaking from past experience he said it would be perfectly practicable to carry out the promoters' intention in crossing the railway and working the proposed traffic. They did not expect to be able to run a quick service of trams, and they would undertake to pass the crossing at a walking pace.

Other evidence having been called for the bill,

Mr. MOON, on behalf of the London & North Western Company, said it could not be contended that the crossing of a railway on the level by an electric tramway could be unaccompanied by danger to the public. If the

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bill were carried the traffic would increase, and so the danger would be intensified. If the Committee thought the tram should pass the railway at all he submitted it should be by a bridge, the whole cost of which should rest on the promoters.

Eventually the Committee passed the preamble, allowing tramway No. 10 as proposed, but adding a proviso that if the Board of Trade should order a bridge to be made the Corporation of Warrington should contribute half the cost.

SOUTHAMPTON TRAMWAYS BILL.

On Monday, the Select Committee of the House of Lords, of which the Duke of Northumberland is chairman, considered the bill to confirm the tramways provisional order granted to the Corporation of Southampton.

Mr. G. M. FREEMAN said this was an order authorising the Corporation of Southampton to construct additional tramways in the borough. By a local act of 1897 the Corporation were empowered to acquire tramways which had been previously in the hands of a private company, and to work them by mechanical power, and to spend £30,000 on the undertaking, including purchase; and having acquired the undertaking, they determined to equip it electrically on the overhead trolley system. They found it would be essential to extend the lines considerably. They obtained the consent of the Board of Trade to a large scheme, which had been approved by everyone except Messrs. Smith, a firm of drapers, who objected to a small portion of line. Messrs. Smith notified their objection to the Corporation, who decided not to work the line. Notwithstanding this, the petitioners had thought fit to commence an action in Chancery in regard to this piece of line and to pile up costs.

Eventually the Committee passed the preamble of the bill, an arrangement being come to with the petitioners.

GARSTON TRAMWAYS BILL.

On Tuesday the Duke of Northumberland's Committee of the House of Lords considered a bill confirming the provisional order granted to the Garston and District Tramways Co. (Ltd.).

Mr. WEDDERBURN, Q.C., for the company, said Garston was a residential suburb of Liverpool, and was a place of considerable commercial importance, having large docks and a large population. The original order for a tramway was promoted by a company, and it was opposed at first by the Garston District Council with a view to obtaining terms. Eventually an agreement was come to, under which the company, having obtained powers, were to construct a tramway; the company were then to sell the tramway to the Council, the price to be paid at the end of 21 years, the object being that the Council should not now have to raise money, which would not suit them; then, the company having sold, the Council were to lease the tramway to the company for 21 years, the company paying the Council £300 a year by way of rent. The result was that the Council need not borrow now. The £300 was intended partly as a contribution to the Council to enable them to meet the increased cost of keeping up the sides of roads which would result from the trams running along those roads. There was only one opponent, the Lancashire County Council, and they did not oppose the preamble but only sought to obtain certain clauses. The tram ran on a main road, and the District Council, having taken over powers from the County Council as road authority, received from the County Council a contribution in respect of the up-keep of that road. The County Council said that while the District Council was receiving this rent from the company, partly for the upkeep of the road, and the extra expense which would be caused by the trams, under the agreement they might spend the rent on anything they liked – there was no guarantee that they would spend it on the road. They therefore suggested that they should be given the £300, or such portion of it as would represent the increased cost of maintenance of the road due to the tramways. He urged, however, that the County Council had no *locus*.

Mr. FORBES LANKESTER, for the County Council, said the cost of the ordinary repairs and maintenance of a main road, whether the main road was vested in the County Council or in the local council, fell on the County Council, and it seemed therefore absolutely unarguable that if the County Council had to bear the extra cost, which it was admitted was incurred in the maintenance of these roads in consequence of the tramway, the District Council should not be able to object.

The Committee admitted the *locus* of the County Council.

Mr. FORBES LANKESTER said he would admit the preamble of the bill.

Mr. LESLIE said the trams would run for about 2 miles through a populous district, and that they had met with no opposition.

The Committee agreed to insert a clause to the effect that the amount which the County Council would, after the tramways were constructed, have to pay to the District Council should be reduced by £300 per annum for 21 years, that being the sum which the District Council under their agreement would receive from the company.

SOUTH-EASTERN METROPOLITAN TRAMWAYS BILL.

This bill, which authorises the conversion of the existing horse-tramway between Greenwich and Catford into electric lines to be worked on either the electric surface contact or electric trolley system, and which has already passed the House of Commons, was to have been considered yesterday by the Committee of the House of Lords, presided over by Lord Rosse, but it transpired that the opposition of the London County Council, asking for a veto on the system to be adopted, had been withdrawn, but on what terms was not stated. The bill, therefore, becomes an unopposed one, and will go before the Earl of Morley's Committee in the usual course.

THE SOUTH STAFFORDSHIRE TRAMWAYS BILL.

This bill, which has already passed through the House of Lords, was considered by the Unopposed Bill Committee of the House of Commons on Wednesday. The bill authorises the South Staffordshire Tramways Co. to sell and transfer portions of their undertakings to local authorities, to confirm a lease of their undertaking to the South Staffordshire Tramways (Lessee) Co., to re-arrange their capital, and for other purposes. The preamble having been formally proved, the bill was ordered to be reported for third reading.

SOUTH LANCASHIRE TRAMWAY BILL.

The protective clauses inserted in this bill at the instance of the local authorities, and which were excised in the House of Lords, have been re-inserted. Consequently the bill will now be treated as practically unopposed.

VALE OF RHEIDOL LIGHT RAILWAY BILL.

This bill, which seeks, *inter alia*, powers to alter the system of traction from steam to electric on the railway, came as an unopposed measure before Lord Morley's Committee at the House of Lords on Monday, and was ordered for third reading.

ELECTRICITY AND POTATO CULTIVATION.

In the House of Commons on Tuesday, Mr. AUSTIN asked if the attention of the Vice-President of the Board of Agriculture and Technical Instruction for Ireland had been directed to a series of experiments made by Mr. O'Sullivan, of Athea, Limerick, with a view of improving the present method of potato growing; whether he was aware that under this new system an increase of 80 per cent. in the crop was shown; and would the Department cause inquiries to be made into the matter.

Mr. PLUNKETT said his attention had been called to the experiments referred to, and he gathered that Mr. O'Sullivan attributed the extraordinary increase in his potato crop to the action of electricity introduced through lightning conductors and distributed through the crop by means of wires. As both the parish priest of Athea and the county surveyor of Limerick are satisfied both as to the effect and the cause of this remarkable phenomenon, he (Mr. Plunkett) had arranged to have inquiries made by the Land Commission on behalf of his Department.

LEGAL INTELLIGENCE.

Corporation of Hyde v. Oldham, Ashton & Hyde Electric Tramway (Ltd.), British Electric Traction (Pioneer) Co. (Ltd.), British Thomson-Houston Co. (Ltd.), and British Insulated Wire Co. (Ltd).

This case came before the Court of Appeal, composed of Lords Justices A. L. Smith, Vaughan Williams, and Romer, on Wednesday and Thursday on the appeal of the defendants from the judgment of Mr. Justice Grantham dated July 3, 1899. (The case was reported in *The Electrician* of July 7, 1899.) Plaintiffs in the action claimed an injunction restraining defendants from breaking open the footways in certain main thoroughfares of the borough of Hyde and laying thereunder electric cables for the purpose of working tramways which the defendants had constructed. The plaintiffs also claimed damages. Mr. Justice Grantham granted the injunction as claimed and awarded plaintiffs £100 damages, and from this decision the defendants now appealed.

Mr. Cripps, Q.C., and Mr. Bartley Dennis appeared in support of the appeal, and Mr. Macmorran, Q.C., and Mr. Sutton opposed it.

It appeared from the statement of Mr. Cripps that by the Tramways Orders Confirmation (No. 2) Act of 1896, Oldham, Ashton-under-Lyne and Hyde District, the British Electric Traction (Pioneer) Co. were authorised to construct the tramways in question, and the Oldham, Ashton & Hyde Electric Tramway (Ltd.) were their successors, the other defendants being the contractors employed to do the work. The plan for the construction of the tramways authorised by the Board of Trade under sec. 24 of the Act of 1896 involved the laying down of cables or feeders under the footways of the streets traversed. Disconnecting stations were authorised to be erected on the curb of the pavement at intervals of between a quarter and half a mile by means of which electric current might be disconnected from any section of the overhead wire. In July, 1898, plaintiffs received notice from defendants of their intention to open the ground of the streets along which the tramway was to pass for the purpose of laying the electric supply mains, &c. Defendants had undertaken to pay £500 towards the cost of widening certain streets, but plaintiffs declined to allow feeders to be laid under the footway unless defendants agreed to pay a further £500 towards widening the streets. Defendants, however, declined to pay any more, and claimed to be entitled to lay the feeders under the footways without the plaintiffs' consent by virtue of sec. 3 and sec. 25 of the Tramways Act, 1870, and their provisional order.

Lord Justice SMITH: The Mayor of Hyde said, "You can only put your wires under the roadway," and you say you can put them under the roadway plus the footway?

Mr. CRIPPS: Yes. The Corporation of Hyde said "We do not want to raise any question about that if you pay us another £500." I say we have a legal right to do it. I also say that if we did it wrongfully the plaintiffs are not entitled to an injunction, and that there ought to be no damages. Those are the two points I have to argue. The contention of

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defendants in the Court below was that the term "road" mentioned in sec. 3 of the Act of 1870 was not limited to the carriageway, having regard to the defendants' second provisional order, which incorporated the Tramways Act of 1870. What the defendants did was to put certain pillars or posts, which were necessary to carry out the obligation of working the tramway imposed by the Board of Trade on the footway. That the defendants were entitled to do. But the defendants had to connect their wires with these posts, which was an essential part of their system, and therefore to a certain extent they had undoubtedly to carry their wires under the footways, as otherwise they could not have connected them with the posts. There is no contest on the point that in order to have an overhead system you have to have underground feeders.

Lord Justice ROMER: Yes; but there is no reason why these underground feeders should not be in the roadway.

Mr. MACMORRAN said that the posts were on the kerb, and to that the plaintiffs did not object; but they did object to the cables running under the footway, as it was constantly necessary for the defendants to take up the footway for the purpose of repairing them. The plaintiffs did not object to the feeders being under the roadway, but they said there was no reason why there should be underground wires under the footway at all.

Mr. CRIPPS: What is really the case here is that the Board of Trade have made these underground feeders an essential part of the defendants' system of tramway.

Lord Justice SMITH: Not necessarily under the footpath.

Mr. CRIPPS: But you must go under the footpath to a certain extent in order to get at the posts. Of course, my learned friend can say, "You must show power to do it," and my case is that having regard to the requirements of the Board of Trade and the posts with which the underground feeders must be connected, being on the footway, we cannot avoid the footway altogether in laying down these feeder wires for the overhead electric wire system in connection with tramway electric traction. The House of Lords had laid it down that the sub-soil was not vested in the local authority and was not a portion of the Corporation property. The defendants had as much right to put feeders there as the plaintiffs had the right to put gas pipes. The plaintiffs were not trespassers as the soil was not the plaintiffs. The plaintiffs were, therefore, not entitled to a mandatory injunction.

Mr. DENNIS, on the same side, submitted that if the injunction were granted it would be to the injury of the plaintiffs. Admitting the defendants were wrong and had to alter their system and put up overhead wires, that would be an eyesore to the public and an injury to the plaintiff. Were the plaintiffs and the public to be injured simply because the former might have a bare legal right?

Lord Justice SMITH: It is for the plaintiffs to judge of that.

Mr. DENNIS: It is for the Court to consider what the effect of granting an injunction would be. He submitted, in any case, that the circumstances here were not such as to warrant an injunction being granted.

Without calling upon counsel for the respondents, Lord Justice Smith, in giving judgment, after stating the facts, said the real point in the dispute was this: Could the tramway company justify breaking up the footway and putting in an electric feeder along the footway, under the Tramway Act of 1870 and the Order in Council? Mr. Justice Grantham had found they could not, and he (Lord Justice Smith) thought he was right in his finding. The Tramway Act of 1870 only applied to laying down tram lines in roadways. He could not see that it had any application to laying down electric feeders under the footpath. Then the defendants justified their conduct under the order in Council; one paragraph in particular of that order was relied upon by defendants as giving them power to lay under the footway electric feeders or cables along and underneath the footways of the borough.—Did it? The paragraph stated that under the provisions of this order the promoters might place and maintain on any street or road in which any of the tramways might be laid such posts and overhead wires as might be necessary for working such tramways. What was the meaning there? Was that authority to lay down a cable or electric feeder underneath the soil, or was it power to lay down something overhead and above the soil? He could not read it as meaning anything other than such posts and "overhead electric wires." He could not find any justification in the order in Council for what the defendants had done, or in the Tramway Act of 1870, against the will of the plaintiffs. He thought that Mr. Justice Grantham was right in granting a mandatory injunction because the evidence showed that, in spite of the objection of the plaintiffs, the defendants went on and persisted in laying down the cable under the footway. He thought that Mr. Justice Grantham's decision must be affirmed.

The other Lords Justices concurred, and the appeal was accordingly dismissed, with costs.

[Mr. Justice Romer during his remarks agreeing with the other Lords Justices read out a modification of the injunction which was accepted by the parties, it being stated by Mr. Cripps that the modification ordered by the Court of Appeal gave him hope that the parties would now be able to come to terms.—ED. *E.*]

Berry, Harrison & Co. v. Lockwood.

This case was heard in the High Court by Mr. Justice Bruce and a jury on Friday last.

Mr. FRANK DODD, Q.C., said the action was brought to recover £172, balance of an account for work done at the Garrick Theatre. The defendant was lessee of the theatre, and in December, 1899, he was about to produce "Puss in Boots." In one of the scenes a good deal of electric lighting was required, and plaintiffs carried out the work and put in the necessary fittings. In doing the work the requirements of the County Council, the Charing Cross and Strand Electricity Supply Corporation, and the insurance company had all to be complied with. The work was essential to the proper production of the scene and to the play. The defence was that the charges were excessive, but owing to defendants frequently requiring the stage for rehearsals and interfering with the work the charges were naturally increased. For materials and fittings the plaintiffs had not, in fact, charged the full list prices. Another defence was that defendant was only managing director of the Theatrical Production Syndicate (Ltd.), of which plaintiffs never heard until after the work was done. While the work was being done plaintiffs asked for a cheque on account and received one from defendant for £40. The full account of £212 was afterwards rendered and the balance was now sued for.

Mr. ERNEST L. BERRY corroborated counsel's statement.

In the result the jury found for plaintiffs for the amount claimed, and judgment was entered accordingly with costs.

A. Shanks & Son (Ltd.) v. Globe Electrical Co. (Ltd.).

This action was heard by Mr. Justice Grantham and a special jury on Monday and Tuesday (July 2 and 3). Mr. Scott Fox, Q.C., for the plaintiffs, said the action was brought to recover £120 on a bill of exchange of which the plaintiffs were drawers and holders, and which had been drawn upon and accepted by defendants, the Globe Electrical Co., London, with whom were joined the London & District Bank (Ltd.), as the plaintiffs alleged they were the same people. The real issue the jury would have to try was as to the constitution and reality of the Globe Electrical Co., because there was no dispute that plaintiffs had supplied a considerable quantity of machinery, value over £400, of which about £300 had been paid, leaving £120 due, for which this bill was given. He did not think it would be denied that the Globe Company had contracted to pay. The question was, who were they? Plaintiffs said they were the London & District Bank.

Mr. FOOTE, Q.C., for the defence, called evidence to prove that the London & District Bank had no connection with the Globe Electrical Co., but, on the contrary, had lost about £1,000 money lent to the man (Inrig) who traded under that style. The jury found for the defendant bank and judgment was given accordingly, with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Asylum Lighting.—A report by the Visiting committee of the Kidderminster Guardians in favour of the introduction of electric lighting at the asylum has been referred back.

Birstall.—The Council have been notified by the North British Electric Supply Co. of intention to apply for a provisional order.

Bolton.—Apparently the Corporation cannot appreciate a good servant until he is about to leave them. It is stated that the borough electrical and tramway engineer (Mr. Arthur Ellis), who was recently appointed electric tramway engineer at Cardiff and who proposes to take up his new appointment on Sept. 1, has now been offered an increase in salary of £150 per annum, in order to induce him to remain at Bolton; but Mr. Ellis points out that, having entered into an undertaking with the Cardiff Corporation, he cannot now honourably withdraw.

Blackpool.—An expenditure of £9,300 on new electric tramcars has been decided upon.

Bradford.—The Electricity committee recommend the Corporation to apply for sanction to a further loan of £140,000 for extensions to the Canal-road distributing station, for laying down additional mains, and for the erection of a new generating station.

Carnarvon.—The Council have referred a project for the erection of electricity works and for the construction of a light (electric) railway to a committee for consideration.

Cheltenham.—An inquiry was held on Friday into the application of the Corporation to borrow, among other sums, £20,100 for electric lighting extensions. The loan will be applied as follows: Extension of mains and new sub-stations, £914; street lighting, £2,530; house services (meters and fuse boxes), £365; cable boxes and labour, £165; transformers (ten 50kw.), £1,300; contingencies, £710; and alteration of voltage from 100 to 200 (already done), £2,100. Previous loans amounted to £101,952, of which £93,000 has actually been spent. The borough electrical engineer (Mr. Hamilton Kilgour), in support of the application, said the works were started in 1895, and in January last were supplying current to the equivalent of 22,650 8 c.p. lamps. At present there were 24,200 lamps connected, and in addition 212 arcs and 16 incandescents were used for street lighting. For the year ended March the trading profit was about £3,320. He said the change of voltage had involved the free supply of something like 5,600 new lamps, the supplanted ones being practically valueless. The change, however, had considerably increased the value of the undertaking. The result of the contemplated extensions would, he believed, be to raise the top load next Christmas to about 700kw., against a present top load of 300kw. Some of the new machinery was necessary in view of the expected demands for the proposed electric tramway to Cleeve Hill. The total length of the existing cables was between 60 miles and 70 miles, and there was a reasonable expectation of demands for the light coming in which would justify the extensions contemplated. Of the 10 new sub-stations three had already been erected; the sites for the others had not been definitely fixed. There was no opposition.

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City of London.—The Streets committee has been authorised to remove all derelict and unidentified wires in the city, under the London Overhead Wires Act (1891) and the City Laws (1892).

Clewer (Windsor).—The Windsor Electrical Installation Co. have notified their intention to apply for a provisional order.

Croydon.—An extension of the arc lighting along the whole of the tramway route, from Norbury to South Norwood High-street, and to the Lower Addiscombe-road terminus, at an estimated cost of £3,360, has been sanctioned.

Derby.—The Corporation, on Wednesday, decided to lay electric lighting mains to the infectious diseases hospital at a cost of £850. The Tramways committee were instructed to prepare a scheme of electric tramways for the borough, and to take steps to obtain the necessary parliamentary powers.

Dover.—The Council propose to renew the electric lighting of the sea-front with festoons of incandescent lamps during the season. The terms of the Dover Electricity Supply Co., which is supplying current, are £45 for installation, maintenance, and removal, and £20 weekly for the supply of current for 14 hours per week. Additional hours to be at the same rate.

East Grinstead.—Mr. Robb, who recently submitted an electric lighting scheme for the town, has been asked to supply further details.

Edinburgh.—At a sitting of the Electric Lighting committee, on Tuesday, it was decided to recommend the Council to accept a tender, amounting to over £3,000, for coal-conveying plant for the McDonald-road electricity station. The question of providing a condensing tower was referred to a sub-committee.

Electric Driving for Printing Machines.—According to the printing trade journals a noticeable feature of the printing exposition and fair held recently at the Grand Central Palace, New York City, was the application of the electric motor to all classes of printing machines and apparatus.

In the United States Government new printing offices at Washington there will be installed 7,000 incandescent lamps, the whole of the building is to be ventilated by electrically-driven fans, 12 electric elevators have been provided, and all the printing presses are to be run by electricity, the larger-sized machines being provided with independent motors. Current will be generated from plant installed in the works.

Electric Power Schemes in Australia.—A company entitled the Victoria Light, Heat & Power Corporation has been formed for the purpose of supplying electric current for lighting, traction and power in the suburbs of Melbourne within a 10-mile radius. It is estimated that a capital of £7,000,000 will be required for the undertaking. It is proposed to supply current for driving in factories in the metropolitan area. The tramway scheme includes a tunnel under the Yarra, to cost between £60,000 and £100,000, and the tramways are to be taken across the Williamstown railway line. The Williamstown Council has referred the matter to a committee.

Electrical Enterprise in Italy.—Statistics issued in the *Gazetta Ufficiale* (Rome) of June 8 give the total length of electric tramways in Italy on Jan. 1 last as 1,974 miles, distributed as follows :—

Lombardy	653 miles.	Sicily	63 miles.
Piedmont	561 „	Apulia	39 „
Emilia	278 „	Campania	38 „
Venice (Province)	150 „	Other Provinces	69 „
Tuscany	123 „		

Fleetwood.—Electric current is now available, and the esplanade was illuminated for the first time last evening by arc lamps.

Glasgow.—In our last issue we gave a brief extract of the accounts of the Glasgow tramways department for the year to May 31. The revenue from the electric cars has been maintained at nearly 14d. per car mile, the total receipts from the section for the year amounting to £53,711. 18s. 8d. The following figures show the operating expenses per car mile by horses and by electricity :—

Power	3·78d. horse.		0·92d., electric.
Traffic	3·05d. „		3·00d. „
General	0·67d. „		0·70d. „
Maintenance	1·32d. „		1·64d. „
	8·82d. „		6·26d. „

Under the heading power for horse traction are included cost of feeding, wages of stablemen, veterinary expenses, shoeing expenses, for electric traction, wages in power station, coal, and other sundry expenses at the power station. In addition to this saving in expenditure there is a large increase in revenue from the electric cars. The balances from the horse and electric traction accounts (£125,243. 19s. 8d.) have been carried to net revenue account. The tramways department borrowed during the year £345,000.

Grantown (N.B.).—The Police Commissioners are divided on the electric lighting question, some members favour the erection of municipal works and others prefer that a company should come in. Reports from Messrs. Lyon & Crosbie and Mr. Druitt Halpin were discussed at a special meeting of the Commissioners last week. Messrs. Crompton & Co. also offered to established electricity supply works at their own cost and risk. They would bear the expense of obtaining a provisional order and would supply current for lighting at 8d. per unit for the first hour and 5d. after. On a division the Commissioners were equally divided, and the chairman declining to give his casting vote, the matter remains in abeyance.

Halifax.—The Corporation on Wednesday considered a recommendation to increase the salary of the electrical engineer from Oct. 1 next. Dr. W. Smith moved an amendment that the matter be referred back. Ald. Spencer strongly urged the Council to approve the proposed increase ; Mr. Street was well worth the money, and their electrical department required and must have a capable chief. Mr. J. W. Hartley pointed out that their engineer had turned a loss of £800 into a profit of £5,000. Comparing the salaries paid by other towns of similar output, his salary was a low one. They drove a good man away in Mr. Wilmshurst, and now they were trying by their policy of so-called economy to drive another away. The amendment was carried by 22 votes to 19. Another amendment, however, moved by Ald. Spencer, to delete all reference to an advance to £500 in twelve months, and to confirm the proposed advance to £400, was eventually carried by the mayor's casting vote.

Heswall (Cheshire).—The Heswall Gas & Lighting Co. intend to apply for a provisional electric lighting order for Heswall, Barnston, Pensby and Gayton.

Hornsea.—A special meeting of the Council will be held on 16th inst. to consider particulars regarding the proposal to construct a light (electric) railway between Hornsea and Driffield, and also to establish electricity supply works for lighting and power in the town. Messrs. Bennett and Ward-Thomas are consulting engineers for the scheme.

Hornsey.—On Monday the Electricity committee reported that they had further considered the electric lighting question, and advised the Council to decline the offers received for a transfer of their provisional order. They recommended the Council, subject to modification of details, to carry out the scheme recently prepared by Mr. Robert Hammond, involving an expenditure of £73,350, to apply for the necessary borrowing powers, and to appoint Mr. Hammond consulting engineer. The report was, after discussion, adopted.

Hull.—A sub-committee has been appointed to report upon the advisability of reducing the price of electric current for power.

Ilfracombe.—The question of transferring the Council's electric lighting order to a company is under consideration by the General Purposes committee.

Kirkcaldy.—The Council have considered the report of their consulting engineer (Prof. A. B. W. Kennedy) on the electric lighting and traction project. In connection with the tramway scheme, the report was remitted back to enable the committee to report upon the relative cost of alternative routes.

Leamington.—Acting on the advice of the General Purposes committee, the Council have offered to purchase the undertaking of the Midland Electric Light & Power Co. for £17,000. The committee obtained a report on the value of the undertaking from Mr. Horace Boot, of Tunbridge Wells.

Light Railways.—The Bromsgrove Light Railway order has been submitted to the Board of Trade for confirmation. Objections by July 21.

The chairman of the Tramways committee (Mr. Boyle) explained at the Corporation meeting on Wednesday the provisions of the agreement made between the committee and the Manchester Tramways & Carriage Co. He said the main purport of the scheme was that they recognised at once, in view of the fact that they had had to face the reconstruction of the whole of the lines—a thing which they had not anticipated at the time the committee was formed—and in view of the difficulty of getting materials, overhead equipment and cars, that they would not be able by the date when the lease expired to take over the system and work it by electricity. The present proposal was that they should make an agreement with the company whereby, before the expiration of the lease the committee should be at liberty to enter upon the work of reconstruction, and thus be able to take over the lines as they became ready. That would mean that they would have electric traction on some routes at an earlier period than would otherwise be the case. The committee had guaranteed to the company up to May 31, 1902, the profits that had been made previously. If, after May 31, 1902, the committee were not ready to take over any lines, and if there should be any sections still unequipped from that date the committee guaranteed that the company should be paid by mileage in respect of those lines they still worked. After discussion the agreement was approved.

Messrs. Bennett & Ward-Thomas have notified the Carnarvon Council, on behalf of a syndicate, that they propose to apply, under the Light Railways Act, for permission to construct a light (electric) railway from Carnarvon to Bethel, Ebenezer and Bethesda, with a

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branch to Dinorwic. It is also proposed to construct a light railway from Carnarvon to Dines Dinlle.

The Duke of Cambridge has intimated his intention to oppose the application of the British Electric Traction Co. for power to construct an electric tramway from Kingston Vale to Esher. The Surrey County Council and the Kingston Corporation, who have rival schemes, will also oppose.

London County Council.—At Tuesday's weekly meeting it was agreed that the Council should exercise its right to require the London, Deptford & Greenwich Tramways Co. and the South London Tramways Co. to sell their undertakings to the Council.

Electricity loans of £20,000 to Poplar, of £5,147 to Battersea, and of £6,935 to Islington were approved. Application has been made by the Strand District Board for a loan of £1,500 repayable on the annuity system within 10 years for the purchase of two motor vans for dirt collecting and street watering. The Finance committee recommended that the application be granted. Mr. SPOKES asked if there was any precedent for such a loan?—Mr. BRUCE said there was no precedent. The committee had reports from its officers that such a loan could properly be made. The recommendation was carried.

Manchester.—The accounts of the Electricity Department for the year ended March 31, now issued, show the total number of units accounted for amounted to 6,468,405, an increase of 24 per cent. over the previous year. The consumers numbered 3,240, an increase of 670. 47 miles 530 yards additional mains were laid, making the total 110 miles 45 yards. Revenue derived from sales of current, &c. (which works out at 3·20d. per unit), amounted to £86,297. 18s. 4d., and working expenditure to £49,905. 11s. 6d., showing a gross profit of £36,392. 6s. 10d. From this is deducted £27,199. 15s. 5d. on account of interest and sinking fund, leaving a net profit of £9,192. 11s. 5d. This surplus, together with £2,000 from last year and £572. 6s. 5d. interest on reserve fund investments, making a total of £11,764. 17s. 10d. has been appropriated as follows:—In aid of rates, £10,000; reserve, £1,764. 17s. 10d. The total capital expenditure was £641,821. 18s.; mortgage debt, £556,278. 9s.; mortgages redeemed to date by action of sinking fund, £49,232. 11s.; balance at credit of renewals suspense account, £335. 4s. 5d.; ditto reserve fund, £13,360. 15s. 2d. Owing to the necessity for renewing a considerable length of mains which had proved defective, the charge upon revenue for repairs and renewals of mains was £7,453. 10s. 6d., against £1,495. 12s. 6d. last year. In addition, £12,459. 10s. 6d. had been taken from the renewals suspense account to cover similar expenditure. The accident at the Dickinson-street station, in September last, did considerable damage, and the sum withdrawn from reserve on account of the breakdown was £7,069. 18s. 1d. The Committee are pushing forward the equipment of the Bloom-street station in order to meet the increasing demand for electrical energy, and to be ready to supply current for working the tramcars. Plans have been approved for the equipment of a part of the Stuart-street station. Considerable progress has been made during the year with the laying of electric mains in Withington, Moss Side, and Levenshulme. Current has been available in portions of Moss Side since December, and in Withington since February last. On Sept. 30 the price of electric current to long-hour consumers was reduced from 1½d. to 1¼d. per unit, and a similar reduction was made in the price for motor power.

Malton (Yorks.).—The agreement with the Northern Electric Supply Association in connection with the proposal to establish electricity works has been signed.

Market Harborough.—A communication has been received from a company asking for sanction to a proposed application for a provisional order.

Marriage.—On Wednesday, at Knaresborough, Mr. C. A. Midgley, city electrical engineer to the York Corporation, was married to Miss Marguerite Emily Simpson, only daughter of Mr. G. E. Simpson, of York and Knaresborough.

Matlock.—Notice of intention to apply for a provisional order has been given by the North British Electric Supply Co.

Melrose.—Messrs. Crompton & Co.'s proposals for the erection of electricity supply works in the district have been approved, and their application for a provisional order will not be opposed.

Municipal Telephony.—A special meeting of the Norwich Town Council was held on Tuesday, when it was decided to approve the application of the Norwich Mutual Telephone Co. for a telephone licence for the Norwich area. The agreement with the company provides for the supply of a constant and continuous telephone service at low rates; that no preference be given to any subscriber; that a reduction be made for the cost of telephonic service to subscribers when the company's receipts exceed a specfied aggregate amount; that the Corporation, under sanction of the Postmaster-General, may purchase the plant compulsorily on Dec. 31, 1911, or Dec. 31, 1916 (in 1911 at fair market value as a going concern, with an additional sum equal to three years' profits in addition; in 1916 on the same terms, but with two years' profit in addition); that, subject to any prior rights of the Postmaster-General, the Corporation be able to purchase at the revocation or determination of the licence; that the company does not assign, underlet, or otherwise dispose of the licence; that the Corporation be represented on the board of the company by two directors; that wayleaves, poles, tubes, &c., be allowed subject to direction of the city engineer; that the Corporation may determine the agreement if a telephone exchange for 200 subscribers and with 3 miles of cable is not laid down in three years, or in the event of failure to perform other conditions of the agreement, or if the company is ordered to be wound-up. The subject was discussed at considerable length by the Council on Tuesday, when it was resolved that the whole of the plant and appliances of the Company should be new and of the most modern and approved description, and that it shall not be competent for the company to acquire or utilise the business or any part of the plant or appliances of any other firm or company.

Owing to the limited success of the circular canvass the Grantham Council has now decided to make a personal canvass of ratepayers to ascertain the number of probable subscribers to the suggested municipal telephone exchange.

Obituaries.—We have to record the death of Mr. Henry Reason, managing director of the Reason Manufacturing Co, which recently took place at Rockhampton, Queensland. In company with Mr. Arthur Wright, Mr. Reason left England some two months ago for Australia, in order to report upon the proposal to establish electricity generating works at Brisbane. The two gentlemen intended to return home by way of America, in order that they might perfect their knowledge of the different electric light installations in force in the principal towns of the United States. Mr. Reason was the founder of the Reason Manufacturing Co. of Brighton (from small beginnings) in 1887. Mr. Reason was only 37 years of age, and leaves a widow but no children.

The death is announced of Sir Robert Murdoch Smith, director of the Museum of Science and Art in Edinburgh. Sir Robert was born at Kilmarnock in 1835, and was formerly a major-general in the Royal Engineers. His principal work was connected with the development of Indo-European telegraphs, especially the Persian Gulf section, and after many years' experience as director-in-chief of the Indo-European Telegraph Department, he was sent to Persia in 1887 on a special Foreign Office mission, and for this was created a K.C.M.G.

We have also to record the death of Mr. Montagu Charles Dent, A.M.I.E.E. (Messrs. Wallis-Jones & Dent), which took place on June 28, after a short illness subsequent to an internal operation. Mr. Dent was educated at Eton and King's College, and from 1892 to 1894 served his time with Messrs. Robey & Co. and at the Loughborough works of the Brush Company from 1894 to 1896. During 1896 and part of 1897 he was employed on installation work at Arundel Castle, on central station work at the Wandsworth electricity station, and in the erection of the exhibition plant at Earl's Court. In October, 1898, he joined Mr. Reginald J. Wallis-Jones in partnership as consulting engineers, and carried out several important installations of electric light and power plants.

The death is announced of Mr. Arthur Albright, senior partner of Albright & Wilson, chemical manufacturers, of Oldbury. Mr. Albright, had reached his 90th year.

The death is also announced of Mr. James Doulton, of Lambeth Pottery, London, S.E.

Padstow.—The Lighting committee has been instructed to report upon the advisability of adopting electric lighting.

Pickering.—The Council will on Monday meet representatives of an electricity supply company which proposes to apply for a provisional electric lighting order for the district.

Provisional Order Transfers.—The Board of Trade have approved the transfer of the Bridgend Provisional Electric Lighting order to the English Industrials (Ltd.).

The transfer of the Lewes Electric Lighting Order (1898) to the County of Sussex Electric Power Distribution Co. was formally sealed on Wednesday.

Ripon.—The Council considered, on Thursday last, a proposal to erect electricity works. Some members of the Council favour the introduction of electric light, and "for the present, at all events, the introduction of a scheme by a company will be opposed."

Salford.—The Corporation had before them on Wednesday a report from the Tramways committee on the negotiations with the Manchester Carriage & Tramways Co. in regard to the future working of the tramways in the borough. The Corporation were recommended to discontinue negotiations with the company for the working of the tramways in Salford and Eccles and the Swinton and Pendlebury districts after April 27, 1901, and that steps should be taken at once to enable the Corporation to work the tramways after that date by horse traction until such time as arrangements were completed for electrical working. After discussion this was agreed to, and the Tramways committee were instructed to prepare plans and estimates.

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Southport.—An inquiry was held here last week into the application of the Council to borrow £9,200 for electric lighting extensions and £13,000 for a refuse destructor. It was also stated that the Corporation had power to borrow £138,500 for electricity supply, and up to March had spent £100,136. They were putting down continuous-current plant for the supply of current for the new electric tramways. They were also prospective customers in the Southport Pier Co., which runs a tramway on the pier, the promoters of the Ormskirk light railway, and the Southport and Lytham tramways, and also in the Lancashire & Yorkshire Railway Co., who contemplate the erection of a new station at St. Luke's.

A Board of Trade inquiry will be held on 17th inst. into the application of the Corporation to borrow £40,000 for re-constructing the tramways recently purchased from the Birkdale & Southport Tramways Co.

The first official trial trip over the new electric tramway route—from London-street to Blowick—took place on Friday last. The Board of Trade inspection of the line takes place on the 17th inst., and the formal opening has been fixed for the following day.

Stretford.—The Council have approved the agreement with Manchester for leasing the local tramways for 21 years. The lines are to be converted to electric traction and worked in conjunction with the Manchester Corporation tramway system.

Sunderland.—The fifth annual report of the Electricity Department has been issued. On March 31 the equivalent of 35,024 8 c.p. lamps were connected, an increase of 36 per cent. in the year. The number of units sold had advanced from 472,343 to 640,079, 35 per cent. The gross profit on the 12 months was £4,047. 6s. 4d., and after paying sinking fund and interest there was a net profit of £466. 15s. 7d. The gross profit for the previous year was £2,865. 17s. 9d., and the net profit £364. 11s. 3d.

The 1850 Anglo-French Cable.—It is announced that the jubilee of the laying of the brothers Brett's submarine telegraph cable between Shakespeare Cliff, Dover, and Cape Grisnez, France, is to be celebrated at Calais on August 28th, the day in 1850 when the "Goliah," starting from Dover, paid out the cable. There was, as is well known, no actual communication by this cable until later in the year.

Tramway Extension in Middlesex.—At the last meeting of the Middlesex County Council the Parliamentary committee recommended that the London United Tramways (Ltd) should be informed that the Council would limit its opposition to clauses in the company's bill if the latter and the councils affected would consent to the County Council being the purchasing authority under the bill. A long discussion ensued, in the course of which it was stated that the eight district councils affected supported the bill, and that the company was expending £120,000 on improving the main roads. The recommendation was carried.

Tramways in Ireland.—The Council of the Dublin Chamber of Commerce has unanimously approved the principle and objects of the Tramways (Ireland) Act Amendment Bill now before Parliament, which is intended to extend to Ireland the facilities of the Light Railways Act of 1896.

Trowbridge.—Mr. D. Stevenson has been appointed consulting engineer to advise upon the suggested electric lighting and refuse-destructor project.

Wakefield.—A formal inquiry was held here on Wednesday into the application of the Corporation to borrow £25,000 for electric lighting extensions. Of the new loan, £7,853. 16s. 7d. is to meet excess of expenditure over borrowing powers.

West Bromwich.—The Local Government Board have sanctioned the borrowing of £30,000 for the erection of electricity works.

Workhouse Lighting.—The Christchurch Guardians have decided to substitute electric for gas lighting at their workhouse. A report by Mr. G. R. Peers, of Manchester, puts the total cost of the installation at £1,610, with an annual charge for maintenance of about £150.

Worthing.—Forty 1,000 8 c.p. arcs are to be employed for street lighting instead of 76 50 c.p. incandescents as originally proposed. The change involves an additional capital cost of £768 and an increase in the annual cost of maintenance, &c., of £122.

Condenser Contracts.—The Wheeler Condenser & Engineering Co. have secured the contract for condensing plant (in duplicate) required for the Lisbon power station of the Portuguese Tramway Co. The Wheeler Company are also supplying the cooling tower and condensing plant required for the Bromley (Kent) Electric Light & Power Co.'s station. Among other recent orders received are the duplicate plants for the municipal stations at Belfast and St. Helens, of the Reading Electric Supply Co., and of the Bedford, Blackpool, Devonport, and West Bromwich Corporation electricity stations.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Beckenham District Council invite tenders for the "free" wiring of premises. Specification may be obtained from the consulting engineer (Mr. R. P. Wilson), 66, Victoria-street, Westminster, S.W., or from the borough engineer and surveyor (Mr. A. Angell) Tenders to the clerk (Mr. F. Stevens) by 4 p.m. of July 16. See advertisement.

The Electric Lighting committee of the Vestry of *St. Mary, Islington* (London) require tenders for relaying York and other stone, and providing new York and other stone where necessary, over the electric conduits and mains which may be required during the ensuing three years. Further particulars are set out in an advertisement, and specifications may be obtained after 9th inst. at the electricity department, 50, Eden-grove, Holloway, N. Tenders to the vestry clerk (Mr. Wm. F. Dewey), Vestry Hall, Upper-street, N., by noon of 25th inst.

Wimbledon District Council require tenders for supplying and fixing telephones at their isolation hospital. Tenders addressed to the clerk (Mr. R. H. S. Butterworth), Council Offices, Broadway, Wimbledon, by 18th inst. See advertisement.

Lowestoft Corporation require tenders for (1) direct-current meters, and (2) cutouts. Specifications, &c., can be had from Mr. R. Beattie Nicholson, town clerk, and can be seen at, but not obtained from, the office of Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C. Tenders to Mr. Nicholson, town clerk's office, Lowestoft, by noon of July 10. An advertisement contains further particulars.

Huddersfield Corporation Electricity committee invite tenders for single-phase steam-generating plant of 1,000kw. capacity. Specifications, &c., can be obtained from Mr. A. B. Mountain, borough electrical engineer, Electricity Works, St. Andrew's-road, Huddersfield, and tenders must be sent to Mr. F. C. Lloyd, town clerk, Town Hall, Huddersfield, by Thursday, July 12.

Rugby District Council invite tenders for taking a lease of their provisional electric lighting order (1898). Applications to Mr. T. M. Wratislaw, clerk and solicitor, Council offices, Rugby, by Aug. 1. See advertisement.

Extension of Time.—The date for tenders for the overhead equipment for about 16 miles of equivalent single track of tramways, for the Corporation of *Durban*, Natal, has been extended. Tenders (in duplicate) to Messrs. Webster, Steel and Co., 5, East India-avenue, London, E.C., by July 20, or to town clerk, Durban, on or about Monday, Aug. 13.

Extension of Time.—Tunbridge Wells Corporation invite tenders for telephone instruments, apparatus, material, and accessories. Tenders to town clerk, Town Hall, Tunbridge Wells, by July 12.

Partick Commissioners invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, cast-iron arc and incandescent lamp standards, arc lamps, automatic switches, &c. Tenders to town clerk, 97, West Regent-street, Glasgow, by July 10.

Hammersmith (London) Electricity and Lighting committee invite tenders for insulated high and low-tension cables, junction boxes, &c., and cast-iron pipes, draw-box covers, &c, required, as per schedule, for 12 months. Tenders to chairman by July 12.

Grays Thurrock District Council require tenders for electricity generating plant. Tenders to clerk by noon of Aug. 9.

Croydon Corporation invite tenders for the reconstruction of the present tramway track and the construction of new tramways and paving of roads. Tenders to town clerk by noon of July 10.

Salford Corporation require tenders for overhead equipment for tramways, exclusive of steel poles. Tenders to town clerk by July 16.

Limerick Corporation require tenders for the supply and erection of electrical plant and apparatus. Tenders to town clerk by July 14.

Blackpool Corporation invite tenders for trolley poles, cables, and trolley wire, boosters, switchboards and storage battery. Tenders to chairman Electric Lighting and Tramways committee by July 23.

London County Council require tenders for the supply (within three months of order) of about 70 arc lamp standards for lighting Victoria Embankment. Tenders to clerk (Mr. C. J. Stewart) by July 10.

Hackney (London) Electric Light committee require tenders for 220 arc lamp pillars. Tenders to clerk by July 11.

Trimdon (Co. Durham) Parish Council invite tenders for public lighting by electricity or acetylene gas. Tenders by July 17.

Southend Council invite tenders for electric traction plant, about 1,180 tons of steel rails, 46 tons of steel fish-plates, &c. Tenders to town clerk by July 25.

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Cardiff Corporation require tenders for about 1,000 tons of tramway rails, fish-plates, sole plates, tie bars, bolts and nuts, points and crossings, copper rail bonds, &c. Tenders to townclerk by July 12.

Wolverhampton Tramways committee require sketch plans and models of single and double-decked electric tramcars. Application to borough engineer.

Birkenhead Corporation require tenders for erecting new tramcar sheds. Tenders to town clerk by 24th inst.

Newport (Mon.) Corporation require tenders for construction of about 1½ miles of double tram track. Tenders to town clerk by 9th inst.

Salford Tramways committee require tenders for steel points and crossings. Tenders to chairman by 17th inst.

Bermondsey (London) Vestry require tenders for the erection of electricity generating and dust destructor buildings. Tenders to vestry clerk by 26th inst.

Halifax Tramways committee require tenders for brass journals and trolley fittings for six months. Tenders to town clerk by 11th inst.

Central Electric Supply Co. (Ltd.), 19, Carnaby-street, Golden-square, London, W.C., require tenders for clearing site of proposed generating station at Grove-road. Tenders by 9th inst.

Baden State Railway authorities invite tenders until July 25 for the supply of two polyphase machines for the electric lighting station at Mannheim. Tenders to the general direction of the Grossh. Badische Staats Eisenbahnen, Carlsruhe, Germany.

Roumania Post and Telegraph Authorities (Bucharest) invite tenders until 17th inst. for the supply of 40 tons of galvanised steel wire, 2mm. diameter.

TENDERS RECEIVED AND ACCEPTED.

The directors of Madame Tussaud & Sons (Ltd.) have received the following tenders for the extension of their electric lighting plant. Mr. R. W. Weekes is consulting engineer for the work. The specification included two 30kw. steam dynamos, two Babcock-Wilcox boilers, switchboard, and connecting cables :—

	Dynamo.	Engine.	
*Johnson & Phillips	Own	Alley & MacLellan...	£1,775
D. Bruce, Peebles & Co.	do.	Willans	2,158
Ditto	do.	Browett-Lindley	1,948
Ditto	do.	Reavell	1,928
Ditto	do.	Alley & MacLellan...	1,918
Christy Bros. & Middleton	Crompton	Willans	2,154
Ditto	do.	Browett-Lindley	2,126
Ditto	do.	Allen & Co.	2,116
Ditto	do.	Reavell	1,924
J. H. Holmes & Co.	Own	Willans	2,150
Drake & Gorham	Parker	do.	2,058
Crompton & Co.	Own	do.	1,963
Ditto	do.	Reavell	1,722

The tender of Messrs. James Simpson & Co., of Pimlico, was accepted for the supply of pipes, feed pumps, heater, &c., at £550.

* Accepted under guarantee to deliver and erect one steam dynamo in eight weeks.

The following tenders have been accepted by the Dartford Council for the supply of electricity generating plant :—

James Carter & Sons (Lancashire) boilers with fittings, economiser, feed pumps, &c.)	£1,545	19	0
James Carter & Sons (automatic stokers)	249	0	0
Aiton & Co. (pipework)	660	0	0
G. S. De Ritter (surface condensing plant)	620	0	0
Reavell & Co. (two dynamos, with vertical enclosed high-speed engines and motor boosters)	2,247	0	0
Marquand Accumulator Co. (storage batteries)	725	0	0
Ditto (maintenance for five years)	275	0	0
Veritys Limited (main switchboard and connections)	667	0	0
Carrick & Sons (6-ton overhead traveller)	162	0	0
Western Electric Co. (underground mains, conduits and roadwork for private and public lighting)	4,866	0	0
Ditto (enclosed arc lamps and posts)	184	0	0
L. G. Tate (station lighting)	39	10	0

Bermondsey (London) Vestry have received the following tenders for the supply of insulated electric mains, conduits, junction boxes, &c.

W. T. Glover & Co. (*accepted*)	£8,134	7	9
St. Helen's Cable Co.	8,109	16	8
Siemens Bros. & Co.	8,113	9	11
Callender's Co.	8,212	7	1
Western Electric Co.	8,219	11	11
British Insulated Wire Co.	8,643	15	10

The St. Pancras (London) Vestry have received the following tenders for the supply and laying of cables in the Hampstead, Tottenham Court and Euston-roads :—

Western Electric Co. (*accepted*)	£2,618	9	8
British Insulated Wire Co.	2,675	10	2
Siemens Bros. & Co.	2,575	15	4
Callender's Co.	2,506	12	2

Subject to the sanction of the Local Government Board, the West Ham Guardians have accepted the tender of Messrs. Frank Suter & Co. for supplying and erecting electricity generating plant, and for wiring and fitting the workhouse and school premises at £5,252.

Cheltenham Town Council have accepted the tender of Messrs. Carrick & Ritchie for a hand-operating crane at the electricity works at £260.

Manchester Tramways committee recommend the acceptance of the tender of Messrs. Macartney, McElroy & Co. for the electrical equipment of three tram routes, at £16,251. 6s. 6d. The three routes are Cheetham Hill, Rochdale-road and Bury New-road, and represent about 10 miles of track.

APPOINTMENTS VACANT AND FILLED.

British North Borneo Co. require a superintendent of telegraphs. An advertisement contains further information, and applications must be made to the secretary, 15, Leadenhall-street, London, E.C., from whom further particulars can be obtained.

Salford Electric Light committee invite applications for the position of engineer to their electrical undertaking. Further particulars are set out in an advertisement, and applications are to be sent to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by 14th inst.

The governors of the Technical Institute, Wandsworth, London, S.W., require a qualified teacher to take classes in electric testing and wiring. Some particulars are given in an advertisement, and applications must be in by July 19.

A junior demonstrator in physics is required for the South Western Polytechnic, Manresa-road, Chelsea, S.W. An advertisement contains further particulars, and forms of application may be obtained from the secretary.

Wimbledon District Council require a temporary draughtsman for the electricity works extension. Applications to the clerk (Mr. R. H. S. Butterworth) by July 10. See advertisement.

Lecturers and demonstrators in mechanical engineering, and in physics and electrical engineering are required for the Derby municipal technical college. Applications to principal by July 9.

A lecturer in engineering is required for the Portsmouth Municipal Technical Institute. Applications to principal by 19th inst.

Swansea Corporation require a resident electrical engineer. Applications to town clerk by July 9.

Mr. U. Barbieri, first-class electrician in the Argentine Navy, has been appointed chief electrician to the Navy, in place of Mr. J. A. Newbery, recently appointed to the position of director of public lighting to the city of Buenos Ayres.

Mr. Samuel Jones, at present in the service of the Shoreditch Electricity Department, has been appointed generating station assistant to the Reading Electric Supply Co.

Colchester Corporation have appointed Mr. A. R. Sillar, the present station manager to be permanent borough electrical engineer.

BANKRUPTCIES, LIQUIDATIONS, &c.

Notice is given that creditors of Dobson & Curtis Bros. (Ltd.) in liquidation, who have not sent in their claims as requested in a previous notice must do so before Monday, 9th inst. Otherwise their claims will be excluded.

Resolutions to wind up voluntarily the Premier Electric Lamp Syndicate (Ltd.) for reconstruction and to appoint Mr. D. L. Chalmers as liquidator have been passed and confirmed. The new company will be entitled the Premier Electric Lamp Co. (Ltd.).

Mr. G. F. Clarke, 71, Cross-lane, Earlstown, Lancs., has been appointed trustee in the bankruptcy of G. H. Bentley, electrical engineer (formerly trading at 18, Market-street, Earlstown).

At the London Bankruptcy Court on 29th ult. Mr. Registrar Brougham gave judgment on the application of John Evelyn Liardet for the Court's approval to the scheme of arrangement recently entertained by the creditors. His Honour said the scheme provided for the payment to the creditors of a composition of 20s. in the £ by cumulative preference shares in Motors and Mechanical Appliances (Ltd.) which was to be formed to acquire and work debtor's inventions, or to those creditors who preferred money, a cash composition of 7s. 6d. in the £. The creditors with one exception had decided to take the composition in shares, but the Act provided that the Court could not sanction a scheme unless it provided reasonable security for the payment of not less than 7s. 6d. in the £. He could not hold that shares in a company which was not even formed provided that reasonable security, and as the amount required to pay 7s. 6d. on all the unsecured debts had not been deposited with the Official Receiver, he had no option but to refuse to confirm the scheme. The scheme was accordingly rejected.

Henry Vincent James, electrical engineer, trading as H. V. James & Mills, Croft-street, and residing at 44, Bolton-road, Pendleton, Salford, has executed a deed of arrangement, with liabilities £2,444. 12s. 8d. and assets £1,352. 7s. 10d. Mr. I. Senior (30, East-parade, Leeds) and another have been appointed trustees.

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Sale by Tender.—Leeds Corporation are open to receive tenders for two horizontal Fowler engines of 400 I.H.P., two sets of Greenwood and Batley dynamos, one spare armature to fit any dynamo, and a switchboard and instruments, the plant being at present in use in connection with the Corporation's system of electric tramways. Particulars will be found set out in an advertisement elsewhere, and it is notified that the plant will be available for removal about February next. Further information can be obtained from Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W.

Sale by Auction.—Messrs. John M. Leeder & Son will sell by public auction at the Port Tennant Copper Works, Swansea, a large quantity of contractor's electric and other plant, machinery, &c., particulars of which are set out in an advertisement. The sale takes place on Thursday next at 11 a.m. Catalogues are in course of preparation, and may be had of the auctioneers, 46, Waterloo-street, Swansea.

"Paragon" Fan Motors.—The Edison & Swan Co. have just issued leaflet No. 137 containing particulars and illustrations of the Ediswan "Paragon" fan motors, 1900 pattern. These fan motors are made in three different types—ceiling, wall or partition, desk or table. All parts are interchangeable. They are attractive in appearance, and require no attention after installation. Each type of fan is illustrated.

Anti-Friction Alloys.—Anti-Friction Alloys (Ltd.), 52, Queen-Victoria-street, London, E.C., have prepared a list of the items of their manufacture of special interest to tramway engineers. These goods include tram and motor car bearings, slide valves, &c.

Tall Buildings.—Messrs. Fairbanks & Co., of 16, Great Eastern-street, London, E.C., have issued an album of the leading prominent buildings of New York City. Copies of the album can be obtained post free. As there is some discussion at the present time in relation to the desirability of tall buildings, the Fairbanks Company think these illustrations may prove interesting.

Acetylene and Carbide of Calcium.—The Acetylene Illuminating Co., of 3, Victoria-street, London, S.W., have issued a pamphlet dealing with the manufacture of these supplies. The company claim that their experience with carbide of calcium and acetylene dates back from August, 1894. They were the first firm in Europe to erect electrical furnaces for the commercial manufacture of carbide. It is stated that now at least 100,000 H.P. are being utilised throughout the world for making carbide. As a matter of historical interest, it is stated that the chief credit of producing carbide of calcium economically on a large scale, and thus laying the foundation of a new and important industry, belongs to Mr. T. L. Willson, a Canadian, who began his experiments on a considerable scale in 1888.

Crossley Gas and Oil Engines.—Useful and instructive particulars relating to the gas and oil engines manufactured by Messrs. Crossley Bros. (Ltd.), of Openshaw, Manchester, are now ready. Many varieties of engines are described and very effectively illustrated. A single-cylinder high-speed gas engine for electric lighting shown on pp. 10 and 11 gives the idea of great strength and easy running. The machine shown is fitted with a heavy fly-wheel, out-end bearing, balanced cranks, &c, the standard engines being fitted with two flywheels. These machines are guaranteed to give safe working loads of 80 B H.P., 95 B.H.P., and 100 B.H.P. with coal gas. Several new patent vertical gas engines are shown for which it is claimed that the gas consumption has been greatly reduced. Double-cylinder engines of the newest designs made in sizes to give safe working loads of 135 B.H.P., 160 B.H.P. and 180 B.H.P., with ordinary gas are supplied. These engines are built on Crossley's new scavenging patent, and are fitted with heavy flywheels when used for electric lighting. The Crossley oil engines (illustrated) show several improvements, one a new design giving 21 B H.P. safe working load. Several new designs of high-speed electric light oil engines are also illustrated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 27 to July 3, with the ports of destination :—

Africa—Alexandria, £62; Cape Town, £506; Durban, £959; East London, £9. *Argentina*—Buenos Ayres, £239 (including £85 telegraph material). *Australasia*—Albany, £137; Auckland, £81; Launceston, £360; Melbourne, £342 (telegraph cable); Port Darwin, £76 (telegraph material); Sydney, £661, *Azores*—£909 (telegraph material). *Belgium*—Brussels, £38; Ostend, £5. *Brazil*—Rio Janeiro, £189. *Canada*—Halifax, £625 (telegraph cable). *Canary Islands*—Teneriffe, £65. *Ceylon*—Colombo, £59. *Chili*—Valparaiso, £115. *Denmark*—Copenhagen, £1,380 (telegraph cable); *Germany*—Hamburg, £1,350 (telegraph material). *Gibraltar*, £61. *Holland*—Amsterdam, £185; Flushing, £19; Rotterdam, £50. *India*—Bombay, £110; Calcutta, £76; Madras, £685. *Norway*—Christiana, £82 (telegraph material). *Russia*—St. Petersburg, £700 (telegraph wire). *Spain*—Malaga, £35. *Straits Settlements*—Singapore, £36. *Sweden*—Stockholm, £279 (telegraph cable). Total £10,485, against £30,231 in the corresponding week last year (June 28 to July 4).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 14, 1900.

6,974. W. P. THOMPSON. Liverpool. An improved system or means for controlling or regulating electrical installations. (C. Coeper, Germany.)
6,981. C. B. KETLEY. Birmingham. Improvements in photographs.
7,031. H. H. LAKE. London. Improvements in electric clocks. (W. J. Dudley, United States.)*
7,034. C. B. KETLEY. Birmingham. Improvements in photographs and graphophones.

April 17, 1900.

7,062. C. RICCI. London. Variable speed gear for mechanically or electrically-propelled vehicles.
7,070. J. C. KNEALE and H. HARTLEY. London. Improvements relating to telephones.
7,084. A. J. BOULT. London. Improvements in or relating to electric motors. (O. H. and A. F. Pieper, United States.)*
7,098. S. H. SHORT. London. Improvements in or relating to multipolar electric machines.*
7,100. L. J. P. HOLLUB and H. MIGNAL. London. A new or improved device to fixing incandescence electric lamps.
7,106. J. M. MURPHY. London. Improvements in electric railway systems.*
7,108. F. R. SIMMS and R. BOSCH. London. Improvements in or connected with magneto-electric machines.*
7,109. R. VARLEY. London. Improvements in electro-magnetic coils.*
7,133. H. H. LAKE. London. Improvements in incandescence electric lamps. (S. D. Washburn and C. H. Tinkham, United States.)*

April 18, 1900.

7,155. J. NEWNS. Liverpool. Improvements in overhead electric tram and railway conductor, junctions and crossings.
7,157. A. MARR. Manchester. Improvements in and relating to telegraphic transmitting devices.
7,198. W. P. THOMPSON. London. Improvements in the method of producing complex chemical compounds by electrolysis with alternating currents. (Alf. Sinding-Larsen, Norway.)*
7,200. W. P. THOMPSON. Liverpool. Improvements in electric belts for the electric treatment of the human body. (M. A. McLaughlin)

April 19, 1900.

7,218. J. T. PEARSON. Burnley. Improvements in and relating to the application of electricity and/or magnetism to fibrous substances and fabrics and/or to machinery and apparatus or parts thereof employed in the preparation, manufacture and treatment of such substances and fabrics.
7,239. V. J. DELEBECQUE. London. Improvements relating to fusible cut-outs for electric circuits.
7,245. H. LEITNER. London. Improvements in the production of plates for secondary batteries.
7,246. H. LEITNER. London. An improved secondary battery.
7,272. H. BAKER. London. Improved connections for carbon electrodes.
7,285. R. C. PARSONS, R. BELFIELD and W. CHAPMAN. London. Improvements in or relating to electric railways operated on the conduit system.
7,287. L. HENNE and G. SCHÖNFELDER. Liverpool. Improvements in electric railways with underground conductors.

April 20, 1900.

7,314. R. C. SAYER. Bristol. Improvements in boiling and vaporising fluids by electricity.*
7,319. A. J. MARLEY and L. TURNER. London. Nubrit electric furniture polish and renovator.
7,320. A. THODE AND CO. London. Improved sound deadener for overhead conductors of electric railways and the like.
7,321. A. THODE AND CO. London. Improved electric rotating insulator.
7,322. W. E. IRISH. London. Incandescent electric lamp.
7,356. E. SCHATTNER and F. W. HARMER. London. Improvements in electrical incandescence lamps.
7,372. A. TRIBELHORN. London. An improved manufacture of electrodes.
7,373. W. LANGDON-DAVIES and A. SOAMES. London. Improvements in the formation of drum windings for dynamo-electric machines.

April 21, 1900.

7,392. A. LEHNER and A. VON DAUBER. Berlin. Electro motor of varying revolutions.*
7,393. A. PERAZZI. London. Electric and chemical apparatus for the scalp.
7,410. P. KÄSBAUER, M. HABERFELLNER, and O. LENCK. London. Improvements in regulators for electric arc lamps.*

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April 23, 1900.

7,433. H. HIRST and J. H. COLLINGS. London. Improvements in joints for rods carrying electric lamps and other purposes.
7,434. H. HIRST and M. ZELLERMAYER. London. Improvements in connections for electrical cables and kindred purposes.
7,471. S. G. BROWN. London. Improvements in electric telegraphy.
7,483. I. TIMAR. London. Electric sweating mattress.*

April 24, 1900.

7,510. C. MILES. Bristol. Improvements in electrically-governed feeding and drinking appliance for animals, live stock, birds, and the like.
7,511. C. MILES. Bristol. Improvements in electrical time checking and registering apparatus.
7,513. S. COWPER-COLES. London. Improvements in secondary batteries.
7,537. A. N. PETIT. London. Improvements in machines for reproducing phonographs and similar records.*
7,547. W. E. IRISH. London. Incandescent electric lamp.
7,561. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in maximum electric meters. (H. O. Westendrap, United States.)*
7,562. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in third rail insulators for electric railways. (E. W. Rice, jun., United States.)*
7,567. H. P. BROWN. London. Improvements in electric bonds for electrically connecting the meeting ends of two contiguous electric conductors.*
7,581. E. A. HAWTHORNE. London. Improvements in phonographs and graphophones.*
7,586. G. B. CRUICKSHANK, H. R. S. COLEMAN, and P. CRUICKSHANK. Birmingham. Improvements in apparatus for electro-plating.
7,593. J. G. S. LEE. London. Improvements in contacts for incandescent electric lamp holders, electric switches, and so forth.
7,594. W. P. THOMPSON. Liverpool. Improvements in graphophones. (G. L. Hogan, United States.)*
7,606. C. A. LINDSTROM, J. HEWITT, and T. HEWITT. London. Improvements in electrical controlling switches.*
7,608. E. RASCH. London. Improvements connected with the production of electric light.
7,609. P. SCHARF. London. Improvements in glow lamps for high-tension currents.

April 25, 1900.

7,639. S. H. HOLDEN and CHAMBERLAIN AND HOOKHAM (LTD.). London. Improvements in dynamo-electric machines.
7,645. S. E. FEDDEN and W. JAMIESON. Greenock. Improvements in distribution of polyphase currents.
7,648. F. M. LONG and E. SCHATTNER. London. Improvements in electric arc lamps.
7,657. W. T. BURBEY. London. Improvements in and connected with cord grips for electric lamp holders, ceiling roses, and the like.
7,675. H. H. LAKE. London. Improvements in electrical time-distributing apparatus. (H. Cuenod, Switzerland.)

April 26, 1900.

7,695. S. S. GALSWORTHY. London. Improvements in wall plugs for electric lighting and heating.*
7,712. M. OLIVER. Sheffield. Improvement in electric billiard-marking time check relating to the balls being out of play at the end of a stated time.
7,721. P. LUDWIG. Germany. Adjustable bracket for electric lighting.
7,725. A. G. NESFIELD. London. Improvements in or connected with electric accumulators or storage batteries.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

25,450. BRITISH THOMSON-HOUSTON CO. (LTD.) (Potter). Systems of electric train control.
25,751. BRITISH THOMSON-HOUSTON CO. (LTD.) (Van Slyck). Electric time switches.

1900.

135 NELLES. Device for renovating phonograph record cylinders and the like.
1,464. MURPHY. Surface-contact electric railway systems.
1,886. NEWTON. (Rabbidge.) Arrangement of switching appliances for use with telephones.
2,150. DALLAIRE. Telephone transmitters.
2,356. SIEMENS BROS. AND CO. (LTD.) (Siemens and Halske Aktien Gesellschaft.) Apparatus for regulating the electric lights on theatre stages.
2,742. MAYLINDER. Apparatus for firing submarine mines by means of Hertzian radiations.
2,797. POPOV. Coherers for telephonic and telegraphic signalling.
2,842. BROOKES. (Woodman and Fiske.) Thermostatic circuit controlling apparatus.
3,105. REED, REED and FARRAR. Systems of electrical distribution and safety apparatus therefor.
3,106. REED, REED and FARRAR. Automatic electric circuit breaker.
3,107. REED, REED and FARRAR. Isolated alternating low tension systems of electric distribution.
3,361. HATHAWAY. Manufacture of secondary batteries.
3,371. PORTER. Electric heaters and switches thereof.
3,545. FRANK. Insulation of electrical conductors.
3,731. SANDER. Manufacture of electrically-conducting material.
3,753. COMMELIN and VIAN. Electrical secondary batteries.
4,052. JOHNSON (American Graphophone Co.). Manufacture of sound records.
4,081. SHEBLE. Phonograph or graphophone instruments.
4,262. NEWTON (Knickerbocker Trust Co.). Electric batteries and in the method of making electrodes therefor.
4,365. SHOOLBRED. Translucent reflectors for incandescent electric lamps.
4,508. GARL. Electric signalling systems for railways.

COMPANIES' MEETINGS AND REPORTS.

United River Plate Telephone Co. (Ltd.).

The fourteenth ordinary general meeting of this Company was held on Tuesday, under the presidency of J. IRVING COURTENAY, Esq.

The SECRETARY (Mr. E M. Reiss) having read the notice calling the meeting, and the report of the Directors having been taken as read,

The CHAIRMAN said: The continued improvement, Gentlemen, anticipated at our last meeting has been fully realised during our financial year. The fluctuations in the gold premium have been slight, the Government scheme for maintaining the minimum gold premium at 127·30 having, so far, met with a measure of success; the average rate for the year ending last March was 17 points lower than the average for the previous corresponding period, while the closing rate at the same date, when our balances were converted, was five points higher than in 1899. The number of our subscribers is now approaching 9,000, the increase being 50 per cent. greater than during the previous year. The new central office building was completed last December, and satisfactory arrangements have been made for renting the portions not required by the Company. Substantial progress has been made with the important work of laying underground plant. It is considered essential, to the Company's best interests to extend the system of subways as rapidly and to as large an extent as possible. Turning to the balance-sheet, the large addition for capital outlay of £23,154 is due to the expenditure on underground plant, switchboards, &c., referred to when I last addressed you. The item of conversion of the old 7 per cent. debentures has disappeared, the balance of £5,504. 6s. 8d., having been written off the depreciation fund. Sundry debtors, £8,222, are some £1,600 more, owing chiefly to advance payments on materials ordered which are carrying interest. Investments amount to a higher figure, real estate being augmented by the further expenditure on new central office properties in Buenos Ayres, and our other investments, being securities at cost, have been increased by sums invested temporarily until required for capital outlay. The stock of instruments and materials in the River Plate, standing this year at £1,000 more than it did last year, consist almost entirely of new material. The remaining items of bills receivable and cash at bankers, in hand, and at call, make the total cash balance £34,406. The debit side shows our subscribed share capital increased by the issue of preference shares by £83,195; the debenture stock remains at £179,947. Sundry creditors, £5,387, are about £500 less, and subscriptions in advance are also slightly below the figure at the corresponding date. The reserve fund is now increased to £40,000, and the depreciation fund stands at £3,495. On the credit side our gross revenue in the River Plate is this year in six figures—a fact, I think, we may justly be proud of, the amount (£101,169) showing an increase of nearly £16,000 over last year. Expenses, on the other side of the account, maintenance charges in the River Plate, (£45,042), show an increase of only £3,000. London expenses show an increase of £2,353, which includes the expenses of the preference share issue. This leaves the balance of profit for the year £35,179, after deducting debenture interest and dividends paid on our preference and ordinary shares at the end of December last, the latter amounting to £7,250; so that the total net profit for the year was £42,429 compared with £33,333 last year. The Board propose that £5,000 should be put to depreciation and £20,000 to reserve. After paying a further dividend on the ordinary shares of 4½ per cent., making a total return for the year of 7 per cent., there remains £5,019 to carry forward. I will now deal with the important subject of capital expenditure. As indicated at our last annual meeting we must recognise the necessity of adding largely to our capital outlay in order to properly equip our telephone plant with the latest improvements and thus render it effective to meet not only the business already existing, but the continual increase in the future which we have every justification for expecting. Our overhead wires are already so numerous, and are of necessity so close together, that it becomes more and more difficult—it is almost impossible—to avoid induction, that great bane to good telephone service, and the obvious remedy is to have as extended an underground system as possible. A substantial beginning of this necessary work has already been made, but much remains to be done, and in order to provide for a scheme which shall at once be not only efficient but also economical, it is essential for the Directors to have the requisite capital at their command. It has therefore been decided to at once issue the balance of the preference share capital which was authorised last year. Of the authorised amount of £200,000, half was then offered to the public, with the result that £83,195 was subscribed. It is now intended to offer the remaining £116,805, and, in allotment, every consideration will of course be given to applications by existing shareholders. I now move the adoption of the report and accounts.

Mr. F. GREEN seconded the motion.

Mr. LEA-SMITH said he thought that the shareholders present ought not to allow a report such as that which had been presented to them on

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that occasion by the Directors to pass in silence. He regarded the dividend as very good, but in his opinion the best part of the report was that in which the Directors dealt with the question of the reserve fund.

Mr. Frank W. Jones and Mr. George Cooper were re-elected Directors, and Messrs. Welton, Jones & Co. were reappointed auditors.

A vote of thanks to the Chairman and Directors was carried by acclamation, and the proceedings then terminated.

Blackheath and Greenwich District Electric Light Co. (Ltd.)

A meeting of this company was held on Tuesday for the purpose of increasing the capital of the company by the creation of 150,000 new preference shares of £1 each, holding special rights and privileges, and also to authorise the board to create and issue 4½ per cent. debenture stock of the nominal amount of £120,000, such stock to have the right of conversion into fully-paid 7 per cent. preference shares of the same amount at any time after July 1, 1905. Sir JOHN WILLOX, M.P., presided.

The SECRETARY (Mr. S. H. Webster) having read the notice calling the meeting,

The CHAIRMAN said when he last addressed the shareholders the company had not commenced the supply of electricity from its own works, but now they had commenced their supply. They had already secured a good many orders both for light and power. When they began their own supply in February the number of lamps connected was equivalent to 5,900 8 c.p., and at the present time they had 10,000 lamps connected. As the longer nights approached that rate of progress would doubtless be accelerated. They were also supplying a considerable amount of energy to industrial works, and had completed contracts for still larger supplies of power for manufacturing purposes. The total expenditure to date was £128,000, and there were other charges to be brought in. The present available resources of the company were not sufficient to meet those liabilities; and there was another reason for new capital—namely, the extension of the company's area of supply, which they had obtained powers for in order to hold it, as another company had made application. That would enlarge their area to 15 square miles, with 60 miles of roads. The amount of their requirements the board estimated at £100,000. The proposed new debenture stock would be repayable in 1931, and would be redeemable at the option of the company at 105 after it had run for 10 years. But the debenture holders were also allowed an option. Under certain restrictions they might convert their debenture stock into an equivalent amount of 7 per cent. cumulative preference shares, but the option of making such conversion practically attached only to a period of five years. Allotments of the stock would be made to the shareholders in priority of other applicants. Some shareholders had assumed, with natural alarm, that the directors proposed to issue both mortgage debentures and preference shares. They had no such intention. What they proposed was to issue £100,000 of debenture stock, and if the debentures were converted into preference shares, such debentures would *ipso facto* be cancelled. He concluded by moving the approval of the resolutions.

Mr. H. W. BOWDEN seconded the motion.

After some discussion,

The CHAIRMAN gave a pledge that the board would issue no preference shares, except for the purpose of exchange, without first coming to the shareholders.

The resolutions were then agreed to, and the meeting terminated.

West African Telegraph Co. (Ltd.).

The fifteenth ordinary general meeting of this Company was held on Friday last under the presidency of the MOST HON. the MARQUIS OF TWEEDDALE, K.T.

Mr. JOHN CAMBROOK (the Secretary) read the notice calling the meeting, as also the minutes of the last ordinary general meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, the gross revenue for the year ended Dec. 31, 1899, amounted to £77,008, against £65,552 for the year 1898, or an increase in the year under review of £11,486. On analysing the receipts we find the principal increase is due to the exceptional traffic with South Africa in consequence of the war in the Transvaal and the Orange River Colony. The increase under this head is £11,498, and there is also an increase of £132, being interest received for money placed on deposit, thereby making a total of £11,630. On the other hand there is an increase in the rent of cables of £563, but there is also a reduction in the loss on exchange of £419, the result being, as already stated, an increase in the gross revenue of £11,486. The total working expenses for the year 1899 amounted to £20,298 as against £21,527 for the year 1898, or a decrease of £1,229. In making comparisons we find that the principal decreases occur in Abstract B, £1,046; foreign agencies also show a decrease of £188, making together £1,234. The expenses attending repairs and renewals of cables amounted to £11,482 in 1899 against £17,718 in 1898, or a decrease of £6,236. I may mention, however, that since the date of these accounts we have had to incur the cost of expensive repairs to the Bathurst-Conakry, Bathurst-Dakar, and St. Thomé-Loanda cables. After providing for debenture interest and sinking fund, the net result of the year's working is to show a profit of £23,298, of which the Directors propose to place £23,000 to the reserve fund, and to carry the balance of £298 forward to the next year. You will notice, however, that the revenue includes £12,000 in respect of the subsidy due from the French Government for 1899, and that the non-payment of this sum has been provided for by transferring a like amount from the general fund to a special fund pending a settlement. The delay in the settlement of this item is no doubt due to the unsettled state of politics in France and consequent frequent change of ministers, but we are not without hopes that before very long we shall see an equitable arrangement arrived at. In 1896 the general reserve fund amounted to £58,000, but owing to the transfers to a special fund which your Directors considered it prudent to make in order to provide against the outstanding subsidy which has been withheld by the French Government, the general reserve fund now stands at £28,881, which, taking all these circumstances into account, must be considered quite inadequate to the requirements of the Company. The question of dividend must therefore, I think, be deferred till we are in a position to replace the heavy withdrawals out of the fund which, as I have already explained, we have been obliged to make. I beg to move the adoption of the report and accounts.

Sir HENRY C. MANCE, C.I.E., seconded, and the motion was carried unanimously.

The CHAIRMAN then explained a resolution (afterwards carried unanimously) on the subject of the staff of the West African Telegraph Co. participating in a scheme of pension and superannuation already established by the other members of the associated telegraph companies.

The Hon. Arthur Brodrick was then re-elected a Director, and Messrs. Deloitte, Dever, Griffiths & Co., were re-appointed as auditors.

A vote of thanks to the Chairman and Directors terminated the proceedings.

Electric Construction Co. (Ltd.).

The report of the directors states that the profit for the year ended May 31, including £1,441. 6s. 2d. brought forward, was £21,729. 1s. 9d., which the directors recommend should be appropriated in providing a dividend of 7 per cent. on the preference shares (£3,500) and a dividend of 6 per cent. on the ordinary shares (one-half to be paid on 31st inst., and one-half on Jan. 31, 1901), amounting to £13,452. The surplus of £4,777. 1s. 9d. is to be carried forward. The buildings and plant have been thoroughly maintained, and the usual sum (£5,000) has been credited to depreciation account, which now amounts to £33,000. The buildings of the extensions, referred to in last year's report, have been finished, and the shops are now being equipped with the latest labour-saving tools and appliances, capable of turning out economically and with despatch the largest electrical machinery that may be required.

Among the more important works of last year were the power house and line equipment, with British machinery and appliances throughout, of the extensions of the City & South London Electric Railway. The works are well supplied with orders at remunerative prices; the relations with all classes of employés are thoroughly harmonious, and the directors have awarded the usual bonus in recognition of good service.

The mortgage on the Madras Electric Tramway has been foreclosed, and the undertaking has been acquired, but it is not intended that this should be a permanent investment. Meanwhile the working of the tramway yields a moderate return on the cost, and the traffic is developing satisfactorily.

The compensation paid under the Workmen's Compensation (1897) Act is, for the year, less than £20, but £150 of last year's profit has been redited to the fund to meet such claims.

Edmundson's Electricity Corporation (Ltd.).

The directors' report for the year to March 31 states that, including £2,572. 5s. brought forward, the net profit, after payment of debenture interest, amounts to £19,832. 6s. 9d. The directors recommend that £5,000 be written off goodwill, and that a dividend of 6 per cent. be paid upon the ordinary and deferred shares (absorbing £10,674. 4s. 2d.), leaving £4,152. 2s. 7d. to be carrid forward.

The electric lighting stations at Folkestone, Winchester, Woolwich, Bromley (Kent), High Wycombe, Salisbury, Ventnor, Chislehurst, and Newmarket, all of which were completed a year ago, have been working satisfactorily, and dividends have been paid to the shareholders of the five first-mentioned companies as the result of the first year's working. These results, obtained at so early a stage, must be looked upon as most encouraging, and confirm the belief of the directors that electric lighting in such towns will prove a profitable investment.

During the year the stations at Guernsey and Alderley Edge have been completed and are now working.

Work has been commenced on stations at Montrose, Brechin, Melton Mowbray, Lymington, Sandown, Shanklin, Newport, and Cowes, and Parliamentary powers are being obtained, with the consent of the local authorities, for several other towns. A considerable number of private installations for country houses, &c., have been carried out, and this department of the business has been well maintained. Investments in the local companies in which the corporation is interested have been taken in the balance-sheet at cost price.

During the year, 9,400 ordinary £5 shares, the balance of authorised capital, have been issued and fully paid up. Further capital will be required for works in progress, and the directors recommend that the nominal capital be increased to £400,000, by the addition of 40,000 shares of £5 each, and propose that £100,000 be issued as 6 per cent. preference shares, reserving £100,000 for issue at a future time.

ELECTRICAL POWER STORAGE CO. (LTD).—The report of the directors states that the profit for the year ended May 31 was £5,309. 4s. 3d., and with the balance from last year (£554. 12s. 11d.), amounted to £5,863. 17s. 2d. Of this, £243. 1s. 1d. has been carried to reserve, and £1,000 to contingent fund, and the payment of a dividend of 5 per cent. on the ordinary share capital is recommended, which will absorb £4,362. 8s. 5d., leaving £258. 7s. 8d. to be carried forward. The buildings, plant, tools, &c., have been maintained in thorough repair and condition at a cost of £2,394. 10s. 2d. out of revenue. The demand for the E.P.S. batteries increases year by year, and the recent extension of the works is being fully utilized. The orders on hand are larger in amount than at any previous time, and include several for tramway and power stations

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the special type manufactured by the company for this purpose having met with the entire approval of engineers. The development of the business has necessitated the introduction of further working capital, and a call of £1 per share has been made during the year on 3,132 ordinary shares on which only £3 per share had been previously paid.

GIFFRE ELECTRO-CHEMICAL POWER CO. (LTD.)—The directors' report for the year ended March 31, submitted at the meeting on 18th ult., expressed the directors regret that it had not been possible to obtain the immediate results anticipated when the company was formed. The directors were disappointed in the hope that from April of last year the output of carbide would have been considerable and regular. As soon as the turbines were set to work it became evident that they did not come up to what was expected of them, and it took considerable time to discover the cause and to remedy the defects. It was found advisable to cancel the order for the four additional turbines until this had been done, and then to order machines of a different type. The defects were being made good by the contractors, who were under obligation to deliver satisfactory turbines and to guarantee their working for one year. One type of dynamo also gave some trouble. Finally, the sudden increased demand for electrodes caused such a dearth that for a time they were unobtainable. Owing to the above causes and the inherent difficulties of getting such important works into working order, the amount of carbide produced to the end of last year was small, but since the beginning of the year a notable improvement had taken place. Against an intermittent output during last year of 633 tons, there was a steady output for the first three months of this year of 475 tons, already increased to 50 tons a week. It was found advisable to maintain the Société Electro-Chimique du Giffre as a separate company, and therefore not to complete the purchase of the whole of the shares. As the rent of the water power, which for 1899 amounted to 125,000f., was, in accordance with the lease, to be raised from Jan., 1900, to 250,000f., the directors of the French company decided that it was advisable to make the authorised issue of debentures for buying the water power outright, and this had been accomplished, and about £10,000 had been employed in enlarging the factory.

NEW COMPANIES, STATUTORY RETURNS, &c.

W. H. ALLEN & SONS (LTD.)—This company was registered on June 29, with a capital of £200,000, in £1 shares, to acquire the business carried on by W. H. Allen, Son & Co. at Queen's Engineering Works, Bedford, and to carry on the businesses of electricians, mechanical and electrical engineers, manufacturers of steam engines and boilers, ironmasters, &c.

ELECTRICAL TESTING LABORATORIES (LTD.)—This company was registered on June 26 with a capital of £3,000, in £1 shares, to take over the Westminster electrical testing laboratories, to establish, erect, maintain and work laboratories for testing, calibrating, or standardising electrical, chemical, or other machinery, &c. The subscribers are W. W. Norman, B. G. Battson, E. R. Blundstone (consulting chemist), A. Sharp (consulting engineer), S. Hutchinson, H. G. Palton, and T. I. Woods.

ELECTRO-MAGNETIC TRACTION CO. (LTD.)—This company was registered on June 27, with a capital of £1,500, in £1 shares, to adopt an agreement with H. Lane and W. Griffiths, and to carry on the business of electrical and mechanical engineers, and any other business connected with electric tramways and light railways, &c.

LEWISHAM AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—This company was registered on June 29, with a capital of £10,000, in £1 shares, to construct and to carry on at Lewisham, S.E., and elsewhere the business of an electric light company in all its branches, and to lay down and maintain mains, cables, wires, electrical machinery, &c. The subscribers (with one share each) are J. Atherton (manufacturer), W. M. M. Forwood, F. Horne, G. T. R. Collis, H. Perry, D. Gayler, A. Purnell.

PREMIER ELECTRIC LAMP CO. (LTD.)—This company was registered on June 26, with a capital of £100,000, in £1 shares, to adopt an agreement with the Premier Electric Lamp Syndicate (Ltd.), and to carry on the business of mechanical and electrical engineers, manufacturers of and dealers in lamps, wires, cables, accumulators, and appliances, suppliers of electricity for light, heat, motive power, or other purposes, &c. The subscribers, with one share each, are Ald. Lloyd Higginbotham (engineer), James B. Atherton (manufacturer), H. A. Watson, D. McKechnie, C. Petrie, T. Briggs, and Jacob Atherton (manufacturer).

ROSLING, APPLEBY & FYNN (LTD.)—This company was registered on June 25, with a capital of £100,000, in £1 shares (50,000 6 per cent. cumulative preference), to take over the business carried on by Rosling & Appleby, and to carry on the business of electrical and general engineers, electricians, motor-car manufacturers, wire drawers, &c. The subscribers are P. Rosling, H. W. Appleby, and V. A. Fynn (electrical engineers), R. Lord, H. O. Enrich (electrical engineer), P. Milne-Milne (mechanical engineer), and J. Orerend (works manager). The first directors are P. Rosling, H. W. Appleby, and V. A. Fynn.

ST. AUSTELL & DISTRICT ELECTRIC LIGHTING & POWER CO. (LTD)—This company was registered on June 27, with a capital of £10,000, in £1 shares (300 founders'), to apply for and obtain a provisional order for supplying electricity at St. Austell, Cornwall, and to carry on the business of electricians, electrical and general engineers, &c., and to enter into an agreement with the United Kingdom Tramway, Light Railway & Electrical Syndicate (Ltd.). The subscribers are J. M. Coon (engineer), H. Hodge, A. P. Coode, E. J. H. Bluett, Major H. Tulloch, J. Parnell, C.E., and W. H. Lawley.

SCHATTNER ELECTRICITY METER CO. (LTD.)—This company was registered on June 29, with a capital of £50,000, in £1 shares (12,500 deferred), to acquire the patents of Messrs. E. Schattner, F. M. Long and F. W. Harmer relating to electricity meters, with the business at Timberhill, Norwich, and to carry on the business of electricians, electrical and general engineers, manufacturers of electricity meters, &c. The first subscribers (with one share each) are E. Schattner (engineer), F. M. Long (engineer), J. C. Wrist, R. S. Baill, F. W. Harmer, R. J. Wallis-Jones (engineer), and A. M. Billington (engineer).

SOUTH LANCASHIRE ELECTRIC SUPPLY CO. (LTD.)—This company was registered on June 29, with a capital of £10,000, in £1 shares, to carry on in South Lancashire or elsewhere the business of electrical and mechanical engineers, electricians, suppliers of electricity, manufacturers of cables, wires, lamps and electrical appliances, &c. The subscribers are the same as those of the Lewisham & District Electric Supply Co.

TYPEWRITING TELEGRAPH CORPORATION (LTD.)—This company was registered on June 26, with a capital of £100,000, in £1 shares, to acquire and develop any patents relating to electric telegraphy or telephony, or the generation, storage, and transmission of electricity, to manufacture and deal in recording telegraph instruments and other electrical apparatus, and to enter into an agreement with the Recording Telegraphs (Ltd.) The prospectus of the company was reviewed in our last issue and we learn that the shares were fully subscribed.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since June 14, 1900). Price of silver 28 7/8d. per oz. (July 5). Consols (2¾ per cent.) 99⅛—99⅜ for money, 99⅜—99½ for account; 2½ per cent. 99—99½ (July 5). Stock Exchange Settling Day: Consols, Aug. 2; Stocks and Shares Continuation Days, July 10 and 25; Ticket Days, July 11 and 26; Pay Days, July 12 and 27; Mining Share Carry-over Days, July 9 and 24.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—Warrants for the payment of interest on the £400,000 5 per cent. debenture stock for the half-year ended June 30 have been posted.

EASTERN TELEGRAPH CO. (LTD.)—Subject to final audit the accounts show after payment of interest on 4 per cent. mortgage debenture stock, dividend on the 3½ per cent. preference stock to March 31, 1900, and the interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31 last, a balance available sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both free of income tax, on the ordinary stock, both payable on the 19th inst., making with previous payments on account a total distribution of 7 per cent. on that stock for the year ended March 31, 1900. The transfer books will be closed from July 11 to July 19 inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended 31st March last of 2s. 6d. per share (tax free), payable on 14th inst. The share register is closed from 6th to 13th inst. inclusive.

W. T. GLOVER & CO. (LTD.)—Mr. A. H. Howard, who has been for some time manager of this company, has been elected to a seat on the board of directors.

GREENWOOD & BATLEY (LTD.)—The directors' report for the year ended March 31 states that, after providing for debenture interest and for management expenses, writing off £1,500 for depreciation on buildings and plant, and making due provision for doubtful accounts and allowances, the accounts show a net profit of £8,829. 7s. 4d., which with £2,955. 13s. 5d. from 1899 leaves £11,785. 0s. 9d. available for distribution. The directors recommend that dividends of 7 per cent. per annum on the paid-up cumulative preference share capital, and 2½ per cent. per annum on the paid-up ordinary share capital, absorbing £11,321. 15s. 3d., leaving £463. 5s. 6d. to be carried forward.

ROSLING, APPLEBY & FYNN (LTD.)—This company, which has a share capital of £100,000, in £1 shares, invites subscriptions for £15,000 6 per cent. cumulative preference shares and £15,000 4½ per cent. first mortgage debenture bonds of £50 each. The list closes to-day (Friday). Particulars of the registration of the company are set out in the current issue.

THOMAS PARKER (LTD.)—The annual meeting of this company was held at the works, Wolverhampton, on June 29, Mr. C. T. Mander presiding. The chairman said that for the year under review it was proposed to declare a dividend of 10 per cent., which he considered was most satisfactory. The fact that they were able to hand over £5,000 to the reserve was also satisfactory. They had not made so much gross profit during the year as in the previous one, which was hardly to be expected, because the price of materials of all sorts had gone up, and they had not thought it policy to increase the price of their manufactures in like proportion. He thought, however, the 10 per cent. dividend, and the £5,000 going to reserve, would be considered satisfactory. The directors' report was adopted.

STOCK EXCHANGE NOTICES.—The 4th inst. has been appointed a special settling-day in 70,000 five per cent. cumulative preference £1 fully-paid shares (Nos. 1 to 70,000) of the *Alliance Electrical Co.* (*Ltd.*) and the fully and partly paid provisional certificate for £100,000 five per cent. second debenture stock of the *Edison & Swan United Electric Light Co.* (*Ltd.*). The first-mentioned securities have also been ordered to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in and to grant a quotation to the further issue of 30,100 ordinary £5 shares of the *Westminster Electric Supply Corporation* (*Ltd.*) and to allow the £500,000 four per cent. debenture stock and the further issue of 100,000 ordinary £5 fully-paid shares (Nos. 490,001 to 590,000) of the *National Telephone Co.* (*Ltd.*) to be quoted in the official list.

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TYPEWRITING TELEGRAPH CORPORATION (LTD.)—We learn that the issue last week of 53,334 shares of £1 each in this company was fully, in fact, somewhat over subscribed, and the directors have proceeded to allotment. We may further state that the underwriters were relieved of their liablity, as the public came in and took the whole of the issue.

UNION ELECTRIC LIGHT & POWER CO.—Notice is given that £5, less tax, will be paid by the National Provincial Bank of England, 112, Bishopsgate-street, London, E.C., upon each $1,000 first mortgage 5 per cent. gold bond of this company deposited under the reorganisation scheme.

VOLENITE (LTD.).—A meeting of shareholders was held in Dublin on Thursday last, to consider a proposal of the Rhea Insulite Synd. to purchase the assets of the company. Mr. Thomas Falls presided, and said the proposal would come before another meeting of shareholders in London on Wednesday. The present meeting was called to ask the opinion of the Irish shareholders as to the sale. The investigation committee of the Fish, Oil & Guano Co. had decided that they could not recommend the sale at the price offered. Mr. Reeves said the works were in a state of chaos, and thousands of pounds worth of machinery had never even been unpacked. He thought the directors should be asked to explain why the business had been allowed to drift into its present condition. Mr. Kilbey said that unless they got 200,000 shares and £50,000 cash they should oppose the proposed sale. The resolution was adopted refusing the offer of the syndicate.

At the meeting in London on Wednesday, the chairman (Mr. A. J. Dudgeon) said that in March last the directors were approached with a view to the sale of the company's works at Alpertone and the British patent for volenite, &c., by a syndicate interested in the production of a mechanical rubber, and from whom, whilst under Mr. Lamplough's management, the company had received an order for 1,000 tons of raw material. There were good and substantial reasons why it was advantageous to agree to the proposed sale. This company would then have, besides the shares in the new company, the property at Gorleston, plus its foreign patents. As regarded the ability of the Rhea Syndicate (the proposed purchasers) to carry out its part of the engagement, they were assured, and believed, it had all the necessary financial power. The rejection of the offer of the syndicate was moved by Mr. T. Falls and this was carried practically unanimously. The chairman said that as the shareholders had rejected the offer the present directors would remain in office for a few days to enable a new board to be elected.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The numbers are set out on another page of a drawing, on 3rd inst., of 155 5 per cent. mortgage debentures of £100 each in this company, which will be paid off at par on Sept. 1 at the National Bank of Scotland (Ltd.), Nicholas-lane, Lombard-street, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	June30	4,452	+ 94	25	110,191	+ 6,441
Blackpool Corporation...	„ 28	729	+ 201	13	7,317	+ 1,522
Blackpool and Fleetwood	„ 30	724	+ 115	26	10,125	+ 194
Bolton Corporation	July 1	1,363	...	13	18,657	...
Bradford Corporation...	„ 1	463	+ 107	13	6,419	+ 1,393
Brisbane Trams	May 16	1,804	+ 456	7	12,694	+ 3,259
*Bristol Trams & Carriage	June29	3,148	- 66	26	74,987	+ 2,821
*Buenos Ayres & Belgrano	„ 3	1,674	- 667	22	49,946	+ 4,285
City & South London Ry.	July 1	1,490	+ 510	26	33,724	+ 6,830
Dover Corporation	June30	213	+ 2	13	2,632	+ 246
Dublin United	„ 29	3,661	+ 110	26	87,005	+13,711
Dublin Southern Dist...	„ 29	963	- 73	26	21,510	
*Glasgow Corporation ...	„ 30	9,132	+ 11	...	...	...
Hull Corporation	„ 30	1,239	...	52	41,258	...
*Liverpool Corporation...	„ 23	8,251	+1,507	25	181,001	+22,491
Liverpool Overhead Rly	July 1	1,682	+ 220	26	37,502	+ 1,310
*Sheffield Tramways	„ 1	2,386	+1,026	26	53,108	+17,252
*South Staffs. Trams.....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, June 27.	Price Wednesday, July 4.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 4. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.) ...xd	100 104	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	60 63	60 63	5 17 0	Feb., May, Aug., Nov.	60	...
£3,088,640	Stock	30/0	Do. Preferred	113½ 114¼	113½ 114½	5 5 9	„ „	114¼	113½
£3,088,640	Stock	27/0	Do. Deferred	1⅞ 13	12¾ 13½	10 7 9	„ „	13⅜	1⅞
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock..... .....x1	102 104	101 103	3 17 0	„ „	103½	102½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	6½	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	6 1 3	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures.....xd	101⅞ 105⅞	100¾ 104¾	4 6 7	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	...	...
£111,003	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.) .. x1	101 103	93 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	148 153	148 153	4 12 5	Jan., Apr., July, Oct.	151	148½
£1,826,888	Stock	3½%	Do. 3½ per Cent. Preference Stock	97 100	97 100	3 10 3	„ „	99⅜	97
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	114	112
250,000	10	6/6	Eastern Extension	14¾ 15½	14¾ 15½	4 11 10	Jan., Apr., July, Oct.	15½	14¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 117	112 117	3 9 2	February and August	...	...
£6,700	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	100 103	...	...	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100 103	...	...	„ „	112	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909..... ..	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	100⅞ 103⅞	100⅞ 103⅞	3 17 8	May and November ...	100⅛	...
180,237	10	2/6	Globe Telegraph and Trust	11¼ 11¾	11¼ 11¾	4 9 4	Jan., Apr., July, Oct.	11⅝	1⅛
180,042	10	3/0	Do. 6 per Cent. Preference	15 15½	15 15½	3 17 5	„ „	15⅝	15
150,000	10	5/0	Great Northern of Copenhagen .....ex coupon 49	32 34	32 34	3 13 6	January and July.....	...	...
£31,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)xd	100 103	98 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	53 57	53 57	4 7 9	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1911 ..	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.) ...xd	102 105	100 103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7⅞ 8½	7⅞ 8¼	4 14 1	April and October.....	8¼	7⅞
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	127	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 103	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures ....xd	100 103	99 102	3 18 7	January and July.....	...	...
88,321	10	1/0	West India and Panama	⅝ ¾	⅝ ¾	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference.....	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures ....xd	104 107	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ..	...	...	4 15 3	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15½	14⅜ 15½	4 11 10	Mar., June, Oct., Dec.	15	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1903)	105 108	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¼ ½	¼ ½	5 0 0	November	...	...
88,492	1	1/0	Do. 5 per Cent. Preference	¼ 1	¼ 1	5 0 0	„	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 15	13 15	4 5 9	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ..	5 5½	5 5½	4 15 3	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.) ...x1	98 101	98 101	3 10 3	June and December ...	100	...
171,504	1	0/3	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	2/6	United River Plate	4¾ 5½	5 5½	7 14 7	July	5⅝	...
16,689	5	2/6	Do. 5% Cumulative Preference ....xd	5 5½	5 5½	4 10 11	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)... ..xd	105 108	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, June 27.	Price Wednesday, July 4.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 4. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅝ ⅞	½ ¾	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	9	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¾ 7¼	6¾ 6¾	...	...	7	..
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9½ 10¼	9½ 10¼	4 5 9	February and August	10	9⅞
20,000	5	2/3	Do. 4½ per Cent. Preference	5¼ 6	5¼ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6¾ 7½	6 7	4 5 9	March	5⅞	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107 110	107 110	4 1 8	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	109 110	109 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8½ 9½	8¾ 9¼	4 4 3	February and August	9¾	9 7/16
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½ 13½	12¼ 13¼	4 8 11	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) ...xd	124 129	122 127	3 18 11	June and December	122⅝	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9 10	9 10	4 0 0	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½ 12½	11½ 12⅝	4 16 0	March and September	12⅛	11
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.) ...xd	110 113	108 111	4 1 1	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	6¾ 7½	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1½	1 1½	...	...	1½	1⅜
49,840	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	4 1/16	4
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98 100	98 100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½ 14½	14½ 15½	3 4 6	April and October	15	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage xd	113 116	111 114	3 18 11	June and December	...	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.) ...xd	97 99	96 98	3 11 6	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary ...xd	16 17	15½ 16½	4 4 10	March	...	..
10,000	5	5/0	Oxford Electric Ordinary	6 6½	6 6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	⅝ ¾	⅝ ¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14 15	14 15	4 16 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9¼	8½ 9½	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	—	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3¾ 4¼	3½ 4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	11 12	11 12	5 8 4	March and September	11⅝	11⅜
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜ ½	⅜ ½	8 0 0	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅝ 1	⅝ ¾	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16 1/8	1/16 1/8	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	4 4 2	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4¾ 5¼	4¾ 5¼	...	...	...	...
90,060	2	1/2⅜	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	4 5 4	September	...	...
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cum.	2 2¼	2 2¼	5 6 8	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 114	109 114	3 19 10	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.) ...xd	103 105	101 103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13½ 14½	13½ 14½	5 3 5	,, ,,	18⅝	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference ...xd	5½ 6	5½ 5¾	4 6 11	,, ,,	5⅝	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.) xd	112 116	110 114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅜ 1⅝	1⅜ 1⅝	5 16 5	...	...	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	5 6 8	...	...	..
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	3 1/16	3⅛
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.) xd	100 103	93 101	5 0 0	,, ,,	...	...
60,000	1	0/7⅛	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	..
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2¼	2 2¼	7 3 9	February and August	2 1/16	2
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4¼	3½ 4¼	6 13 4	,, ,,	4 1/16	4
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.) xd	93 95	91 93	4 6 0	June and December	92	91
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜ 5	4⅜ 5	6 0 0	Half-yearly	4⅝	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101 104	101 104	...	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 6 8	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3 3⅜	3 3⅜	4 0 0	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 105	103 103	3 16 2	January and July	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13 14	13½ 14½	6 11 0	February and August	14	13¾
30,000	5	1/6	Do. 4½ per Cent. Preference	5¼ 5¾	5¼ 5¼	3 18 3	,, ,,	6¼	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	22⅜	21
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	35 39	35 39	4 12 4	March and July	39⅛	37¼
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909 ...xd	102 105	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½ 11½	10⅝ 11⅝	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7½	6½ 7½	4 2 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 105	105 108	3 13 8	May and November	105½	105
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½ 18½	17½ 18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102 104	103 105	4 16 7	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	23½ 23¾	22½ 23¼	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully paid) ...xd	10⅜ 10⅝	10⅜ 10⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures ...xd	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10⅞	10½ 10⅞	4 13 0	May and November	10⅝	10 5/8
30,000	10	11/0	British Elec. Trac. Ord. (Nos. 1 to 30,000) xd & rights	16 17	14 15	4 0 0	...	14⅛	14½
15,000	10	8/7½	Do. (Nos. 60,001 to 75,000) ...xd & rights	15 17	14 15	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref. ...xd & rights	12½ 13½	12 13	4 12 4	February and August	12⅝	12½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	125 126	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (Issued Feb. 5, 1900)	120 123	120 124	...	...	121½	...
40,000	5	2/8 1/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5 5½	5 5½	5 14 4	...	5⅝	5 1/16
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	101 104	100 103	4 17 1	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk. Prov. Certs (£57½% to be pd.)	38 41	38 41	...	...	...	...
206,297	10	3/0	Central London Ordinary	10¼ 10⅞	9¾ 10⅛	2 15 6	June and December	10⅛	9⅞
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	65 66	64 66	2 16 9	February and August	66	...
370,500	10	1/5 1/16	Do. (Nos. 24,501 to 60,000)	6 7	6 7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	,, ,,	130½	...
£200,000	Stock	5%	Do. (1898)	132 137	132 137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123 123	123 123	3 2 6	May and November	...	...
20,000	10	8½	†Imperial Tramways Ordinary	22½ 24½	22½ 24½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture ...xd	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	⅛ ⅜	⅛ ⅜	32 0 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	¼ ⅜	1/16 ¼	24 0 0	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9¼ 10	9¼ 10⅜	4 16 2	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8½ 8¾	9¼ 9⅜	4 5 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13¾	13½ 13¾	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3⅝	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4¼ 5¼	4¼ 5¼	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 18	18 18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜ 10¾	10⅜ 10¾	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	10 11	4 10 11	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	100 103	98 101	2 19 5	June and December	100	99

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,156. [No. 12, Vol. XLV.] FRIDAY, JULY 13, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 20fr., or 16gr.

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NOTES.

It is satisfactory to note that the remaining three important power bills—the South Wales, the Lancashire and the Durham County bills—have finally passed the committee stage in the House of Commons, and have been reported for third reading. We are also gratified to see that the ambiguities pointed out in our recent leading article have been to a large extent removed by the final wording of the clause defining and limiting the powers of the companies supplying electrical energy, and of the local authorities within the areas affected.

Local authorities have done much to impede the advance of electrical engineering in this country by their opposition to new tramways and power distribution schemes, but the climax has surely been reached when the Richmond Town Council actually protests against the establishment of a National Laboratory in the borough of Richmond to promote the development of physical science and of the industries depending upon it. The contention that a physical laboratory is likely to disturb the quietness of the neighbourhood is flagrantly absurd. We are glad that a counter-deputation of those interested in the National Physical Laboratory has applied the necessary correcting coefficient to the ideas which the first deputation sought to impose upon Mr. Hanbury.

In our Parliamentary Intelligence columns will be found answers by Mr. Ritchie in the House of Commons on the subject of wireless telegraphic communication with lightships. An inter-departmental committee has been appointed to consider the question. As long ago as October, 1897, the Royal Commission on Electric Communication with Lighthouses and Lightships recommended in their final report :—

> Having regard to the present expense of establishing and electrical communication with light vessels, the Commissioners do not fee justified in recommending the connection of any more of those stations until the ethereal system at present under trial has been fully tested. In the event, however, of any improved system rendering the maintenance of communication with light vessels less costly than it now is, they are of opinion that the East Goodwin, Cross Sand, Kish, Tongue and Sunk lightships have the first claims to consideration, together with the Scarborough lightship already recommended.

The "ethereal system" can be deemed to have long ago passed the experimental stage, so far as communication between lighthouses and lightships and the shore is concerned, and it is certainly not costly; yet, while both France and Germany have already made successful use of it for this purpose, the supreme maritime power has got no further than to relegate the matter to an inter-departmental committee.

Signor Tommasina's observations on the luminosity of the elongated primary Hertzian wire known in wireless telegraphy as the mast-head wire or "feeler" (*antenne*) promise to furnish some valuable indications with regard to the efficiency of the various connections and apparatus used. For the luminous phenomena described in Mr. Fournier d'Albe's note in another column are in intimate relationship with the period of the oscillator and of the induction coil; and if they can furnish a test for the synchronism of both they may also serve to reveal other advantages or defects. From the point of view of efficiency, the very occurrence of such luminous effects is of course a sign that there is something wrong, for the energy spent in producing both these and the sound effects sometimes heard is deducted from the supply of energy available for the transmission of the signals. From the theoretical point of view, however, the effects described are of great value and interest. The waves emitted by the vertical feeler are cylindrical waves. They are not the waves as ordinarily transmitted along a wire system like that of Lecher, but are of a secondary type produced by the abrupt termination of the wire. The luminous effects are evidently connected with the finite conductivity of the wire. An examination of their behaviour in a vacuum would probably reveal some close relations between them and the ordinary luminous effects in a vacuum tube.

Within the last few days we have had the opportunity of inspecting two different specimens of instrument, termed by their inventors "telephonograph" or "telegraphone," but for

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which we would suggest the simpler name "recording telephone." The idea is one that has been self-evident since the introduction of the telephone and of the commercial form of phonograph, viz., that it should be possible, by a combination of these two instruments, to record a message transmitted from a distance through an ordinary telephone line. We believe that EDISON worked at this problem, and that he even constructed a working instrument in his laboratory; at all events, this was among the applications of the phonograph which were suggested when the wax cylinder instrument was first put upon the market. Possibly EDISON, who has always been an acute man of business, did not consider that the financial gain accruing to the maker of such a machine would compensate for the time spent in working out the necessary details. Now, however, that the telephone has become almost one of the necessities of commercial and social life, an efficient and reliable recording telephone is certainly a desideratum, and it is to be hoped that the necessary details of the construction and application of such an apparatus will soon be worked out.

A LOUD-SPEAKING telephone, held in front of a receiving diaphragm of a phonograph, will undoubtedly cause a record to be traced on the wax cylinder, but the result, on reproduction, is a considerable distortion of the voice. Mr. E. O. KUMBERG, whose instrument we examined and tested at Messrs. JOEL & Co's offices this week has, it appears, set himself the task of diminishing this distortion, but up to the present it can hardly be said that he has been eminently successful. He makes use of the ordinary phonograph, adding to it only a loud-speaking telephone receiver in place of the usual receiving diaphragm. This attachment is a large two-pole receiver with a strong magnet of elliptical section similar to that of the two-pole Bell receiver, but larger. This is enclosed in a brass cylinder, and a fairly thick tin plate serves as a diaphragm and is clamped with a brass drumhead. Attached to the centre of the diaphragm is a short stiff wire terminating in the centre of a mica diaphragm, to which it is also rigidly attached. A brass eyelet is let into the middle of the mica diaphragm, and the cutting style is connected to this by a simple chain link. The style is hinged, and a hinged brass flap, to which the fulcrum of the style lever is attached, acts as a weight, pressing the style against the wax cylinder and compensating for any inequalities in the surface of the latter. This arrangement, when used with a "Hunningscone" transmitter and four No. 2 wet porous-pot Leclanché cells, certainly reproduced sounds loudly, and also traced a record on the phonograph cylinder deep enough to actuate the ordinary speaking diaphragm; but the articulation was in both cases most indistinct.

THE other instrument, due to the Danish engineer WALDEMAR POULSEN, was referred to in *The Electrician* for May 4th last, and is described in one of Mr. FOURNIER D'ALBE'S notes in this issue. The apparatus is on view at the Paris Exhibition, but it is not actually in operation there. In the experimental type, shown a steel wire is wound spirally on an insulated cylinder which is rotated by clockwork, moving forward each revolution by a distance equal to the pitch of the spiral. A small electromagnet is connected in place of the receiver when receiving and simply in series with the local receiver when recording. The same magnet also serves for erasing the record when traversed by a continuous current. The speed at which the wire moves past the electromagnet is very fast; in the portable instrument shown at the Paris Exhibition it only takes three minutes for it all to pass. Some idea of the experimental stage in which this invention still is, may be gathered from the fact that it was found too difficult at the Exhibition to make the necessary adjustments in order that the working of the apparatus might be demonstrated to visitors. A cheap and efficient recording telephone would certainly be a boon to telephone subscribers, but its realisation appears at present to be somewhat remote.

The 1,000 Miles Automobile Trial.—The judges' report on this trial, which took place between April 23 and May 12, together with the list of awards, has been issued. The conditions were such, however, that no electric vehicle took part in the contest.

Canadian-Azores Cable.—Messrs. Siemens Bros. & Co.'s cable steamer "Faraday" arrived at Fayal, Azores, on Tuesday afternoon, all well, and proceeded to lay the shore end of the Fayal-Canso cable for the Commercial Cable Co. As stated in a previous issue, about 600 miles of this cable were laid some time ago from Canso towards the Azores.

University of Birmingham.—At a meeting of the Council of the Birmingham University on Friday last week, the new Principal, Dr. O. J. Lodge, was welcomed by the Vice-Chancellor. A communication was also received announcing the election of Prof. Poynting as Dean of the Faculty of Science. Mr. G. Leigh Shakespear has been re-appointed assistant lecturer in physics.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Paramaribo—Cayenne	Feb. 16, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Gibraltar—Tangiers	June 28, 1900 ...	July 5, 1900
Hong Kong—Macao	June 28, 1900 ...	July 9, 1900

Long Distance Power Transmission.—With regard to Prof. Forbes' Paper before the Institution of Electrical Engineers "On Distant Electric Power Transmission," Mr. Reginald Wood writes us that "the most advantageous method of transmission" was described in his patent specification No. 10,218 of 1893, and that it is to have frequent feeding points and "on each feeding point to have an accumulator and boost on the current to the next feeding point so as to keep the line under full pressure."

Electrical Winches and Cranes.—In the course of the report of the chief inspector of factories for the year 1899, it is stated in the section referring to dock accidents, that there is a decided tendency to replace many existing steam cranes by hydraulic cranes or electric winches and crabs, except in those docks where only few cranes are necessary to cope with all the traffic. Steam cranes, however, appear likely to continue in use at smaller wharves and quays, where they have to carry goods from one spot to another as well as hoisting them. It appears that hydraulic cranes are at present employed to a greater extent than electric cranes, the report stating that the latter are in use in only a very limited number of docks or wharves.

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Obituary.—We regret to report the death of Señor Don Francisco de Paula Vasquez, who died at Madrid on the 24th of last month after a short illness. Señor Vasquez, who was only 61 years of age, had been a high official in the Cuerpo de Telegrafos, and was Honorary Local Secretary in Madrid of the Institution of Electrical Engineers, as well as agent for the Spanish National Telegraph Co. and the South American Cable Co. Many of our readers will have pleasant recollections of meeting Señor Vasquez at the telegraph conference at Paris, where his kindly humour and sympathetic manner gained for him many English friends, who will join in expressing condolence with his family and with his many friends in Spain.

Continuous v. Polyphase Current for Electric Tramways.—In a Paper read before the Zürich Engineering and Architectural Society, an abstract of which is given in the *Journal* of the Institution of Civil Engineers, M. E. Huber gives a table showing the comparative costs of installation of an electric tramway 12½ miles long in the two cases of continuous and polyphase current. The calculation is based on a service of five cars in use at once, one car at each end, and the remaining three at a distance of three miles apart; each car is assumed to take 20 kw. The tram is made up of a motor-waggon and one or two trailer cars, the whole weighing 20 tons. The maximum gradient is assumed to be 1 in 20. The trams run at intervals of 30 minutes at speeds of 12 to 15 miles per hour. The overhead trolley system is assumed to be used, and the pressure for continuous or polyphase current is in both cases taken as 500 to 600 volts. In the case of continuous-current working, with the generating station in the middle of the line, and an efficiency of 80 per cent., the total cost of the electric part of the work in the power station, along with overhead wire to feeders, would be £4,600 and an annual expenditure of £532 for wages, interest and sinking fund; with polyphase current the initial cost would be £5,400, and the yearly expenditure £618. 16s. If the generating station were at the end of the line, and the efficiency again taken as 80 per cent., the total initial costs for the continuous and polyphase currents are calculated to be £10,000 and £5,500 respectively, and the annual cost £856 and £626 respectively. With the station at the end, and transmission by polyphase current, and feeding by continuous current with an efficiency of 70 per cent., the figures would be £8,720 and £1,099.

Electrical Power Distribution in Factories.—The *Engineer* states that the motive power for the works of the Westinghouse Air Brake Co., formerly consisting of a central boiler plant, supplying steam to 30 Westinghouse steam engines located in the various buildings, has been recently replaced by electrical power, generated at a central station and distributed to the several shops. There was about 4,000ft. of steam piping, the condensation in which represented a loss of about 50 H.P. The boiler plant remains unchanged, and consists of 16 Babcock and Wilcox water-tube boilers, aggregating 2,000 H.P., fed by automatic stokers and worked at 125lb. pressure. The ratio of grate surface to heating surface is as 1 to 52·8. The only ones of the former steam engines which have been retained are two of 10 H.P. for the exciters, and those for the stokers, air pump, and rotary pump in the boiler house. In the power station are three Westinghouse-Parsons steam turbines, each coupled to a bipolar alternating generator, running at 3,600 revs. per min., and delivering current at 400 volts. There are also two exciter units, delivering current at 100 volts, the air pumps and condensers for the turbines, driven by a 50-H.P. motor, and two air compressors driven by 100 H.P. motors. All the motors are of the Westinghouse induction type, belted to the original line shafts, which run at 112 to 175 revolutions, an increase of about 12 per cent. in speed. Countershafts are largely dispensed with. In the machine shops there are 25 motors aggregating 435 H.P.; boiler house, three motors, 60 H.P.; blacksmith shop, two motors, 50 H.P.; brass foundry, three motors, 35 H.P.; iron foundry, 13 motors, 185 H.P.; leather room, two motors, 25 H.P. Total, 48 motors, 790 H.P. There are also 2,500 incandescent lamps and 60 arc lamps of 100 hours' capacity, all taking current at 110 volts.

Photometry of Enclosed Arc Lamps.—At the Convention of the American National Electric Light Association, held in Chicago last month, a report on this subject was submitted by a committee, consisting of Henry W. Doherty, W. E. Goldsborough, and J. Q. Brown, appointed to carry out measurements on various types of enclosed arc lamps, under various conditions of current supply. By an ingenious arrangement of apparatus, devised by Prof. C. P. Mathews, who carried out all the photometric measurements, it is stated that the measurements were carried out with an accuracy equal to that with which the comparison of monochromatic sources can be made. Two mirrors, placed on either side of the arc, were used to reflect the light on to the photometer screen, and a sectored disc was used to reduce the intensities of the two lights to be compared down to a point at which the colour difference ceased to be troublesome. The experiments were made with enclosed arcs only, and the following results for watts per c.p. were obtained, the arc being here considered as a light producer and not as a light distributor. I. Continuous current 110 volts—(i.) Opalescent inner globe, no outer, 2·10 watts per c.p.; (ii.) Opalescent inner, clear outer, 2·66 watts per c.p.; (iii.) Opalescent inner and outer, 3·04 watts per c.p. II. Alternating current, 110 volts—(i.) With clear outer globe, 2·62 watts per c.p., and (ii.) with opalescent outer globe, 3·20 watts per c.p. A suitable shade was stated to increase the mean spherical intensity of a lamp having a clear outer globe, in the ratio 254 : 169—*i.e.*, by 50 per cent. The conclusion finally arrived at by the committee is that, with a suitable shade such as it is recommended should be invariably employed for street lighting, the direct-current enclosed arc, without shade, gives 89 per cent. more useful light than the alternating current enclosed arc, with shade, and at slightly greater economy. The above candle powers are all expressed in Hefner units.

Power used in Machine Tools.—The *Engineering Magazine* quotes from an article by Herr Loch in *Glaser's Annalen* some interesting information as to the power required by various machine tools in the railway shop at Gleiwitz. In this shop there are 107 electric motors of various sizes used for running tools and other machines. When the machines were bought it was found that the makers themselves were generally ignorant of the power required to run them, and so there were some mistakes made in choosing suitable motors, some being too weak and some too strong for the work they were called upon to perform. A great many measurements were taken at Gleiwitz to determine the proper size of motor to run the various machines, and there is a list of 57 tools, with their corresponding motors, in the original German article. Among other results, it was found that a planer with a working surface 300cm. by 100cm. needed a 5 H.P. motor, while another one, 160cm. by 85cm., took 3 H.P. A shaping machine, with a 30cm. to 40cm. stroke, used 2 H.P., the same as a circular saw 50cm. in diameter, while small and medium lathes required 1 H.P. to 2 H.P. A horizontal milling machine was satisfied with 1 H.P., borers and drills of various styles and sizes needed from 1 H.P. to 6 H.P., emery wheels, 2 H.P. to 4 H.P. The no-load power consumption of car-wheel lathes of different makes varied from ·63 kw. to 1·9 kw. The reversal of the motion or the quick back-stroke of the working parts often, it is stated, demands the greatest outlay of energy, in the wood-planing machines, for instance, requiring more than the working stroke. The influence of different speeds on the power consumption is shown by the following example: A shaping machine required 1·7 kw. to 2·3 kw. at starting. When running light is used:—

At 10 strokes per minute and 18cm. length of stroke, 0·46 kw.				
At 16	ditto	18cm.	ditto	0·53 ,,
At 24	ditto	18cm.	ditto	0·59 ,,
At 38	ditto	18cm.	ditto	0·85 ,,
At 38	ditto	10·5cm.	ditto	0·63 ,,
At 38	ditto	30·9cm.	ditto	1·38 ,,

When working with a 4mm. cut, at 16 strokes per minute and 18cm. length of stroke, only 0·85 kw. was consumed.

The 107 motors in the main shop have a combined output of 334·5 H.P., and require 331 kw. at their terminals, or 347 kw., including the loss in the conductors leading to them.

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If all the motors had been made large enough for their work, they would have had an output of 454 H.P., and the corresponding consumption of energy would have been 426 kw., or 461 kw., including the line drop. When running under normal conditions the motors use, on an average, from 250 amperes to 450 amperes, at 220 volts. The total energy consumed per month is about 15,000 to 20,000 kilowatt-hours. From these figures it follows that the average load of all the 107 motors is only from 16 to 29 per cent. of their normal capacity.

A Portable Zinc—Lead-Peroxide Primary Battery.—In Nos. 8 and 9 of the *Centralblatt für Accumulatoren und Elementenkunde* Herr W. A. Th. Müller gives a description of a portable zinc—lead-peroxide cell, which was exhibited at the Berlin International Motor Exhibition last year, and curves are given showing the output of the cell under different conditions. The chief feature of novelty in the construction of the cell is that the electrolyte is contained in a concentrated form in the pores of the peroxide plate, and that the plates when once thoroughly formed, can be kept stored away without deterioration for nearly a year, and when they are required for use a normal electrolyte is obtained by placing them in water. The lead peroxide plates are of the lattice grid type, and the wide meshes are filled in with an active material composed of litharge and alum crystals blended into a plastic mass with a solution of caustic potash by a patented process. The result is a very hard and porous plate. When the forming process is complete the plates are raised from the bath and run along on a carrier to a drying chamber, where all the water is evaporated from them, so that when they are lowered into a vat of strong sulphuric acid they absorb it freely. When the absorption is complete the plates are lifted out of the acid and coated with dry, ground potassium silicate, to prevent the sulphuric acid taking up moisture from the air, and after this coating the plates are stored away in a dry place. The negative electrodes used in this cell are formed of zinc plates, whose thickness varies from 1·5mm. to 3mm. according to their size. These plates are set up in hard rubber or celluloid boxes, so that there is room between them for the insertion of the peroxide plates. The battery boxes are closed by covers provided with contact knobs which make connection between the individual plates of like sign, which answers well for small currents, and has the advantage that when the lid is removed any plate can be taken out separately for examination without disturbing the remainder. For large currents the method is unsuitable, as the heating of the knobs causes the celluloid to take fire, and so lead-coated iron hooks have to be employed. When the battery is discharged the peroxide plates are removed and regenerated, and the spent solution is withdrawn. The cells are filled up with fresh water, and fresh peroxide plates are inserted, when it is required to use the battery again. The zinc plates can be used several times before they require renewal, so that all that is needed to enable the battery to work continuously is to keep a supply of peroxide plates close at hand. These positive plates are made by Adolf Krüger, of Berlin, according to Messrs. Rothmund von Burgwall's and L. Ofenschüssl's patent. In his article Herr Müller describes experiments which have been conducted with this battery, and discusses the economic considerations involved in its use.

Light Railway Commission.—In a Paper read at the recent meeting of the Tramways and Light Railways Association at the International Tramways and Light Railways Exhibition, Mr. R. H. Scotter reviewed the work of the Light Railway Commission since it came into existence. Referring to the non-political or rather dual-political character of light railway agitation, and the rapidity with which the facilities afforded by the Light Railways Act of 1896 were taken advantage of all over the country, he stated that, as the act itself expires next year, the Association would render a service to the public and the tramways and light railways industry generally by discussing freely the working of the act and submitting to the proper quarters some practical suggestions for its improvement. He considered the delegation of the duties hitherto performed by the House of Commons to the Board of Trade and Light Railways Commission had been an unqualified success, as the system of local inquiry had done much to interest local bodies and the public generally in our railways and tramways. As evidence of the success of the movement, he gave the following figures:—

> Between December, 1896, and May 31, 1900—3½ years—proposals, plans, and estimates have been received by the Commission for a mileage of 2,800 miles, a length greater than the total mileage of Irish railways, equal to the London & North-Western and London & South-Western combined, and greater than our longest railway, the Great Western, and more than double the total mileage constructed in 30 years under the Tramways Act. . . . Places as far distant and as dissimilar as Penzance, Wick and Inverness, Colwyn Bay, Bedgelert and Southend-on-Sea have benefited by the act, as well as the most thickly populated manufacturing centres in the North and Midlands of England and in the metropolitan area. During the years 1897-8-9-1900, the Commissioners have held 208 local inquiries into the merits of 247 schemes, the general result being that 55 per cent. were granted, 24 per cent. rejected, 14 per cent. withdrawn, and 7 per cent. remain to be dealt with.

While the Commission itself has, in Mr. Scotter's opinion, done its work well, he finds fault with the delay due to other sources in putting schemes into effect:—

> When the Light Railway Commissioners have satisfied themselves that a scheme is a good one, we should think the Board of Trade, the Commissioners, promoters, solicitors, and all concerned, would hurry matters forward, so that the line might come into existence as soon as possible. But such is not recent experience. . . . The average time between the deposit of the plans and the issue of the order is 16 months, or nearly double the time required for the obtaining of similar powers per Act of Parliament or provisional order. Of this period not more than six months elapses between deposit and local inquiry; hence, on an average, 10 months are occupied in the process of "settling the order." Here, then, appears to be one weak spot in the constitution of the Light Railway Commission. More help is required, in order that the order, when once approved, may be rapidly settled. This point has been brought out very forcibly by the Commissioners in their reports.

He suggests as a remedy for this evil an increase in the number of Commissioners and the granting to them of some additional powers by which they might spur on promoters, objectors, and their solicitors to prompt action within a given time. He next refers to the relations between light and heavy railways, pointing out that the former tap new districts, and that they must rely largely on creating new traffic. "When it has been created and nursed it will not be fair that our quasi-benevolent neighbours—the railway companies—should *then* swoop down and take all the profit." The author also warns promoters that some County Councils (other than the London County Council) are making efforts to obtain a clause in each light railway order in their area that, at the expiration of 25, 30, or 35 years, they shall have the power to purchase the undertaking if the local authority fail to do so. On the terms of the act and the relations between light railways and tramways, the following passage is of interest:—

> Cannot this new bill be made to settle once for all the supposed difference between a light railway and a tramway? Cannot we ineist upon the Tramway Act, 1870, being revised at the same time? I beleve it will be possible to effect such a change, if we show ourselves desperately in earnest about the matter. It will be noted that the Light Railway Commissioners themselves divided all applications into two classes: (*a*) Light railways resembling ordinary railways; (*b*) Lines which may be shortly described as road or street railways. By approving over 250 miles of the latter class, they have set their approval on the use of the ordinary roads of the country for the carriage of both passengers and goods traffic. I believe this practice to be a good one, and that it opens up an enormous field for electric traction, as steam locomotion is by no means suitable for this purpose. . . . In revising the Tramways Act our policy must be to get rid of Clause 43. Parliament has gone half way by allowing promoters of light railways a longer time than 21 years in which to recoup themselves. Here, again, tramways and light railways should be put on the same footing.

Finally, the author says:—

> On the question of financing light railway and tramway undertakings, I will content myself with mentioning the fact, that although Parliament some four years ago sanctioned the spending of £1,000,000, by way of loans at 3½ per cent. for the purpose of helping the development of light railways, the concession is so hedged in by "provided thats," that so far only half-a-dozen grants have been promised. I think that the future of the movement depends very largely upon the support private enterprise can give it, and in this direction I would point out that, although investors have not given great attention to light railways, they will certainly become paying concerns in the future. The Board of Trade and the Light Railway Commissioners exercise such a rigid control over the financial side of the matter, that over-capitalisation is practically impossible.

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THE CENTRAL LONDON RAILWAY.

(*Continued from page 357.*)

The Power Station (continued).—Continuing our description of the equipment of the power station, our readers will remember that we were describing the main generating sets when the course of our articles was interrupted by the opening ceremony. These six three-phase sets are all constructed alike, and possess the same electrical, magnetic and mechanical characteristics. An immense number of tests have already been carried out upon these generators, the results of some of which are embodied in the accompanying series of curves, Figs. 18 to 26. The weight of the magnet wheel is 34,000lb.,

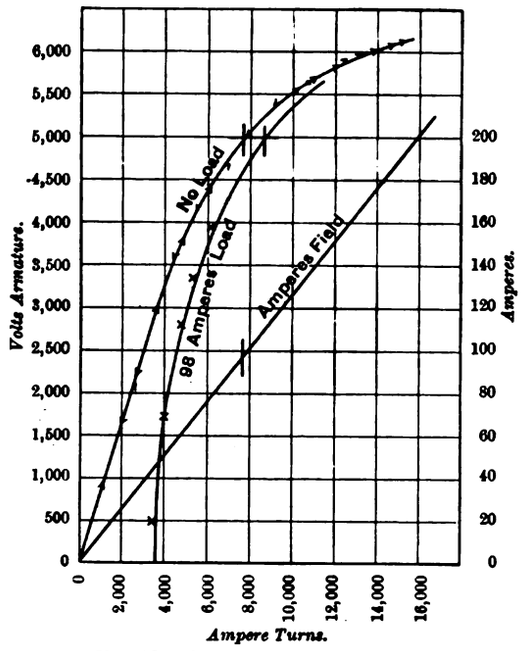


FIG. 18.—Observed Saturation Curve.

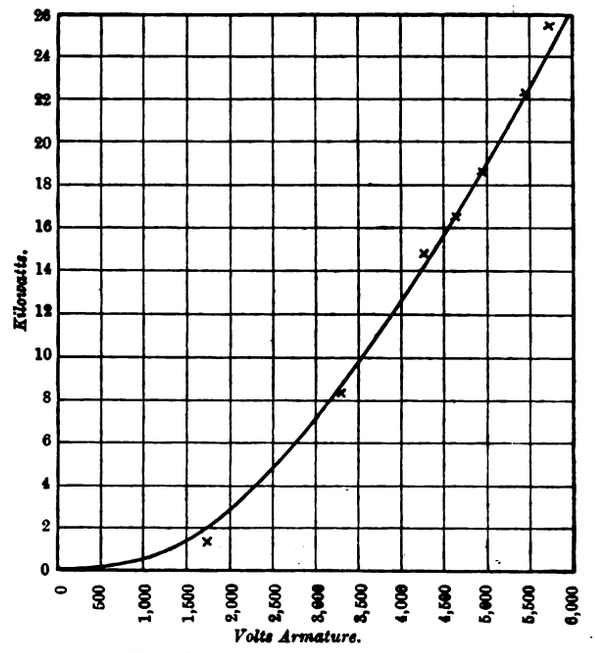
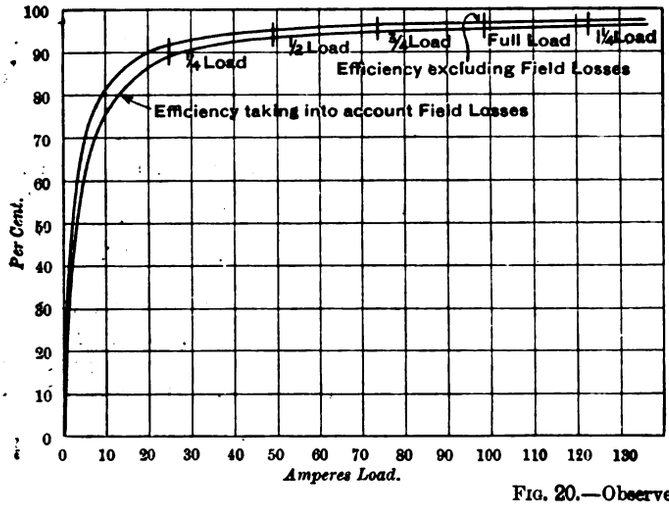


FIG. 19.—Observed Core Loss Curve.



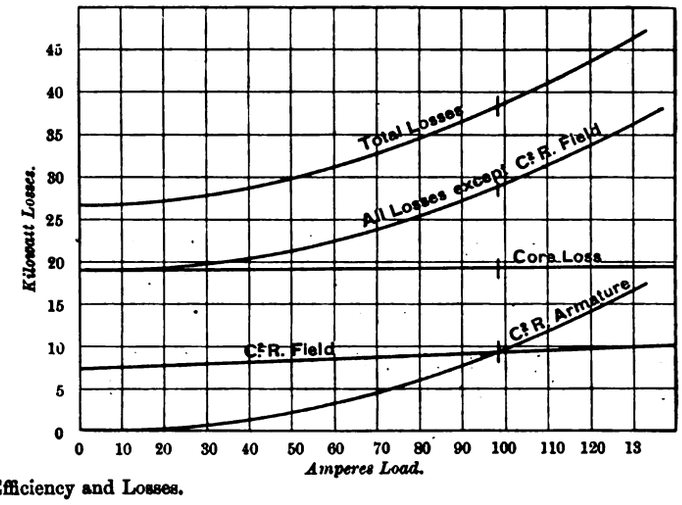
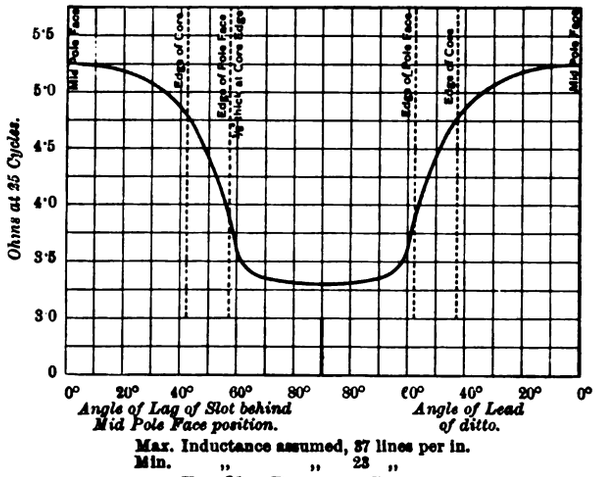
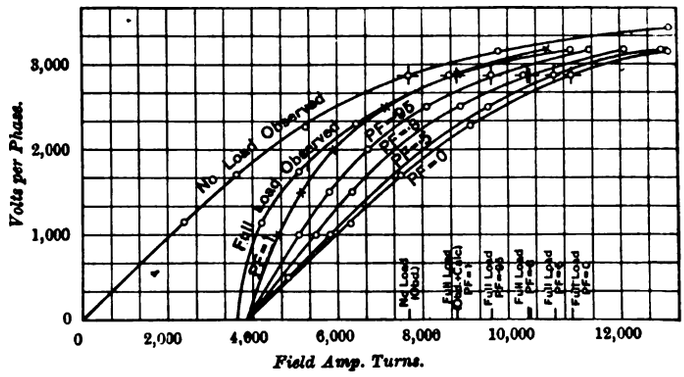


FIG. 20.—Observed Efficiency and Losses.



Max. Inductance assumed, 37 lines per in.
Min. " " 23 "

FIG. 21.—Reactance Curve.



In calculating these Curves the No Load Observed Curve was used.
Inductance assumed constant.

FIG. 22.—Saturation Curve. For Full Load and various Power Factors.

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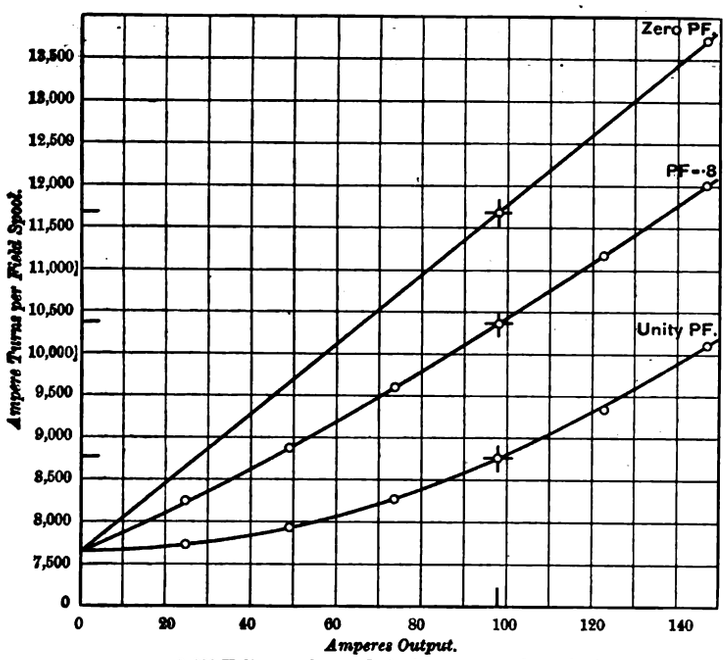
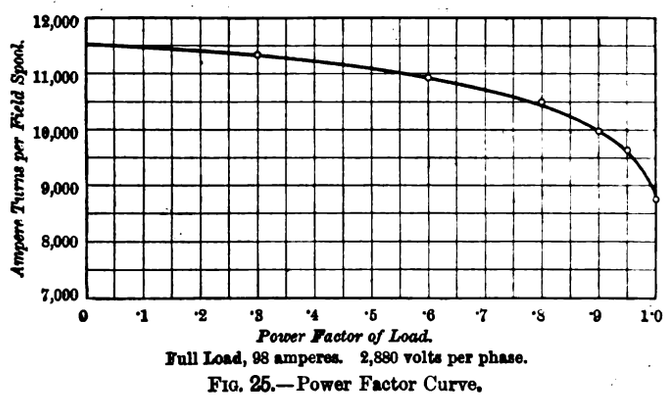
that of the armature iron 4,500lb., and that of the complete armature 48,000lb. The power required to excite each machine



2,880 Volts per phase. Inductance assumed constant.

FIG. 23.—Excitation Regulation.

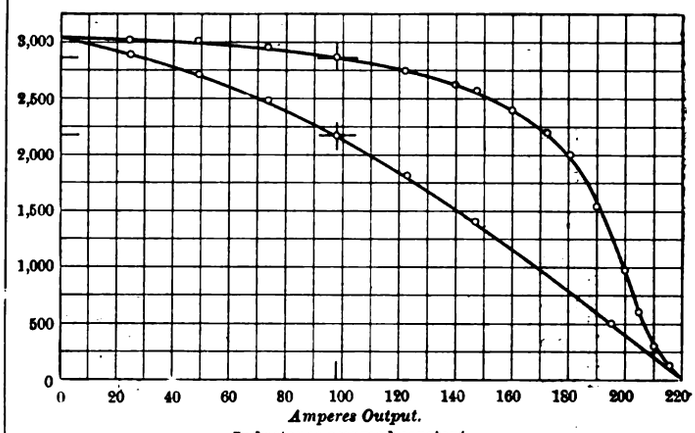


Full Load, 98 amperes. 2,880 volts per phase.

FIG. 25.—Power Factor Curve.

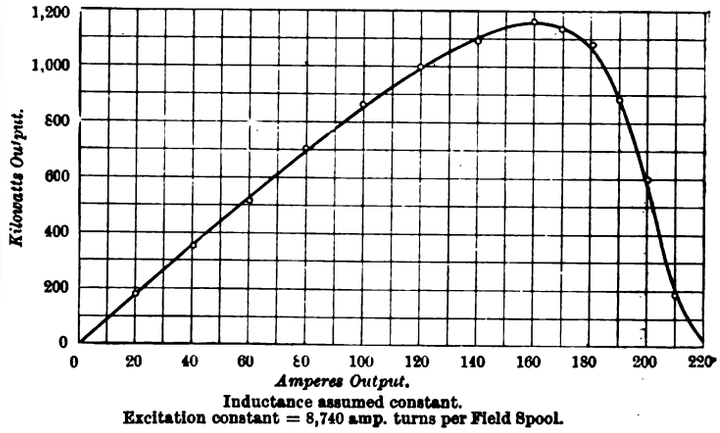
at full load is 13·75kw., the variation of field regulating resistance between no load and full load being about 0·014 ohm.

lines per sq. in. The curves need little description. Fig. 18 shows the observed saturation curves at no load and with a load of 98 amperes. Fig. 19 gives the core loss with different excitation of the field as measured in volts on the armature.



Inductance assumed constant.
Excitation constant = 8,740 amp. turns per Field Spool.

FIG. 24.—Volt Ampere Curve. (Inherent Regulation.)



Inductance assumed constant.
Excitation constant = 8,740 amp. turns per Field Spool.

FIG. 26.—Characteristic Output Curve. Unity P.F.

Fig. 20 gives the efficiency curve and dissects the various losses. Fig. 21 shows the reactance diagram. Fig. 22 shows the saturation curve for full load and for loads giving various power factors between 0 and 0·95. Fig. 23 is the excitation

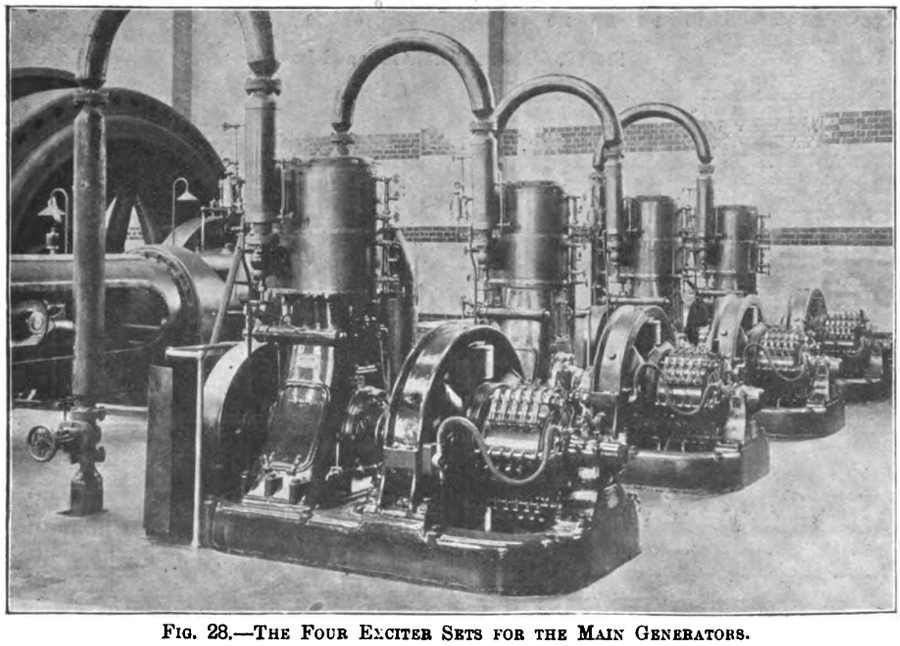


FIG. 28.—THE FOUR EXCITER SETS FOR THE MAIN GENERATORS.

The magnetic induction density in the pole faces is 91,100 C.G.S. lines, in the yoke 54,700 lines and in the core 50,200

regulation curve for various power factors between zero and unity. Fig. 24 shows the volts corresponding to different

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amperes of output and indicates, therefore, the self-regulation of the machine. Fig. 25 gives an important curve showing the relation of the power factor to the excitation, while Fig. 26 is the main characteristic output curve assuming a power factor of unity.

In addition to these main generators, and the spare space for two similar generators when the need for extension arises, as it shortly will do, there is a considerable amount of floor

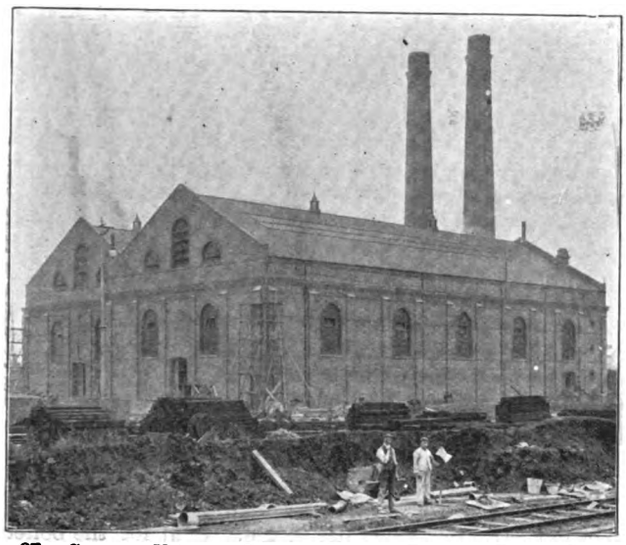

Fig. 27.—General View of Central London Railway Power Station.

space set apart for the exciter sets and the station lighting sets. The exciter sets shown in Fig. 28 are four in number. Each consists of a vertical enclosed tandem compound single-crank Allis steam engine, direct-coupled to a multipolar continuous-current Westinghouse generator. Each set runs normally at 400 revs. per min. The engine cylinders are 9½in. and 15in. diameter respectively, and the stroke is

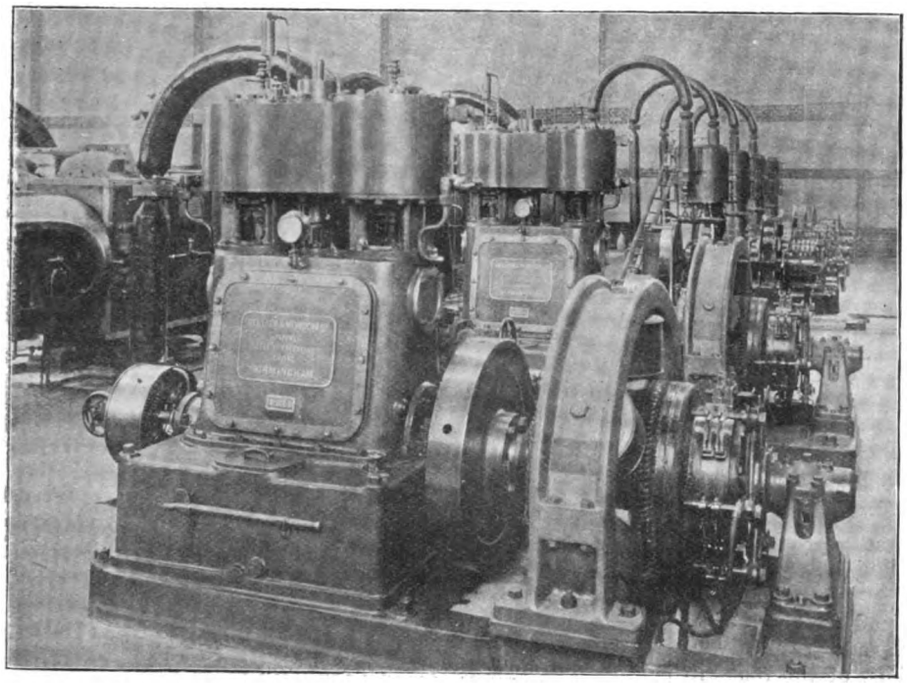

Fig. 29.—View Showing the Two Station-Lighting Sets in Foreground.

6in. At the normal speed, the rated output and pressure are 50kw. at 125 volts. The exhaust steam from these exciters, as also from the two station lighting engines, is taken to a Wheeler surface condenser in a small annexe adjoining the main machinery room. The station lighting sets, two in number, are shown in Fig. 29. They differ considerably from the exciter sets, consisting as they do of Belliss enclosed vertical two-crank steam engines direct coupled to Westinghouse multipolar generators. The output of these sets is also 50kw., and the dynamos have also the same number of poles as in the exciter dynamos, viz., six poles. Connections from the exciter and station lighting sets are taken to special panels on the main switchboard, which is erected on a spacious gallery almost immediately over the sets. In our next article we shall describe these switchboard arrangements.

(To be continued.)

SWANSEA ELECTRIC TRAMWAYS.

Swansea, although ranking as the second town in Wales, has taken the lead in adopting electric traction. On Saturday, June 30th, the electrical working of the Swansea tramways system was successfully inaugurated. It is hardly necessary here to say more about the history of the inception of electric traction in this town beyond recalling to our readers' memories the fact that in May, 1897, the Corporation applied to Parliament for a bill empowering them to purchase the tramway undertaking of the Swansea Improvements and Tramways Co. The Corporation proposed substituting electric traction for horse power, erecting a dust destructor, and putting into effect their electric lighting powers. These proposals, known as the triple scheme, met with such effective opposition that the bill was rejected, whereupon, in July of the same year, the tramways company in the face of the Corporation's opposition successfully applied for powers to convert their lines for electrical operation, subject to their keeping the roads in repair to the satisfaction of the Corporation. Eventually the British Electric Traction Co. acquired the undertaking, and proceeded to equip the lines on the overhead trolley system.

Owing to delay in the delivery of plant, the work of conversion was seriously hindered, and it was not completed till the early part of May, although a trial trip on the Cwmbwrla route took place about the beginning of April.

The accompanying sketch plan shows the present extent of the tramways. It will be noticed that the tramway depôt and power station is situated at St. Helen's—at one end of the system. The site is that of the old tramways depôt and the original car sheds have been reconstructed and fitted with the necessary pits for the inspection and repair of the motors and trucks.

Although at present excentrically situated, the power-house will be quite central when the company has converted the Mumbles Railway (now worked by steam) to electric traction. The eastern end of this latter line, is shown in Fig. 1 terminating near the Victoria Station of the London & North Western Railway. The total length of this light railway from Swansea to within about a mile of Mumbles Head, the western horn of Swansea Bay, is about 5½ miles. The company has taken up a long lease of this railway as well as the pier and intends to adopt electric tractionon it as soon as possible.

The total length of route at present served by the tramways is about 5½ miles, and the system may be described as consisting of an almost complete little loop in the town from which there radiate four branches—one to the power station at St. Helen's, one to the docks, a third to Cwmbwrla, and the fourth (and longest) to Morriston. Three feeders leave the station and serve respectively the centre of the system,

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the Cwmbwrla and the Morriston branches. The most hilly route is that to Cwmbwrla, but there are practically no bad gradients in combination with curves. The chief gradient is one of 1 in 22, although there is a trifling length at 1 in 15. The sharpest curve is one of 40ft. radius.

Our Figures 2, 3 and 5 give examples of the span wire, bracket arm, and centre pole line work employed at Swansea. Fig. 5 shows the work at Cwmbwrla bridge. The trolley wire is of No. 0 S.W.G. (0·324in. diameter) copper and the metals of 86lb. girder rail. The return circuit afforded by the rails is supplemented from a point half-way along the

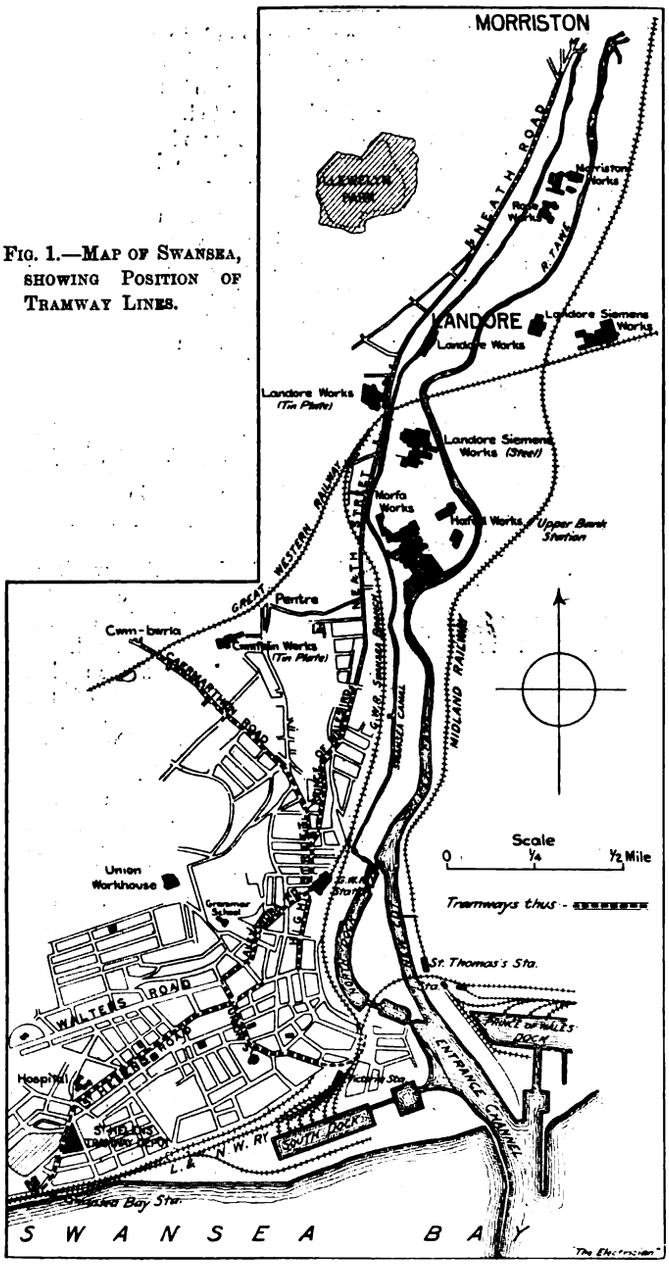

FIG. 1.—MAP OF SWANSEA, SHOWING POSITION OF TRAMWAY LINES.

Morriston section by two 37/12 Callender lead-covered cables. The feeders, also Callender lead-covered, and respectively 37/13, 37/16 and 19/16, are laid at the sides of the roads in cast-iron piping and feed into the trolley wire at intervals of half a-mile, lightning arresters being installed at the feeding points. The Morriston feeder has a total length of about $2\frac{1}{4}$ miles and the Cwmbwrla one $1\frac{3}{4}$ miles.

Coming to the power station, the buildings include an engine room, 65ft. by 29ft., and a boiler-house, 37ft. wide by 39ft. long. All the electrical work, including the lines, has been carried out by the British Electric Traction Co. for the tramways company. The station buildings were erected by Messrs. Walters & John, of Morriston, from the plans of Mr. J. P. Rowlands, of Swansea. The boiler-house contains at present two of the largest size Babcock & Wilcox boilers, each capable of evaporating 7,000lb. water per hour under a pressure of 150lb. per square inch from a feed temperature of 150°F. A Babcock & Wilcox superheater enables an extra 100deg. of temperature to be raised on the steam. This

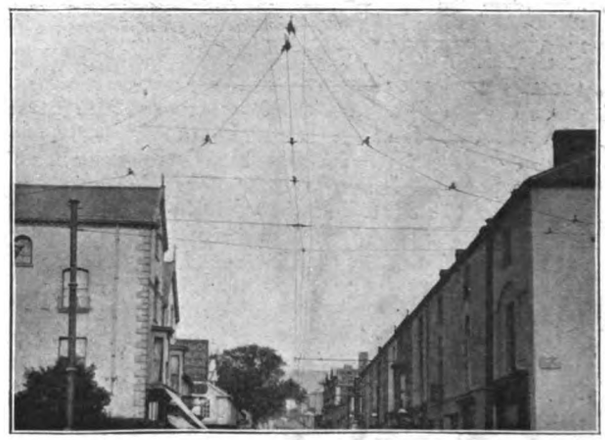

FIG. 2.—SPAN-WIRE CONSTRUCTION.

superheater is flooded when not in use. Coal for the boilers before being tipped into the bunkers passes over a weigh-bridge conveniently situated just outside the boiler-house approach. Two small weighing machines enable the firemen to record the quantity of coal used during their shift.

The gases from the furnaces pass either through a Green's 160-tube economiser or, by means of a bye-pass, direct to the

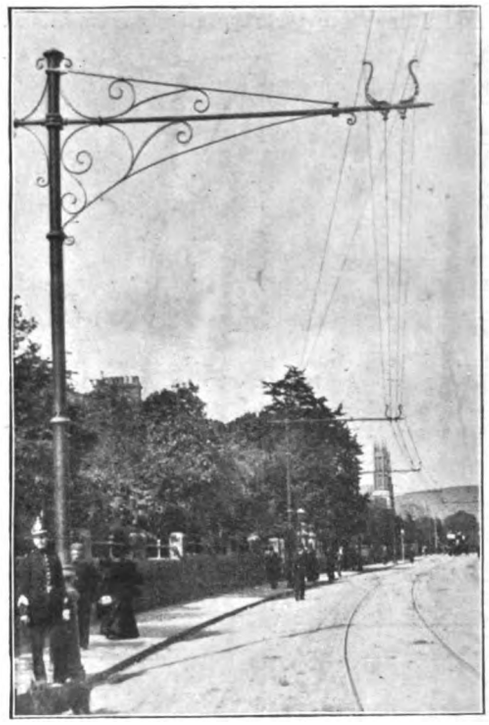

FIG. 3.—BRACKET POLE WITH GUARD WIRES.

chimney-shaft. The economiser scrapers are, as usual, worked by an electric motor. In Fig. 6 is shown some of the auxiliary plant serving the boilers.

For condensing purposes two wells have been sunk on the station site each 36ft. deep. Water is pumped from these up to two tanks on the roof, and, to facilitate the cooling of this water, which is used for circulating in the condenser, Körting

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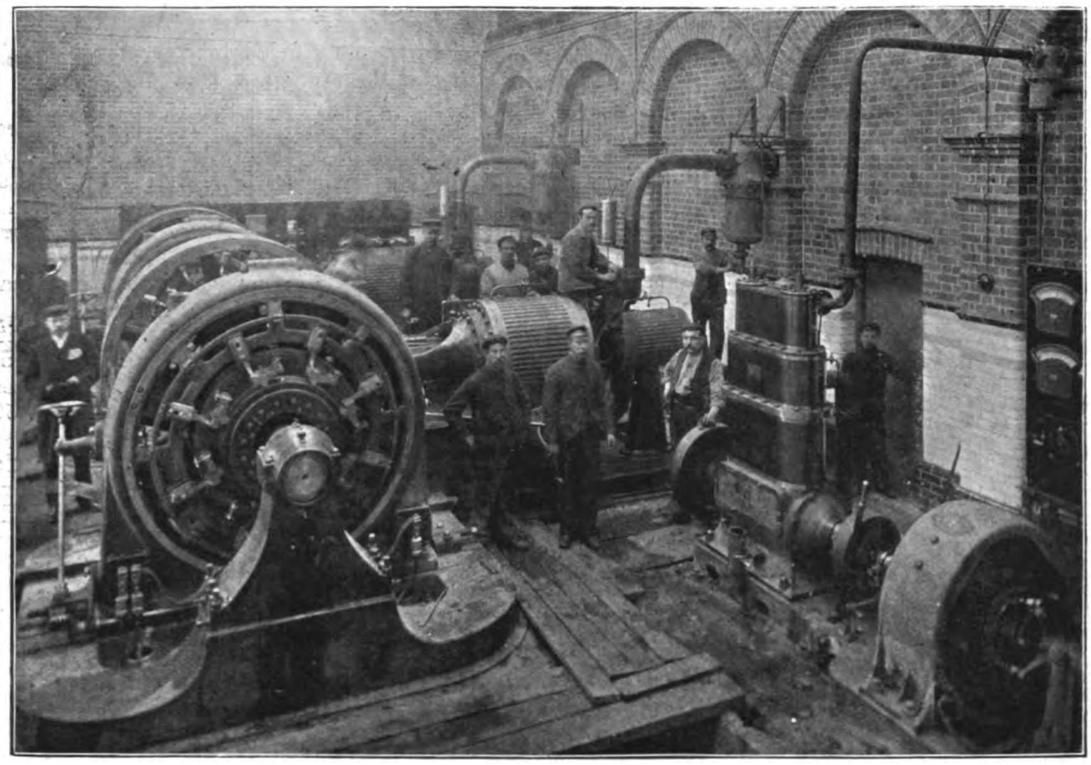

FIG. 4.—GENERAL VIEW OF ENGINE ROOM.

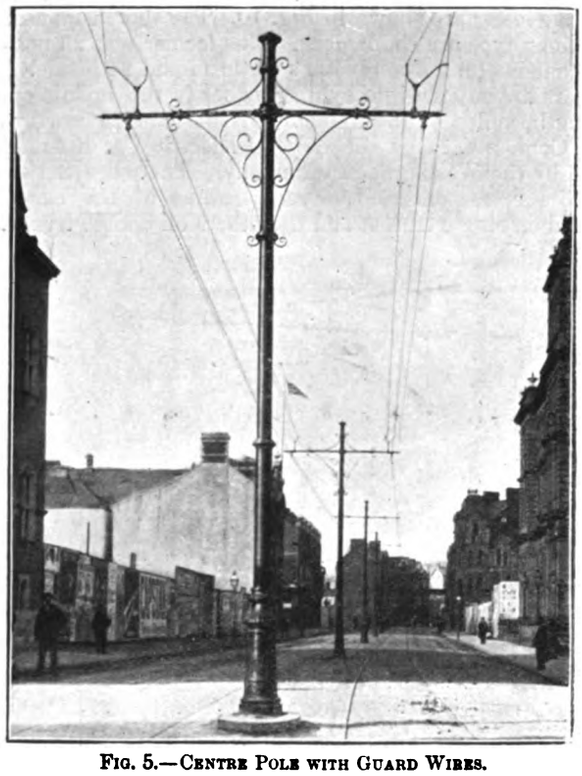

FIG. 5.—CENTRE POLE WITH GUARD WIRES.

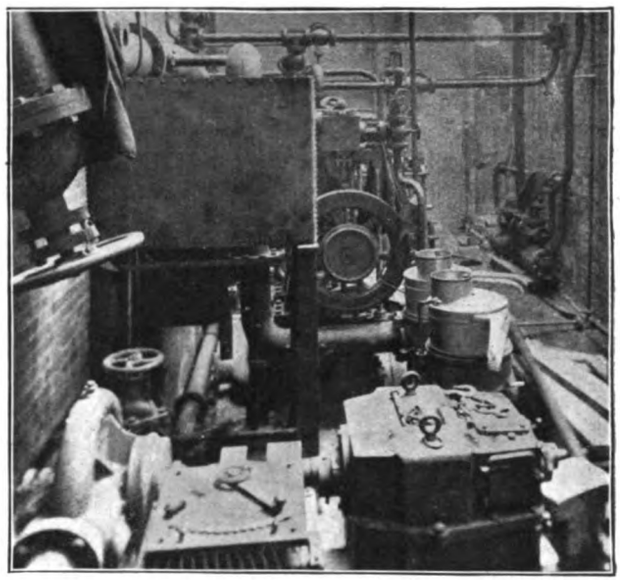

FIG. 6.—AUXILIARY PLANT SERVING BOILERS.

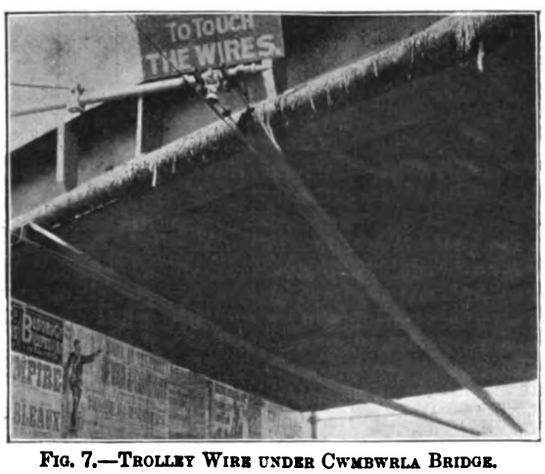

FIG. 7.—TROLLEY WIRE UNDER CWMBWRLA BRIDGE.

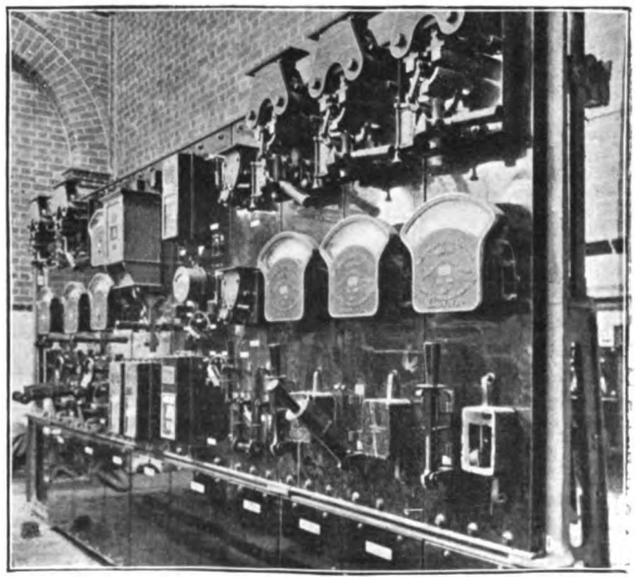

FIG. 8.—MAIN SWITCHBOARD.

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sprayers are installed. The condenser is a Wheeler horizontal surface one of 700 sq. ft. area. The water is normally circulated by means of a Brush motor-driven centrifugal pump, but this, as well as the Crompton motor-driven feed-water pump, is supplemented by Blake & Knowles steam feed and circulating pumps. The circulating pumps are each capable of delivering 14,000 gallons of water per hour. The air-pump is of the vertical type, by W. H. Allen, Son & Co. Water for feed purposes is stored in two large tanks side by

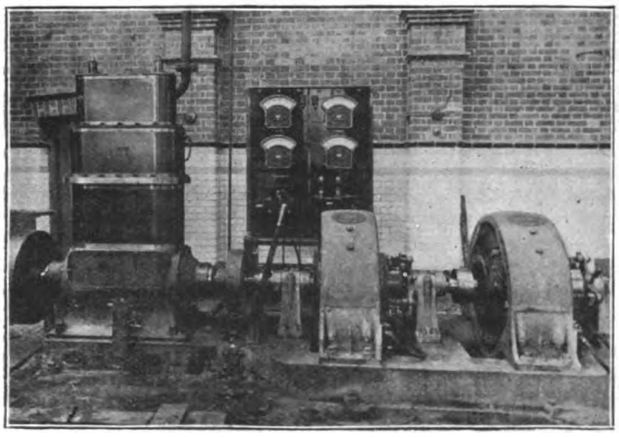

FIG. 9.—ALLEY & MACLELLAN—BYNG-HAWKINS DOUBLE SET.

side with the circulating water tanks, but the feed-water originally is taken from the town supply. Provision, as usual, is made for exhausting into the atmosphere, the bye-pass to the air being automatic in the event of, for instance, the air-pump failing.

The two boilers deliver by 6in. pipes into a 7in. main steam pipe, from which the engines are fed. Geipel steam traps drain the pipe arrangements of condensed steam.

generator over-compounded to compensate for feeder drop, and capable of meeting a load of 365 amperes at 550 volts.

The third set comprises a 50 B.H.P. vertical tandem-compound engine by Messrs. Alley & Maclellan, of Glasgow. This engine has cylinders 6½in. by 10in. by 8in. stroke, runs at 450 revs. per min., and, by means of a friction clutch, can be coupled to the shaft of a Byng-Hawkins motor generator. This set is shown in Fig. 9. Next to the engine is the motor of the set, being run as such when the main engines are running, and driving the generator on the right, which delivers current at 100 volts. Its capacity is about 200 amperes. At night time, when the main generators are not running, the engine of this set, being coupled up to the motor generator, the motor furnishes current at 500 volts for moving the cars about in the sheds.

There is a 4·75kw. booster connected in on the negative side of the system. This machine runs at 950 revs. per min.

The main switchboard is by the General Electric Co. There are three panels controlling the three feeders, one panel each for the generators and two for the meters and voltmeters. One of the panels controls the auxiliary switchboard seen behind the motor generator plant in Fig. 9. This latter board has two panels, one controlling the motor, the other the generator. The engine-room contains sufficient space for another of the large generating sets, and this additional set is soon to be installed. An overhead travelling crane by Messrs. Carrick & Ritchie, of Edinburgh, spans the width of the engine room.

There are 41 cars in all—viz., 26 short ones and 15 long cars; the latter are shown in Fig. 10. The short cars as well as the long type are single deck. The former seat 26 persons—two outside on the conductor's platform and 24 inside. The long cars are entered into by a side door in the middle of the car length, and seat 46 persons. Of the cars 15 are by the Brush Company, 11 by the General Electric Co. of America, and 15 by the Westinghouse Company. There are the usual two 25 H.P. motors to each car. Some of the cars are mounted on single trucks, and the others on double trucks.

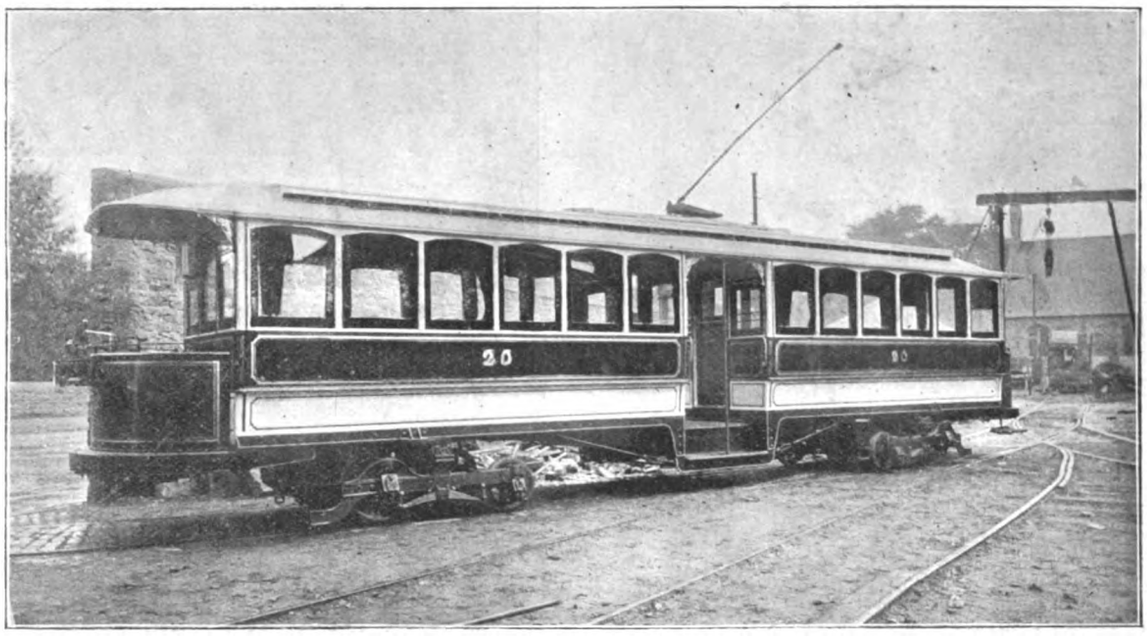

FIG. 10.—SINGLE-DECK BOGIE-CAR FOR 46 PASSENGERS.

In the engine-room are installed at present two large generating sets and one smaller set. The larger engines, which are identical in size, are horizontal, by Ball & Wood, and at 150lb. pressure steam are rated at 350 I.H.P. The cylinders measure 15½in. and 31in. respectively by 16in. stroke. The steam admission to the high-pressure cylinder is governed by a flywheel governor. Directly coupled to each of these engines is a Westinghouse 8-pole railway

No change has been made in the fares charged by the company, and the service is to be one of 5min. on the Morriston section, of 10min. on the Docks and St. Helen's sections, and of 8½min. on the Cwmbwrla section.

Our thanks are due to Mr. F. De Guerrier for furnishing us with information, and for personally conducting us over the works, and to the British Electric Traction Co. for supplying us with some of the photographs illustrating this article.

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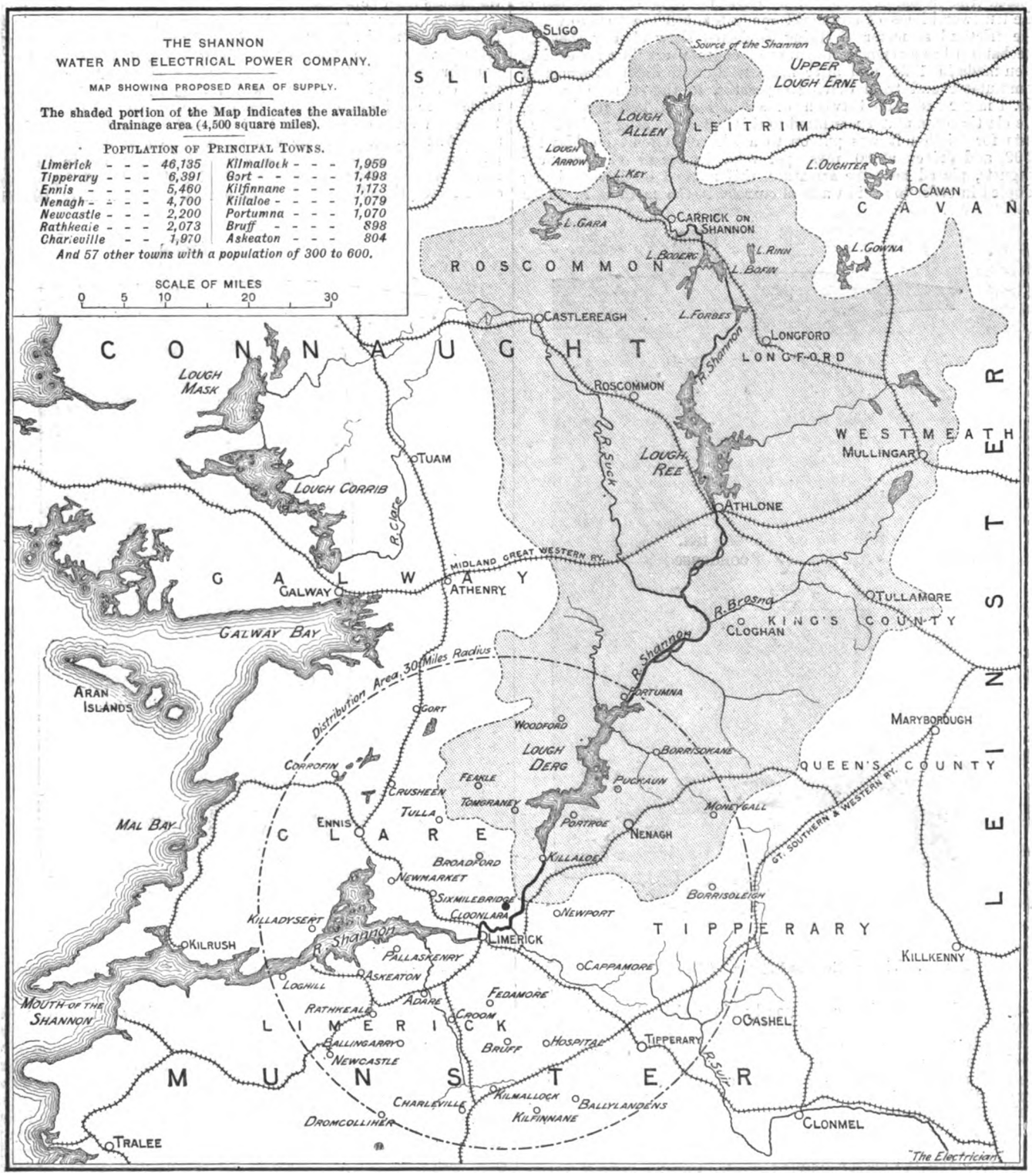
PROJECTED ELECTRICAL POWER SCHEMES.

(Concluded from page 207.)

6. Shannon Water Power Scheme.—The last of the power bills before Parliament this Session, the preamble of which has just been declared proved by a House of Commons Committee, presided over by Sir F. Godson, is that of the Shannon Water and Electrical Power Co. The promoters are Baron Lurgan and Messrs. V. W. Brown and M. F. Armstrong. The proposed area of supply will be seen by a reference to the accompanying map. Water is to be taken from the River Shannon near the entrance of the Board of Works canal at Errina, and the power-house will be erected at Cloonlara, where a fall of some 40ft. can be obtained. Two years is the estimated period for the completion of this part of the work. To provide compensation water to the river, it is proposed to make arrangements for the lowering of Lough Derg a few feet, but as during some eight or nine months of the year the discharge from the 4,500 sq. miles of drainage area of the River Shannon would probably suffice to generate 20,000 H.P., the lake would only require to be drawn upon for a short period in each year. The estimated cost of the work is some £200,000. The capital of the company is fixed at £300,000, with borrowing powers of £150,000.



MAP OF THE SHANNON WATER AND ELECTRICAL POWER COMPANY'S PROPOSED AREA OF SUPPLY.

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A FRICTIONLESS MOTOR METER.*

BY S. EVERSHED.

(*Continued from page 330.*)

Tests for Endurance.—There would be little advantage in any reduction of friction which was either not permanent or obtained at the cost of great delicacy of adjustment, and therefore liable to increase whenever the adjustment was accidentally disturbed. Prolonged trial in actual service is, of course, the only conclusive test of the trustworthiness of any novel apparatus, but the tests to which the frictionless meter is being subjected show already that the mechanism has a remarkable power of endurance. Two meters had been made in 1898, and after many trials with different forms of commutator and train driving apparatus, in the course of which No. 1 meter had made between three and four million revolutions, the elastic commutator was fitted to this meter, and after preliminary tests for friction it was put on to a 100-volt circuit on May 25, 1899, and driven at 80 revs. per min. by means of permanent magnets, placed near the armature, this method of driving being adopted in order to avoid waste of current in the main coils. This

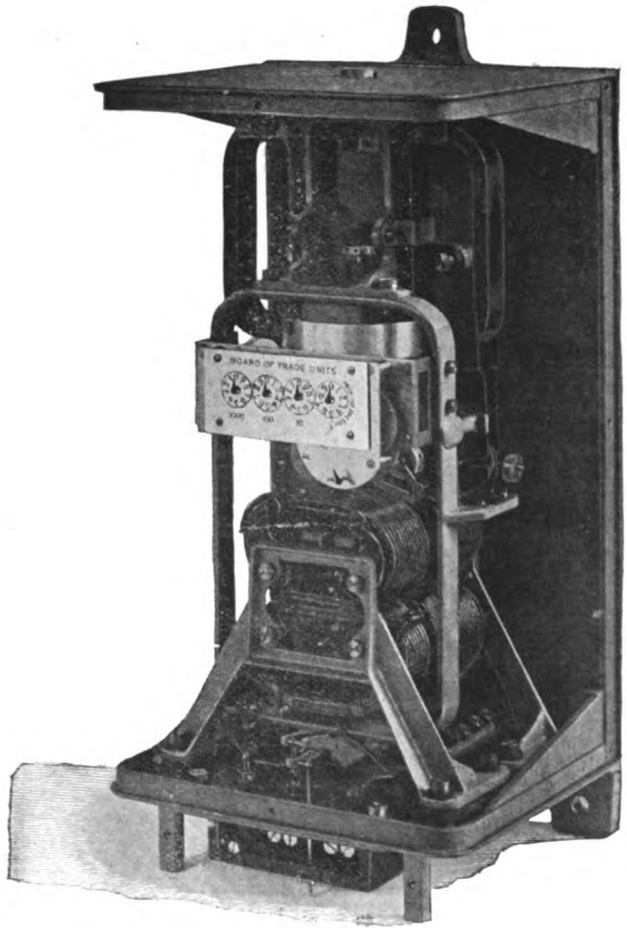

FIG. 13.—View of Evershed Meter. (Case Removed.)

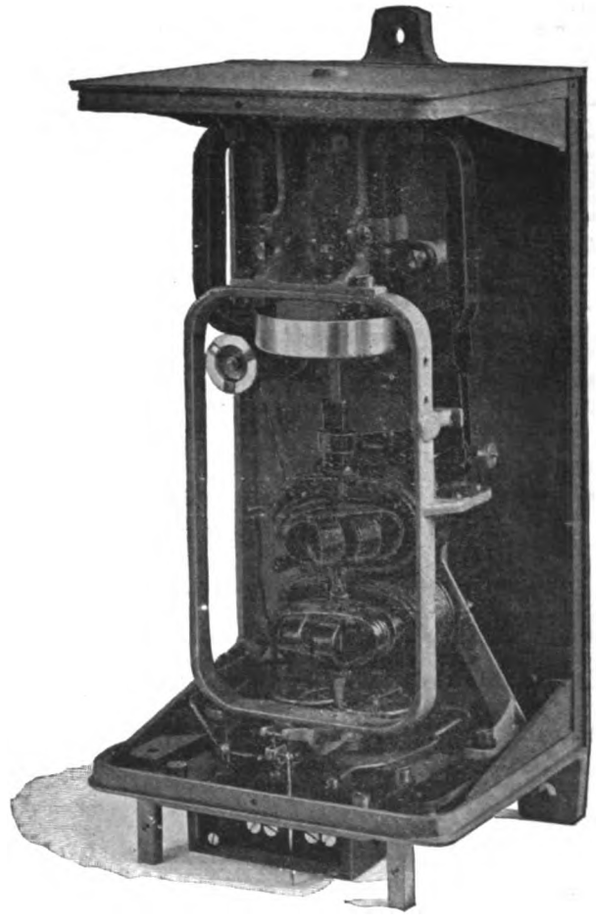

FIG. 14.—View of Evershed Meter. (Front Current Coil Removed.)

meter has been running continuously since that date, with the exception of the few hours occupied in making friction tests. The tests made up to the date of writing are given in Table III. The revolutions are reckoned from the day when the test began, and give the total made by the commutator correctly; but, as already mentioned, the meter had previously run for over 3,000,000 revs., so that the step bearing has been subjected to so much more wear and tear. The standard pressure current is 10 milliamperes, but for the purpose of this test it was raised to 18·2 milliamperes in order to make the energy running down in sparks upon the commutator when the train coils are reversed the same as it is with the standard size of train coil, No. 1 being fitted with a smaller train coil. This increase of current increases the sparking on all the sections, so that the total energy tending to destroy the commutator is far greater than it is with a standard train coil. During the first few weeks some sparking was visible, but this has gradually diminished until at the present time sparks are only seen occasionally. There is no apparent wear either on the commutator wires or on the brush wheels. Platinum in the form of black powder clings to the inside of the wires, and has also settled in a ring round the axle inside the commutator; otherwise there is no visible change. It is possible that the presence of the powder accounts for the diminution of sparking; the energy may be absorbed in heating up the powder, which quite possibly acts as a variable resistance, and so ensures a gradual reduction of the current to zero instead of a sudden interruption and consequent spark. On the other hand the commutator may still be sparking as at first, and the powder may simply prevent the sparks from being seen.

As soon as it was seen that the elastic commuator was a step in the right direction, No. 2 meter was similarly fitted, but with a commutator having much finer wires—about 4mm. diameter—and with brass brush wheels lightly gilt upon their edges. After long tests with different pivots, during which time the elastic commutator made three and a half million revs., No. 2 meter was put on to the 100-volt circuit on October 12, 1899, and it has been running at about 57 revs. per min. day and night since that date. Periodical friction tests have been made, and the results are given in Table IV. No. 2 meter is fitted with a standard train coil, and the pressure current was, therefore, fixed at the normal value—namely, 10 milliamperes. No appreciable wear is visible on the commutator wires, but a curious change has gradually become apparent in the brush wheels. Where they roll in contact with the iridio-platinum wires their edges have acquired a smooth deposit of platinum, and under a magnifying glass they have the characteristic appearance of a surface which has been platinised by the ordinary electro-chemical process.

During these tests no adjustments or alterations of any kind have been made in the meters, nor have any precautions been taken to keep dust and dirt away from them. They are running in a dirty workshop with loose covers over them, and the slowly-increasing friction noticed with No. 2 meter is probably due to the collection of dust—which is very visible—within the step bearing and in the brush-wheel bearings. The normal speed at full load has been fixed at 50 revs. per min., so that No. 2 meter is running 14 per cent. and No. 1 meter 60 per cent. above full speed.

If we assume the average consumer to use the equivalent of 1·8 hours at full load each day, his meter will at the above speed (50 revs. per minute) make 2,000,000 revs. per annum. No. 2 meter has therefore been subjected to wear and tear corresponding to five years' service, while No. 1 meter has run for a period corresponding to

* Paper read before the Institution of Electrical Engineers, May 10.

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Table III.—*Friction Tests* of Meter No. 1. This meter was started on May 25, 1899, and has been running at about 80 revs. per min. continuously since that date.*

Date.	Total revolutions of armature axle.	Moment of frictional resistance (Dyne cm.)
May 25, 1899	0	Not measured accurately, but about = 7 dyne cm.
June 28, 1899	3,460,000	6·8
Sept. 26, 1899.....	12,275,000	6·8
March 30, 1900	29,046,000	7·2

Table IV.—*Friction Tests* of Meter No. 2. This meter was started on October 12, 1899, and has been running at about 57 revolutions per minute continuously since that date.*

Date.	Total revolutions of meter axle.	Moment of frictional resistance. (Dyne cm.)
Oct. 12, 1899	0	3·2
Oct. 12, 1899	100	2·1
Oct. 13, 1899	not noted	2·3
Oct. 16, 1899	not noted	2·4
Oct. 20, 1899	not noted	3·2
Nov. 7, 1899	2,088,000	2·9
Nov. 20, 1899.....	3,080,000	3·0
Dec. 21, 1899	4,313,000	2·9
Jan. 29, 1900	...	3·3†
Jan. 30, 1900	7,233,000	3·5‡

* For methods of measurement see Appendix.

† Commutator observed to be making irregular contact. After making test, examination showed a fine hair wound round and entangled in commutator. The hair was removed as carefully as possible without taking the meter to pieces.

‡ Taken immediately after removal of the hair.

about 14 years. These figures are mentioned in order to enable the value of the tests to be estimated with some sense of proportion; they are not adduced as in any way a substitute for the test of hard work under all the varying conditions necessarily imposed upon supply meters in everyday use.

Possibility of Further Reductions in Friction.—The results so far obtained and an examination of the causes of the remaining friction afford some ground for believing that its limiting value has not yet been reached. The calculated value of the total frictional resistance in Meter No. 2 (see Appendix) is 1·6 dyne cm., 1·1 being attributable to the step bearing and 0·5 to the brush-wheel bearings. It is quite possible to use aluminium wheels and so reduce the pressure on their step bearings to about one-half of the present amount, reducing this part of the friction to 0·25. The pressure of the steel point upon the jewel of the armature axle bearing can be reduced by coupling the train coils back to back, as in Fig. 11, so as to eliminate the effect they now have in alternately increasing and diminishing the induction through the axle and supporting pole. If at the same time some means can be found to prevent the axle from accidentally rising from the step bearing, the only absolutely unavoidable pressure downwards will be about 1 gramme, an amount which is, of course, necessary to prevent the mutual force between the train lever and the train coils from lifting the axle. To err on the safe side, we may assume that it is possible to reduce the pressure from 12 grammes to about 2 grammes, the corresponding reduction in friction being from 1·1 to about 0·2 dyne cm. Hence it seems not impossible to reduce the 1·6 dyne cm. of total calculated friction to 0·45, or say 0·5 dyne cm., a reduction of 1·1. This should be subtracted from the lowest observed value of the frictional resistance in No. 2 meter, and would bring the initial friction in a new meter down to about 1 dyne cm.

Again, the moment of frictional resistance per gramme weight upon the step bearing depends on the acuteness of the steel point resting upon the cup jewel. In the meters hitherto tested no attempt has been made to secure a fine steel point. The point having been ground to an angle of about 30deg., is rounded off at the tip until it forms a hemispherical end of from 5mm. to 7mm. radius. This rests on a sapphire cup of from 20mm. to 40mm. radius, and although two spherical surfaces of different radius ought to touch in a point quite independently of the ratio of their radii, it is obvious that in practice we must look upon our spherical steel point as one with a rough surface making contact with the jewel in a number of points distributed over a very small and approximately circular area, the diameter of which will depend on the ratio of the radii of jewel and point, and upon the smoothness of the two surfaces. Now, as the formula for point friction indicates (see Appendix), the moment of friction is proportional to the diameter of contact, so that we may expect a decrease in moment if we diminish the radius of the spherical point—an expectation which is, of course, borne out by the result of everyday experience. Whether the reduction so brought about will be permanent depends on how far the gradual burnishing of the steel by the jewel is affected by the pressure per unit of contact surface, and on the effect of the burnishing itself upon the co-efficient of friction. No data drawn from engineering experience are likely to afford any clue to the answer to these questions, and no means have hitherto existed for obtaining a direct answer by experiment. The author is now investigating the behaviour of different kinds of step bearings for use in meters with a view to the determination of the type having the greatest power of endurance.

Engineers accustomed to dealing with power in kilowatts and friction measured by hot bearings will be inclined to regard all such discussion of apparently insignificant details as so much industry wasted in the splitting of hairs. It will, however, be agreed that we cannot be said to have solved the problem of metering electric energy until meters possessing an adequate range and accuracy can be so constructed that they may be relied upon for many years' service without need of adjustment or repair.

In this matter we may learn something from the gas meter, of which—in spite of much unmerited and ignorant abuse—it may safely be said that while in point of accuracy it compares not unfavourably with the average electric meter, in other respects it is far in advance of any electric meter at present in use. The value of gas to a consumer depends upon its calorific and illuminating powers, and only in a minor degree upon its pressure. Hence the gas meter may, and does, absorb a large fraction of the available pressure without much disadvantage to the user, and its remarkable power of endurance has been brought about by the use of a motor capable of doing a far larger amount of work than is required to overcome friction, even when the mechanism is much worn by use. A properly made gas meter may be installed upon the consumer's premises and remain there in constant use without adjustment or repair of any kind for from ten to fifteen years before the motor is sufficiently worn to cause a serious error. With an electric supply, on the other hand, energy is what the consumer wants and what he pays for, and for lighting purposes he must have the energy supplied at constant pressure; hence the electric meter cannot be allowed to absorb more than a very small fraction of the energy and pressure of supply. The mechanical power of the electric meter being therefore limited by the conditions of supply, it is only by diminishing friction and wear and tear that we can hope to attain and maintain the required accuracy throughout many years of service. From this point of view it is clearly of the greatest importance that every cause of mechanical friction should be ascertained and as far as possible removed. It was with this conviction that the Author, quite in the early days of public electric supply, set about devising means for diminishing meter friction, and the outcome of a good many years of experimental work is the meter described in this Paper. It is not claimed for it that it is in all respects the ideal of what a meter should be, but the author hopes it may be regarded as a step in the right direction.

NOTE.—The author desires to acknowledge his indebtedness to Mr. Cox, who has the charge of the Experimental Department at Woodfield Works. During three years' continuous work upon the meter Mr. Cox's fertility of resource and inexhaustible patience have surmounted many difficulties and led to numerous improvements. When it was decided to try roller brushes making elastic contact with the commutator, and some trouble was met with in producing rollers of the requisite elasticity, Mr. Cox proposed to have the rollers rigid and make the commutator wires thin enough to provide the necessary elastic rolling contact—an idea which has been adopted with the happiest results.

Electric Automotor Station at Boston, U.S.A.—The *Electrical World* for June 16, gives an illustrated description of a large motor car charging station at Boston, U.S.A. The station belongs to the New England Electric Vehicle Transportation Co., which started work in May, 1899, with three cabs. At the present time there are some 150 vehicles attached to the station, including broughams, hansom cabs, delivery waggons, surreys, stanhopes, runabouts, &c. The charging station is a circular building, about 123ft. in diameter. Power is obtained from the three-wire circuits of the Boston Edison Co., boosters being used to supply the additional E.M.F. The current for each car battery is regulated by means of rheostats. Besides the charging department, there are admirable departments for the inspection, repair and cleaning of vehicles. The capital of this undertaking is one million sterling, which indicates that electric automotor cars are not altogether a failure on the other side of the Atlantic.

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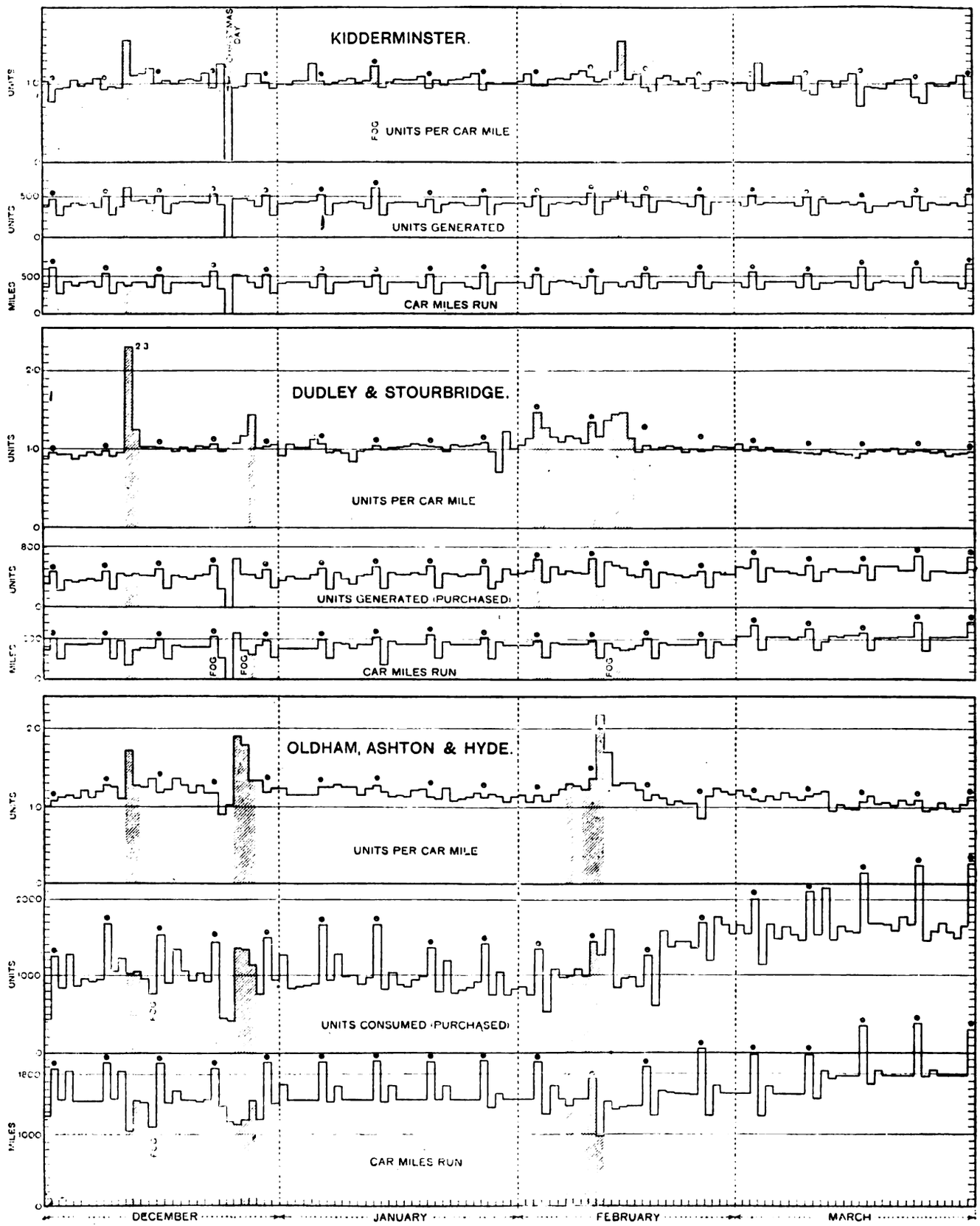
POWER HOUSE DIAGRAMS.

By favour of the British Electric Traction Co., we are able to publish the diagrams below, giving interesting particulars of the running of three electrically-driven tramways for a period of four months from December 1, 1899, to March 31, 1900. They are taken from the power-house records and show the total car miles run on each day during the period named, the total number of units generated for all purposes, and the ratio of the two amounts or the units generated per car mile run, no allowance being made for the units used in the station and only the paying car mileage being given. Mr. H. M. Sayers, the company's power engineer, points out that the smaller consumption per car mile at Kidderminster may be due to the fact that this line is chiefly one of easy gradients and has some fairly free running along a country road-side. The period included in the diagrams contains all the snow-days of the past winter, and the effect of snow is very plainly shown, the increase of the con-



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sumption per car mile being due to increased resistance of the cars themselves, and also to the snow ploughing, which is not counted as car mileage. Fog is also seen to cause an increase of the current consumption per car mile owing probably to the necessity of ultra-cautious handling of the cars. The effect of the Saturday half-holiday is particularly marked in the Lancashire line, but it is not greatly accentuated in Staffordshire. This is not perhaps so much because Saturday is less of a holiday in Staffordshire as that the service is so fully occupied on all days that Saturdays do not present much of a contrast, though doubtless they will do so when the number of cars available for extra Saturday traffic is increased.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Permanent Magnets.—An exhaustive investigation of the various conditions affecting the permanency and the moment of a steel magnet has been carried out by H. Frank. A number of magnets were prepared of the same piece of English silver steel. They were chilled from several high temperatures ranging from a dull red to a white heat, and then magnetised by the same current and coil. The highest magnetic moments were shown by those magnets which had been chilled from a normal read heat, midway between the dull red and the white. The influence of the temperature is very considerable. Thus the moment obtained after heating to normal red is double that obtained after heating to dull red, and 30 per cent. higher than that obtained after heating to a white heat. The duration of the heating, however, seems to have no influence whatever. The temperature at which the magnetisation itself is carried out is also of importance. If carried out at a low temperature, the moment obtained is higher than if the magnetisation takes place at, say, 100deg. But the difference is very slight when the steel has been chilled from a bright red or a white heat. The "loose magnetism" is more easily got rid of when the chilling took place from a low heat than from a high one, and Barus and Strouhal's methods of ageing magnets either by boiling or by cycles of temperature appear to be the best all round.

[H. Frank, *Ann. der Physik*, No. 6, 1900.]

Electrical Transparency of Liquids.—With very simple apparatus, A. de Heen has demonstrated some great inequalities in the transparency of liquids for electric waves. He produced electric waves by attaching a piece of wire gauze to one terminal of an induction coil driven by a Wehnelt interrupter, and let them traverse a set of two concentric test-tubes, the outer one being filled with the liquid to be examined, while the inner one contained a sensitive vacuum tube serving as a wave indicator. It was found that all the liquids examined could be divided pretty sharply into two classes, the transparent ones and the opaque ones respectively. The former include ether, petroleum, benzine, xylene, and butyric and valerianic acids. On the other hand, water, alcohol, aldehyde, carbon bisulphide, and ethyl bromide are opaque to electric waves. This classification shows no connection with other physical properties. For all the liquids are transparent to light, and electrostatic conductivity seems also to be without any determining influence, for water and ether are both conductors, and yet one of them is opaque and the other transparent. A good deal of interest attached to mixtures of an opaque and a transparent liquid. The transparency of ether was reduced from 1232 (in arbitrary units) to 73 by adding 30 per cent. of its volume of alcohol, and to zero by adding 43 per cent.

[A. de Heen, *Comptes Rendus*, May 28, 1900.]

New Sparking Phenomenon.—W. J. Humphreys has noticed that the discharging distance between the poles of an ordinary Toepler machine could be very greatly increased by the aid of small sparks, taken by the hand or otherwise from the negative pole, or from any part of the machine in metallic contact with it; and also that this property is peculiar to the negative side, no such effect being produced by sparks taken from any of the positive parts. The same phenomenon occurs in the case of other types of influence machines, the increase in the sparking distance being often as much as 75 per cent. The poles should be well polished, and condensers should be added to produce the best results. The outside coatings of the jars should be connected with a metallic rod. The phenomenon ceases when the outer coatings of the jars are so insulated that there can be no oscillations or "surges" between them. That the breakdown takes place only when the auxiliary spark is taken from the negative side is explained by the author by supposing that the dielectric is far more sensitive to shocks next the anode than it is next the cathode. For "a spark from either pole will cause an impulsive rush of the opposite charge to the other pole and a consequent rise of its potential." The author does not seem to take into account the ultra-violet light of the auxiliary spark.

[W. J. Humphreys, *Phys. Review*, May—June, 1900.]

Low-Temperature Photometry.—To determine the manner in which the brightness of a luminous body increases with the temperature, O. Lummer and F. Kurlbaum compared the radiation of a "black" hollow space at various temperatures with that of a piece of platinum foil kept at a constant temperature, and reduced the radiations to apparent equality by means of Abney's revolving sector. The relation between brightness and temperature may be expressed by the relation

$$\frac{H_1}{H_2} = \left(\frac{T_1}{T_2}\right)^x,$$

where H is the brightness, T the absolute temperature, and x a coefficient which varies with the temperature. This coefficient has at low temperatures an extraordinarily high value, being 30 at 900deg. abs., 25 at 1,000deg., and 15 at 1,600deg. This circumstance is greatly in favour of photometric measurements of temperature. Differences of colour are fortunately not so fatal as might be expected, owing to the fact that when two adjacent patches of different tints are equal in brightness, the dividing line loses its sharpness. The measurements were made with the help of a Lummer-Brodhun prism. The authors promise to determine x for all available temperatures.

[Lummer and Kurlbaum, *Verhandl. Deutsch. Phys. Ges.* II., No. 8.]

Discontinuity of Cathode Radiation.—The nearest approach yet made to a continuous cathode ray discharge is probably the high-voltage continuous-current discharge described by Trowbridge. He, however, beyond mentioning that he employed several million ohms to eliminate the oscillations, does not bring any direct proof, by the telephone or any other method, to show that the discharge was really continuous. Some experiments recently made by P. Villard go to show that cathode rays have a strong tendency to discharge themselves intermittently, and that they do it, so to speak, on the slightest provocation. He makes a cathode beam rotate about its axis by means of a revolving magnetic field. A continuous beam would then describe a circle on a fluorescent screen. But a cathode beam only produces a series of patches arranged on the circumference of a circle. When the tube is worked by an alternating current, each active semi-period is thus broken up into a series of equidistant discharges. The discharge of an influence machine is similarly broken up, and Birkeland has shown that the same rule applies to the discharge of an induction coil.

[P. Villard, *Comptes Rendus*, June 25, 1900.]

Telegraphone.—The instrument described under this name by W. Poulsen is intended to record any sound or spoken word at a distance. Instead of a telephone receiver an electromagnet is inserted in the telephone circuit, and between its poles a steel wire or band is drawn along at a uniform rate. The variations in the current produce variations of the magnetic field, and hence also of the transverse magnetisation of the band. On passing the wire or band between the poles of the same electromagnet, and inserting a telephone receiver into the circuit, the original sound is reproduced. The band can be rendered available for renewed service by sending a continuous current through the electromagnet, and passing

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the band through. Several simultaneous messages can be recorded on the same band and read without confusion. Each message is recorded by two independent electromagnets, one of which can be subsequently reversed, so that it opposes the other, and produces silence. The second message can then be read independently, with its two electromagnets in series.

[W. POULSEN, *Comptes Rendus*, June 25, 1900.]

Photographic Effects from Radiating Wires.—The mast wire used in "wireless" telegraphy is known to give out a slight rustling noise when in action. T. Tommasina has followed up this observation by inserting a short length of thin wire enclosed in a light-tight box in the mast wire, and has observed luminous brushes, which he has also photographed. The brushes vibrate in unison, not with the oscillator, but with the interrupter of the induction coil. When both are in unison the brushes are distributed at regular intervals along the wire. They can be photographed by placing the sensitive plate in immediate contact with the wire. It then appears that the brushes form straight lines normal to the wire. When the sensitive plate is laid face downwards, and held down by a wooden block, there is a minimum of brushes under the middle of the block and two maxima at the ends. Under an iron block the minimum is not so pronounced, but there is a distinct convergence of the brushes towards the middle, as there is in the magnetic lines of force of a bar magnet. The finer the wire the smaller are the brushes and the closer together they are. The author concludes from these observations that the electric energy radiated by the wire, and partly converted into these brushes, is propagated from the individual molecules in planes at right angles to the wire.

[T. TOMMASINA, *Comptes Rendus*, May 28, 1900.]

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Professional Papers of the Corps of Royal Engineers." Edited by Capt. R. F. Edwards, R.E. Vol. XXV. 1899. (Chatham: W. & J. Mackay & Co.) 10s. 6d.

"Medical Electricity." By Dr. H. Lewis Jones. 3rd edition. (London: H. K. Lewis.) 10s. 6d.

"*Proceedings* of the Royal Society." No. 431. Vol. LXVI. (London: Harrison & Sons.) 2s. 6d.

ELECTRICITY WORKS ACCOUNTS.

Kingston-upon-Hull Municipal Electric Supply Works.

From our summary of the Hull accounts for the year ended at March 31st last it will be seen that, in so far as the financial results of the year's operations are concerned, there was an unfortunate falling off from the position of the previous year.

On the other hand, the progress made in the acquisition of new business showed a marked improvement. During the year the additional lamps connected raised the total equivalent lamp connection to 79,376 8 c.p. lamps, or nearly 31 per cent. The output, at 940,192 units sold, marked an advance of over 25 per cent. on the corresponding quantity in 1898-9. Unfortunately, there was a material falling off in the load factor from 7·96 per cent. to 7·64 per cent. These are low figures, and to them no doubt is attributable, to a great extent, the somewhat high cost figures in relation to the output.

With the exception of the repairs item, all the generating costs have risen. The fuel item is the chief offender, and although a rise to some extent in this department has been inevitable, yet the advance of nearly 0·22d. per unit, or 33 per cent., seems rather abnormal, especially for a town situated as Hull is. In spite, however, of the increases the other items are, we must say, satisfactory, and the total costs present a figure by no means above the average under similar conditions of output and load factor.

The diminution in the revenue, the increased capital and working expenditure have naturally had their effect on the working profit, and it has fallen from 10·9 per cent. to 7·57 per cent. The large additions to the lamp connections show that the sacrifice of revenue has not been made in vain, and we hope the reward will be in evidence in the current year's accounts.

The Scarborough Electric Supply Co. (Ltd.).

The results of the Scarborough company's operations during last year are, on the whole, satisfactory. The increase in the output, while nothing like as great as in the preceding year, was above the average. The load factor, however, which was 9·05 per cent. in 1898 has fallen to 8·65 per cent. During the year 82 new consumers were acquired and the lamp connections were increased by the equivalent of 4,827, or nearly 22 per cent. Among the generating costs the fuel and repairs items have materially increased, but they are by no means abnormal in the circumstances. The management and property charges show a very reasonable figure which, in combination with the moderate works costs of 2·59d. per unit, results in the aggregate costs being sensibly below the average at similar outputs.

It should be gratifying to the company that, in spite of the increased price of fuel, the working profit has been so well maintained. After an allocation of £472 to the depreciation fund and with the balance of £368 from the preceding year and £80 premiums on shares, the amount available for distribution was £2,576, out of which an ordinary dividend of 6 per cent. was paid.

It can hardly be said that this company's depreciation fund has been very liberally dealt with. It is only during the last three years that any allocation has been made at all, and the balance to the credit of the fund is but £1,400, although during the last four years the dividend has risen steadily from 4½ per cent. to 6 per cent.

We reproduce the following figures for comparison:—

Year.	No. of consumers.	Equiv. lamp con.	Output (units sold).	Max. supply demanded Kw.	Plant capacity. Kw.	Total costs per unit.	Gross profit. Total.	Gross profit. % to mean cap.
1894	183	10,480	86,594	150	300	...	...	...
1895	235	12,788	135,177	215	525	4·39d.	£993	3·19
1896	298	17,727	174,514	246	525	3·80d.	£1,603	4·93
1897	330	20,067	211,407	286	525	3·53d.	£2,021	5·83
1898	383	22,344	217,251	274	675	3·43d.	£2,296	6·07
1899	465	27,171	257,412	340	675	3·33d.	£2,634	6·22

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	July 6, 1900	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, 1899	Liverpool (Municipal)	June 22, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	July 14, 1899	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, 1900	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, 1900	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 18, 1900
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	July 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, 1899	Woolwich (Company)	Jan. 13, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	June 9, 1899		

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	KINGSTON-UPON-HULL.		SCARBOROUGH.	
Undertaking Worked by	Kingston-upon-Hull Corporation.		The Scarborough Electric Supply Co. (Ltd.)	
Date of Commencement of Supply	January 16, 1893.		September, 1893.	
System of Supply	3-wire con.-curr. with batteries and rotatory [trans. in sub-stations.		Alt.-curr. transformer sub-stations and partly [house transformers.	
Chief Engineer	A. S. Barnard.		F. G. Holden.	
YEAR ENDED	MAR. 31, **1899.**	MAR. 31, **1900.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	958,132	1,210,490	443,066	450,208
„ SOLD (TOTAL)	749,69)	940,192	217,254	257,412[h]
„ sold to consumers	749,690	940,192	217,254	257,412[h]
„ sold for public lighting, &c.	nil	nil	nil	nil
„ used on works	127,495	160,605	2,755	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	17·2	15·6	10·3	12·2
Maximum supply demanded	1,074·7 kilowatts	1,405 kilowatts	274 kilowatts	340 kilowatts
Number of public lamps	nil	nil	nil	nil
Number of consumers	960	1,326	383	465
Connections to mains in 8-c.p. lamps	60,661	79,376	22,344	27,171
CAPACITY OF PLANT IN 8-C.P. LAMPS	43,600	60,300	21,100	21,100
CAPACITY OF PLANT IN KILOWATTS	1,395	1,928	675	675
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£127,990 / £91·8	£128,490 / £66·7	£50,000 / £74·1	£50,000 / £74·1
Share	— / —	— / —	50,000 / 74·1	50,000 / 74·1
Loan (including Debenture charges)	127,990 / 91·8	128,490 / 66·7	— / —	— / —
RECEIVED (TOTAL)	94,959[a] / 68·1	130,302[e] / 67·6	38,083 / 56·4	45,003 / 66·7
Share	— / —	— / —	38,083 / 56·4	45,003 / 66·7
Loan (including Debenture charges)	93,959 / 67·4	128,490 / 66·7	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	34,031 / 24·4	nil / —	11,917 / 17·7	4,997 / 7·41
Share (unissued)	— / —	— / —	5,000 / 7·41	nil / —
Share (uncalled)	— / —	— / —	6,917 / 10·3	4,997 / 7·41
Loan (including Debentures)	34,031 / 24·4	— / —	nil / —	nil / —
REPAID (TOTAL)	8,389 / 6·02	11,516 / 5·99	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	— / —	10,093 / 5·24	900 / 1·33	1,400 / 2·07
EXPENDED (TOTAL)	94,958 / 68·1	133,802 / 69·4	40,039 / 59·4	44,648 / 66·2
Lands and buildings	10,783 / 7·73	13,526 / 7·02	7,040 / 10·4	7,545 / 11·2
Plant	41,076 / 29·4	63,302 / 32·8	19,900 / 29·5	20,913 / 31·0
Mains	40,544 / 29·1	55,825 / 29·0	12,452 / 18·5	15,211 / 22·5
Miscellaneous	2,555 / 1·83	1,150 / —	647 / 0·959	979 / 1·45
BALANCE OF CAPITAL ACCOUNT	— / —	−3,500[f] / −1·82	−1,956[a] / −2·90	−355 / −0·526
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£16,488 / 5·285d.	£19,291 / 4·927d.	£5,402 / 5·972d.	£6,205 / 5·785d.
Revenue from supply	15,546 / 4·980d.	18,390 / 4·698d.	5,231 / 5·782d.	5,996 / 5·590d.
„ meters, &c.	456 / 0·146d.	617 / 0·158d.	171 / 0·189d.	202 / 0·188d.
„ public lighting	— / —	— / —	— / —	— / —
„ sale of lamps, &c.	— / —	— / —	— / —	7 / 0·007d.
„ miscellaneous sources	485 / 0·155d.	283 / 0·072d.	1 / 0·001d.	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£8,005 / 2·565d.	£10,632 / 2·715d.	£3,106 / 3·431d.	£3,571 / 3·330d.
WORKS COSTS	5,601 / 1·794d.	7,893 / 2·015d.	2,416 / 2·670d.	2,779 / 2·590d.
Generation of electricity	*4,657 / 1·492d.*	*6,746 / 1·722d.*	*2,229[b] / 2·464d.*	*2,669[i] / 2·489d.*
Fuel (including cartage, &c.)	2,034 / 0·652d.	3,398 / 0·868d.	1,080 / 1·194d.	1,313 / 1·224d.
Oil, waste, water, stores	298 / 0·096d.	416 / 0·106d.	101 / 0·112d.	127 / 0·118d.
Wages at station	1,386 / 0·444d.	1,999 / 0·511d.	733 / 0·811d.	805 / 0·751d.
Repairs and maintenance at station	938 / 0·301d.	933 / 0·238d.	249 / 0·275d.	355 / 0·331d.
Distribution of electricity	*944 / 0·303d.*	*1,147 / 0·293d.*	*187 / 0·207d.*	*110 / 0·103d.*
Wages, &c.	194 / 0·062d.	456 / 0·116d.	99 / 0·109d.	86 / 0·080d.
Repairs, renewals of mains, &c.	750 / 0·240d.	691 / 0·176d.	88 / 0·097d.	24 / 0·022d.
Public lighting	— / —	— / —	nil / —	nil / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	2,405 / 0·771d.	2,739 / 0·700d.	690 / 0·763d.	793 / 0·740d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*845 / 0·271d.*	*1,116 / 0·285d.*	*217[c] / 0·240d.*	*280 / 0·261d.*
Management	*1,560 / 0·500d.*	*1,623 / 0·415d.*	*473 / 0·530d.*	*513 / 0·478d.*
Salaries	965 / 0·309d.	1,155 / 0·295d.	272[d] / 0·301d.	252[d] / 0·235d.
Stationery, &c.	157 / 0·050d.	126 / 0·032d.	63 / 0·070d.	70 / 0·065d.
Establishment charges	308 / 0·099d.	175 / 0·045d.	46 / 0·051d.	51 / 0·048d.
Law charges, &c.	130[b] / 0·042d.	167[g] / 0·043d.	92[e] / 0·102d.	140[j] / 0·131d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,483 / 10·9%	£8,659 / 7·57%	£2,296 / 6·07%	£2,634 / 6·22%
Sum carried to Depreciation Fund	8,169 / 10·4%	1,924 / 1·68%	417 / 1·103%	472 / 1·11%
Sum carried to Reserve or Sinking Fund	2,555[c] / 3·27%	3,506 / 3·06%	— / —	— / —
Net interest on loans (incl. Debenture charges)	2,267 / 2·90%	3,230 / 2·82%	12 / 0·032%	35 / 0·033%
BALANCE FROM LAST ACCOUNT	4,509 / 5·77%	— / —	189 / 0·50%	368 / 0·869%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	2,333[f] / 6·17%	2,576[k] / 6·08%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	5½% / —	6% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	48·5%	55·1%	57·5%	57·6%
Expenditure per kilowatt capacity	£5. 14s. 10d.	£5. 10s. 3d.	£4. 12s. 0d.	£5. 5s. 10d.
REVENUE PER KILOWATT CAPACITY	£11. 16s. 0d.	£10. 0s. 0d.	£8. 0s. 2d.	£9. 4s. 0d.
Expenditure per 8-c. lamp capacity	3s. 8d.	3s. 6½d.	2s. 11½d.	3s. 4½d.
REVENUE PER 8-C.P. LAMP CAPACITY	7s. 6¾d.	6s. 4¾d.	5s. 1½d.	5s. 10½d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 4½d.	4s. 10½d.	4s. 10d.	4s. 6¾d.
Price charged for lighting, per unit	6d. to 5½d. to 3d.[d]	5d.[h]	6½d. to 5½d.[g]	6½d. to 5½d.[g]
Price charged for power, per unit	2½d.	2½d.	2½d.	2½d.
Price charged for public lighting	—	—	—	—

KINGSTON-UPON-HULL.—REMARKS—*a* Includes £1,000 from revenue, being instalment written off meters; and also £40,483 temporary loan. *b* Includes £124 to insurance. *c* Includes £1 000 to capital; instalment in respect of meters. *d* Maximum demand system (one-hour scale). *e* Inclusive of £1,812 instalments written off meters and £74,905 temporary loan. *f* Over-expended. *g* Includes £160 to insurance. *h* Consumers having their premises wired for not less than 6 kilowatts have the option of being charged on "Wright" system, 5½d. per unit for first hour and 2½d. per unit after.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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ELECTRICITY WORKS FOR SMALL TOWNS.

A number of questions of considerable interest to electrical engineers are raised in the two Papers on electricity works for small towns, read at the recent meeting of the Municipal Electrical Association, and in the discussion which ensued. These Papers, by Mr. C. S. VESEY BROWN, of Lincoln, and Mr. G. M. HARRIS, of Bray, respectively, have already appeared in our columns, and an abstract of the discussion is printed in this week's issue. Mr. BROWN'S Paper treats the question purely from the standpoint of erecting a separate works for each small town, whereas Mr. HARRIS, though recognising some advantages in a separate station, is also willing to concede that many of the smaller towns will have to depend upon their being included in the very much greater area of large power schemes. Indeed, one almost hears the dying wail of the small electricity works echoed in the following words from from Mr. HARRIS'S Paper: "Where there are no such advantages there appears to be no alternative but to wait for the great power companies to pick up such small areas as may be within their reach, or upon the direct line of route of their mains to larger ones." At this time of the day it would probably be better for small towns to wait until they are thus absorbed into the supply systems of large power distribution schemes than to expend a large capital in developing electricity works of their own. We trust and believe they will not have long to wait.

It is this difficulty of placing small electricity works upon a satisfactory self-supporting basis which is at the root of the controversy these two Papers started, as to whether the owners of such small works should engage an outside consulting engineer, or place the design of the works and all future extensions in the hands of their resident engineer. Mr. VESEY BROWN'S suggestion to small local authorities is, that "they should employ a competent expert to advise and initiate a policy and system, and for the first stage of the undertaking pay him the usual fees; that then they should engage a resident manager, whose duties would be to manage both

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commercially and technically the whole undertaking, and that as extensions are required, the consulting expert should be called in to advise, he being paid an annual retainer to cover the advice given." Several speakers, however, took exception to this proposal, though, on the other hand, many supported it. The view of the opponents seemed to be that if a man is competent to run works he must necessarily be competent to design and superintend the carrying out of their extensions. This, however, is by no means the case. There are many first-rate marine engineers perfectly competent to run an ocean liner, but who would be absolutely unable to design the engine room of a steamship. The same applies to central station engineers and especially to those whose experience is limited to small undertakings. Moreover, a central station engineer is apt to repeat his experience in his extensions; whereas an outside consulting engineer is likely to introduce more modern ideas, and thus enable the works to keep pace with the progress of engineering. One, in fact, tends to crystallise the works into the original pattern from which he obtained his largest experience, the other has every inducement to bring extensions up to date. We are quite aware that these remarks do not apply to the resident engineers of really large works, who are from the nature of their daily engagements thoroughly competent not only to carry on extensive works of the most modern design, but are capable of advising their employers as to important extensions. The salaries which are paid to these men, however, can never be paid by the local authorities of small towns, who must be content with offering a remuneration that will capture, doubtless serviceable, but by no means first-rate men. In these circumstances, therefore, it is the wisest policy of the smaller local authority—if a local electricity works must indeed be erected—to place the design of the entire system in the hands of a competent outside expert. These same considerations, but slightly modified, point to the advisability of adopting the same practice whenever small works require extension. We are, therefore, in full accord with Mr. Vesey Brown in his suggestion on this subject.

Mr. J. E. Edgcome, of Kingston-on-Thames, suggested in the discussion that it would be an admirable office for the Municipal Electrical Association to undertake if it were to offer to supply the names of competent engineers, who could advise small local authorities as to the erection or extension of electricity works. We presume that it is Mr. Edgcome's intention that the Association should nominate some of the more prominent municipal resident engineers, whose experience in larger towns would enable them to carry out the work of equipping small towns properly. If such a suggestion were to be carried out seriously, it would present a combination in formidable competition with the independent non-municipal consulting engineer. We doubt very much, however, whether local authorities would, to any great extent, prefer to consult the Council of the Municipal Electrical Association rather than to place their work directly in the hands of an independent consulting engineer on the strength of his public reputation. Moreover, remembering that every member of the Council of the Association aspires to a consulting practice, it would be curious to know how the Council would proceed to nominate their man. Would it be by ballot, or on the principle of turn and turn about, or would the President for the year have a right of veto? In any case, we do not think the local authority would always be best served by such a plan as Mr. Edgcome suggests. Independent private action is, in the ranks of consulting engineers, the most satisfactory course for both consultants and clients.

ELECTROMAGNETIC THEORY.—CXVI.*

BY OLIVER HEAVISIDE.

(*Continued from p. 247.*)

§ 466. In consequence of the circuitality of the currents, electric and magnetic respectively, all states of induction and displacement which are due to impressed electric and magnetic force depend solely upon the curl of e or of h. This was shown in Vol. I., § 87. Now, intrinsically electrised and magnetised bodies are brought into the theory by what are equivalent to e and h. The disturbances produced by moving such bodies therefore involve the consideration of the waves emitted from the seat of the curl of e or h. It is also true that the static states themselves may be regarded as arising from the superimposition of waves continuously emitted by the sources mentioned. But this is useless, though curious. On the other hand, when e and h vary in intensity, either in time or in place, or in both, the consideration of the waves in question is imperative. In Vol. I., § 89, was described generally the nature of the waves from a circular source; and above have been investigated several cases of moving magnets, &c., under such circumstances as give rise to simple plane waves. The results are sometimes rather incredible, but that soon wears off. The human mind is so made as to be capable of believing anything, no matter how silly, provided it is imprinted heavily enough. That is well known to all astute people—to those priests in particular who convert men and women into sheep by saying the same thing over and over again. In the end they have no judgment left. The incredibility of results is no evidence by itself of necessary error. The reasoning man may not believe till he sees it: that does not imply disbelief, but a reserved attitude, waiting for more light.

The electromagnetic wave from a straight line source when stationary I have considered before, *El – Pa.*, Vol. II., p. 456. It is wanted here, as a foundation for the theory of the same when moving; so for completeness I give what is necessary, in a somewhat different way, and with an addition. Let there be a straight line source of f or curl e. It generates induction at the rate f per second. That is how the wave originates. For the induction spreads all round at speed v, and along with it is electric force, according to the circuital laws. But it is not so simple a matter in the present case as with a plane source of f, already considered. There is a mixing up in the cylindrical wave.

By symmetry H is uniformly distributed round about the axis which is the straight line of f, so that the general characteristic $\nabla^2\mathrm{H} = q^2\mathrm{H}$, where $q = p/v = d/d(vt)$, reduces to the zeroth Bessel form

$$\left(\frac{d^2}{dr^2} + \frac{1}{r}\frac{d}{dr}\right)\mathrm{H} = q^2\mathrm{H}, \tag{1}$$

where H is the intensity of magnetic force at distance r from the axis.

The appropriate solution is

$$\mathrm{H} = \mathrm{K}_0(qr).\ \mathrm{A}, \tag{2}$$

where A is a time function to be found to suit f given as a function of the time. To find A, note that the second circuital law

$$-\operatorname{curl}(\mathbf{E} - \mathbf{e}) = \mu p\mathrm{H} \tag{3}$$

takes the special form

$$\frac{1}{r}\frac{d}{dr}(r\mathrm{E}) = f - \mu p\mathrm{H}. \tag{4}$$

This is proved at once by considering two adjacent circles of E. In this equation f is the density of curl e. But let all the f be concentrated at the axis to make a line source, of strength f_0, say, and then integrate (4) over a circle of infinitesimal area centred upon f_0. The integral of μpH vanishes, whilst that of f is f_0. This is the same as saying that the circuitation of E round f_0 tends to the value f_0 as r is reduced to 0. That is,

$$2\pi r\mathrm{E} = f_0, \qquad \text{when } r = 0. \tag{5}$$

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But the first circuital law

$$\text{curl } \mathbf{H} = cp\mathbf{E},$$

reduces to

$$-\frac{d\mathrm{H}}{dr} = cp\mathrm{E}; \tag{6}$$

so, by (2) and (6), used in (5), we get

$$f_0 = -\frac{2\pi r}{cp}\frac{d}{dr}\mathrm{K}_0(qr)\mathrm{A} = -\frac{2\pi r}{cp}\frac{d}{dr}\left(-\frac{2}{\pi}\log\frac{qr}{2}\right) = \frac{4}{cp}\mathrm{A}. \tag{7}$$

See Vol. II., p. 226, equation (4), or p. 250, equation (48), for the full formula for $\mathrm{K}_0(qr)$, of which the only significant part at the axis is the log term here employed. So $\mathrm{A} = \frac{1}{4}cpf_0$, and therefore

$$\mathrm{H} = \tfrac{1}{4}cp\mathrm{K}_0(qr)f_0 = \frac{1}{4\mu v}\mathrm{K}_0(qr)q\,f_0 \tag{8}$$

is the operational solution for H, true for any varying f_0.

Let f_0 be steady, beginning at the moment $t=0$. The algebrisation was given in Vol. II., § 436, p. 456, equation (119) equivalently. But interchange r and vt in that investigation to suit the present case. The result is

$$\mathrm{H} = \frac{f_0}{2\pi\mu r(v^2t^2 - r^2)^{\frac{1}{2}}}, \tag{9}$$

and the corresponding E is

$$\mathrm{E} = -\frac{1}{cp}\frac{d\mathrm{H}}{dr} = \frac{vtf_0}{2\pi r(v^2t^2 - r^2)^{\frac{1}{2}}} \tag{10}$$

These are valid between the axis and the wave front at $r = vt$, beyond which E and H are zero. At the axis H varies as t^{-1}. If the value of H at the axis had been known the above investigation would have been unnecessary, because H at r is derivable from H_0 at the axis by

$$\mathrm{H} = \mathrm{I}_0(qr)\,\mathrm{H}_0 = \mathrm{I}_0(qr)\frac{cf_0}{2\pi t}, \tag{11}$$

which produces the formula (9). Compare with equation 118(e), §436, Vol. II., in which Δ and q, r and vt should be interchanged.

In the above the divergent K_0 function was employed to effect the algebrisation. But we may obtain the same result by the convergent Bessel function. Thus,

$$\mathrm{I}_n(qr)q\mathrm{1} = \frac{(\frac{1}{2}qr)^n q}{0\lfloor n} + \frac{(\frac{1}{2}qr)^{n+2}q}{1\lfloor n+1} + \ldots \tag{12}$$

$$= \frac{1}{vt}\left\{\frac{(r/2vt)^n}{\lfloor 0 \lfloor n \lfloor -(n+1)} + \frac{(r/2vt)^{n+2}}{\lfloor 1 \lfloor n+1 \lfloor -(n+3)} + \ldots\right\}, \tag{13}$$

the transition from (12) to (13) being made by turning $p^n\mathrm{1}$ to $t^{-n}/\lfloor -n$, according to the theory given in Vol. II., with numerous examples. Now

$$\mathrm{K}_0(qr) = -\frac{2}{\pi}\frac{d}{dn}\mathrm{I}_n(qr), \quad (n=0). \tag{14}$$

This applied to (13) makes

$$\mathrm{K}_0(qr)q\mathrm{1} = \frac{1}{vt}\frac{2}{\pi}\left\{g'(-1) + \frac{(r/2vt)^2 g'(-3)}{\lfloor 1 \lfloor 1} + \frac{(r/2vt)^4 g'(-5)}{\lfloor 2 \lfloor 2} + \ldots\right\} \tag{15}$$

$$= \frac{2}{\pi vt}\left\{1 + \tfrac{1}{2}\left(\frac{r}{vt}\right)^2 + \frac{1.3}{2.4}\left(\frac{r}{vt}\right)^4 + \ldots\right\} \tag{16}$$

$$= \frac{2}{\pi}\frac{1}{(v^2t^2 - r^2)^{\frac{1}{2}}}. \tag{17}$$

This corroborates equation (9). For the values of the g' functions used see Vol. II., p. 451, equations (78).

Being in the way of it, it is worth while giving the corresponding results when the medium is a conductor instead of a non-conductor, and its permittivity is ignorable. The operator cp in the first circuital law becomes k, the conductivity. This makes $q^2 = \mu kp$. Therefore

$$\mathrm{H} = \tfrac{1}{4}k\mathrm{K}_0(qr)f_0 \tag{18}$$

is the operational solution, instead of (8). To algebrise, proceed thus.

$$\mathrm{I}_n(qr)\mathrm{1} = \frac{(\frac{1}{4}\mu kpr^2)^{\frac{1}{2}n}}{\lfloor 0 \lfloor n} + \frac{(\frac{1}{4}\mu kpr^2)^{\frac{1}{2}n+1}}{\lfloor 1 \lfloor n+1} + \ldots$$

$$= \frac{(\mu kr^2/4t)^{\frac{1}{2}n}}{\lfloor 0 \lfloor n \lfloor -\frac{1}{2}n} + \frac{(\mu kr^2/4t)^{\frac{1}{2}n+1}}{\lfloor 1 \lfloor n+1 \lfloor -(\frac{1}{2}n+1)} + \ldots \tag{19}$$

To this apply (14), giving

$$\mathrm{K}_0(qr)\mathrm{1} = -\frac{2}{\pi}\left\{\log \mathrm{Z}^{\frac{1}{2}} + g'(0) - \tfrac{1}{2}g'(0) - \tfrac{1}{2}\mathrm{Z}g'(-1) - \tfrac{1}{2}\mathrm{Z}^2\frac{g'(-2)}{\lfloor 2 \lfloor 2} - \tfrac{1}{2}\mathrm{Z}^3\frac{g'(-3)}{\lfloor 3 \lfloor 3} - \ldots\right\}$$

$$= -\frac{1}{\pi}\left\{\log \mathrm{Z} + \gamma - \mathrm{Z} + \frac{\mathrm{Z}^2}{2\,2} - \frac{\mathrm{Z}^3}{3\,3} + \ldots\right\}, \tag{20}$$

where $\mathrm{Z} = \mu kr^2/4t$, and $\gamma = g'(0) = 0{\cdot}5772$. Therefore

$$\mathrm{H} = -\frac{kf_0}{4\pi}\left\{\log \mathrm{Z} + \gamma - \mathrm{Z} + \frac{\mathrm{Z}^2}{2\,2} - \frac{\mathrm{Z}^3}{3\,3} + \ldots\right\} \tag{21}$$

expresses H at r at time t due to the source f_0 at the axis beginning at $t=0$. The series is convergent, and is therefore suitable when Z is not large. To suit larger values of Z we may turn (21) to a divergent series. Use equation (93), p. 452, Vol. II. It produces

$$\mathrm{H} = \frac{kf_0}{4\pi\mathrm{Z}}\epsilon^{-\mathrm{Z}}\left\{1 - \frac{1}{\mathrm{Z}} + \frac{2}{\mathrm{Z}^2} - \frac{3}{\mathrm{Z}^3} + \ldots\right\}, \tag{22}$$

which is proper when Z is too large for the practical use of (21). It is curious to see that the series following $\epsilon^{-\mathrm{Z}}$ is that series itself with every term turned upside down. It is also curious to see that we cannot get away from the divergent series, either operationally or numerically. They seem to have come to stay, like other things before.

If f_0 is impulsive, we get the corresponding H by time-differentiation. Let the impulse be B_0, then we put $p\mathrm{B}_0$ for f_0 in (18). This makes

$$\mathrm{H} = \tfrac{1}{4}k\mathrm{K}_0(qr)p\mathrm{B}_0 = \frac{k\mathrm{B}_0}{4\pi t}\epsilon^{-\mathrm{Z}}, \tag{23}$$

by differentiating (21). This, observe, or test to corroborate, is the same as

$$\mathrm{H} = \mathrm{I}_0(qr)\frac{k\mathrm{B}_0}{4\pi t}, \tag{24}$$

where the operand is the value of H at the axis. But if you try to turn (23) to a divergent series by differentiating (22), you will come to the convergent solution (23) again.

Observe that (23) is the same as

$$2\pi r(\mathrm{B} = \mu\mathrm{H}) = -\mathrm{B}_0\frac{d}{dr}\epsilon^{-\mathrm{Z}}. \tag{25}$$

It follows that the total B over all space is B_0, constant. This is because we impulsively generate B_0, and it then simply diffuses outwards, but cannot be destroyed by the electric conductivity of the medium. It requires magnetic conductivity to destroy it. See Vol. I., §§ 194, 195.

Similarly, in case of the continued source f_0, the total B at time t amounts of f_0t. We must integrate over all space to find it, because in pure diffusion the speed v is infinite. On the other hand, in the nonconducting dielectric, the induction to the amount f_0t is to be found always between $r=0$ and vt. An easy integration of (10) will show that the induction between $r=0$ and mvt, where m is any fraction, is proportional to f_0t. Here the radius of the circle considered is always a constant fraction of the radius of the wave front. But within any circle of constant radius, the total induction falls to zero because B tends to zero, everywhere save at the wave front, where it is always infinite. This infinity, however, is of no consequence, being empty.

The electric field tended to is specified by

$$\mathrm{E} = \frac{f_0}{2\pi r}. \tag{26}$$

It is the electric field due to an electric shell of strength f_0 having a single straight edge at the axis, and therefore extending to an infinite distance. But if it is stopped by another straight edge parallel to the first at any distance, a second source is introduced, which is the negative of the first. There are then two waves produced, according to the above formulæ. The total induction (algebraically reckoned) is now always zero; although before the waves overlap the steady generation at a rate of +B by one source and −B by the other, and their existence in separate regions is evident.

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Fig. 28 will give a general idea of the spread of the H wave from a line source. Distance from the axis at O is reckoned along the base line, and the two curves show the intensity of H in the wave at two moments of time, say $t=1$ and $t=2$, when the wave front has reached P and Q respectively. The scale is quite arbitrary, because one curve is a copy of the other. At the initial moment, there is just the solitary infinite value of H at the commencing wave front, at O. The infiniteness is merely because f_0 is assumed to start action with infinite suddenness.

Now consider the state of things due to a line source in motion, or to a plane source steadily extending itself by the continuous addition of line sources at its straight edge. To fix ideas and formulæ, refer to Fig. 29. Let z_1 be the actual

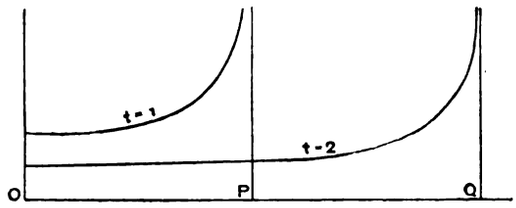

Fig. 28.

position of the edge of the plane source at time t, whilst z and r are the co-ordinates of the point P where H is to be determined. The directions of f and H are perpendicular to the paper. The origin of z may be conveniently situated at a distance to the left, to avoid negative values. Let the plane sheet be of density f per unit length along z, and start at z_3 at the moment t_3, and grow along z at speed u. The position z_2 indicates the limit of action at P. That is, P at time t receives H from the sheet between z_3 and z_2, but not from the part between z_2 and z_1, where its edge is situated. As for z_0, that is any intermediate position to be employed in the integral.

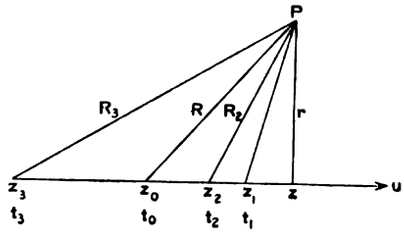

Fig. 29.

With the above conventions, the value of H at P is given by

$$H=\frac{fu}{2\pi\mu v}\int_{t_3}^{t_2}\frac{dt_0}{\{v^2(t-t_0)^2-r^2-[z-z_1+u(t-t_0)]^2\}^{\frac{1}{2}}}, \quad (27)$$

this being derived from (10) above by putting in the special distance concerned. The diagram is drawn for the case $v>u$, so that the time of going from z_2 to P at speed v equals the time of going from z_1 to z at speed u.

The above is the same as

$$H=\frac{fu}{2\pi\mu v}\int_{\tau_2}^{\tau_3}\frac{d\tau}{(v^2-u^2)^{\frac{1}{2}}\sqrt{\tau^2-a^2}}, \quad (28)$$

where

$$\tau=t-t_0-\frac{u(z-z_1)}{v^2-u^2}, \qquad a=\frac{\sqrt{v^2(z-z_1)^2+r^2(v^2-u^2)}}{v^2-u^2}. \quad (29)$$

Integrating (28), we get

$$H=\frac{fu}{2\pi\mu v(v^2-u^2)^{\frac{1}{2}}}\left[\log\left(\tau+\sqrt{\tau^2-a^2}\right)\right]_{\tau_2}^{\tau_3}, \quad (30)$$

provided $v>u$. But (28) may also be written

$$H=\frac{fu}{2\pi\mu v}\int_{\tau_2}^{\tau_3}\frac{d\tau}{(u^2-v^2)^{\frac{1}{2}}\sqrt{a^2-\tau^2}}; \quad (31)$$

so, when $u>v$, we have the result

$$H=\frac{fu}{2\pi\mu v(u^2-v^2)^{\frac{1}{2}}}\left[\sin^{-1}\frac{\tau}{a}\right]_{\tau_2}^{\tau_3}. \quad (32)$$

At present consider the case of $v>u$. Then the limits τ_2 and τ_3 are got by putting t_2 and t_3 for t_0 in the expression for τ in (29) above. At the lower limit in (28) the radical vanishes. So $\tau_2=a$. The upper limit depends upon the moment t_3 of starting action. So

$$H=\frac{fu}{2\pi\mu v(v^2-u^2)^{\frac{1}{2}}}\log\frac{\tau_3+(\tau_3^2-a^2)^{\frac{1}{2}}}{a} \quad (33)$$

is our solution. Note that H begins at P when $R_3=v(t-t_3)$. This makes $\tau_3=a$. So $H=0$ initially.

If we differentiate (33) with respect to t_3 we get a formula of the type (10), expressing the effect of the introduction of a stationary filament at z_3. But if we differentiate (33) to z_1, we obtain the formula for the H due to a filament of f introduced at z_3 at time t_3, and then moved at speed u to the right, being at z_1 at time t. In carrying out the differentiation, which is complicated, both τ_3 and a must be differentiated, because they both contain z_1. The result is

$$\frac{dH}{dz_1}=\frac{f}{2\pi\mu v}\left[\frac{v^2(v^2-u^2)^{-2}}{\{v^2(t-t_3)^2-R_3^2\}^{\frac{1}{2}}}+\frac{uv^2(z-z_1)(v^2-u^2)^{-\frac{3}{2}}}{\{v^2(t-t_3)^2-R_3^2\}^{\frac{1}{2}}\{\tau_3+(\tau_3^2-a^2)^{\frac{1}{2}}\}}+\frac{u(z-z_1)(v^2-u^2)^{-\frac{1}{2}}}{(z-z_1)^2+r^2(1-u^2/v^2)}\right]. \quad (34)$$

In this formula R_3 is defined in the last figure. It is connected with τ_3 by

$$(v^2-u^2)(\tau_3^2-a^2)=r^2(t-t_3)^2-R_3^2. \quad (35)$$

If f is understood to be the strength of the filament, then dH/dz_1 means the magnetic force to correspond. When $u=0$ we get the cylindrical wave from the stationary filament at z_3.

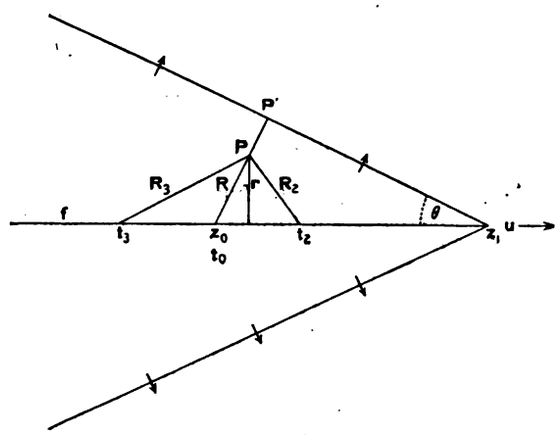

Fig. 30.

But when $t_3=-\infty$, we get the steady wave of H travelling with the filament when it has been in motion for a sufficiently long time. Calling this H′, it is expressed by

$$H'=\frac{f_0}{2\pi\mu v}\frac{u}{(v^2-u^2)^{\frac{1}{2}}}\frac{z-z_1}{\{(z-z_1)^2+r^2(1-u^2/v^2)\}}. \quad (36)$$

The eolotropic effect is now clearly visible.

When u/v is very small

$$H'=\frac{f_0}{2\pi\mu v}\frac{u}{v}\frac{z-z_1}{(z-z_1)^2+r^2}=\frac{f_0u}{2\pi\mu v^2}\frac{\cos\theta}{R} \quad (37)$$

where R and θ are the polar co-ordinates of P where H′ is reckoned with respect to the filament's position and line of motion. This formula may be readily checked by the static method.

There is always vanishing of H′ at the plane $\theta=\frac{1}{2}\pi$. At the same time, increasing u causes a concentration of H′ towards that plane. So, in the limit, when $u=v$, the result is two plane electromagnetic waves of reverse natures, both travelling the same way.

Now pass to the case $u>v$, equation (32) above, in which τ and a are known, whilst the limits have to be considered carefully. We require a separate figure. As the edge of the sheet advances the envelope of the cylindrical waves emitted by it make the wave front consist of two planes inclined to one another at the angle 2θ, the edge of the sheet being their meeting line. The angle θ is given by $\sin\theta=v/u$. Now if P is outside these planes, there is no H at all. When it is

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just on the boundary, say at P', the cylinder from z_0 just reaches it, and $t_2 = t_3$. When it is inside the planes, as at P in Fig. 30, there are two limiting points, marked t_2 and t_3 whose distances from z_1 are u/v times the distance of the same points from P. In the figure $u/v = 2$. So the range of integration is from z_3 to z_2, or τ_2 to τ_3 determined by giving τ the corresponding values. That is to say, the H at P is entirely due to the filaments from z_3 to z_2. The waves coming from filaments to the left of z_3 have not reached P; nor have those coming from filaments between z_2 and z_1, which last is the position of the foremost filament at the moment in question. Here, of course, it is assumed that the sheet began to form before the time t_3. The range is, of course, less at the beginning. The important matter is the final result when the limits are full. Then we have

$$v^2(t-t_0)^2 - R^2 = v^2(t-t_0)^2 - r^2 - \{u(t-t_0) - (z_1 - z)\}^2, \quad (38)$$

and also

$$= (u^2 - v^2)(a^2 - \tau^2). \quad (39)$$

So the full limits are $\pm a$ for τ in equation (32). This makes

$$H = \frac{fu}{2\mu v(u^2 - v^2)^{\frac{1}{2}}}, \quad (40)$$

constant everywhere between the two planes.

(To be continued.)

ELECTRICITY WORKS FOR SMALL TOWNS.

Below we give an abstract of the discussion which followed the reading of a Paper on "Electricity Supply for Small Towns," by Mr. C. S. Vesey Brown, and a Paper on "The Lighting of Small Towns," by Mr. G. M. Harris, at the Municipal Electrical Association, at Huddersfield :—

Mr. J. E. EDGCOME (Kingston-on-Thames) said an important point was the choice of an engineer. How were small towns to find out the engineer they wanted at a fair salary? He thought the Municipal Electrical Association should be allowed to supply names of those engineers who could do the work for the smaller towns. The general procedure was to appoint a consulting engineer to put down the works and afterwards appoint an engineer to take charge of the works when completed. After a short time, however, it was generally found necessary to make extensions, and the expert was again called in. His advice, however, was often different from that of the resident engineer, but the latter of course knew better the needs of the particular neighbourhood, as he was continually on the spot. The result of this difference of opinion was often very serious, and impeded the progress of the undertaking. He thought that the Association should lay themselves out to suggest certain names to small corporations which had under 40,000 or 50,000 inhabitants, and he considered it would be best for the corporations to appoint at the beginning a resident engineer and pay him a fair salary for his work.

Mr. H. L. P. BOOT (Tunbridge Wells) said it was a very easy matter to put down works which would be remunerative from the first in such large towns as Manchester, Glasgow, and Edinburgh, but when they came to a small town where the revenue was small it was a more difficult task. He would like to lay stress upon the question of capital expenditure, which should be kept down. With reference to the question of site, it was important to bear in mind the smoke and vibration difficulties, and where possible to erect the generating works away from the centre of the town. Mr. Vesey Brown mentioned in his Paper that it was advantageous to have an economiser. He (Mr. Boot) thought, however, that where tubular boilers were in use the capital expenditure upon an economiser was too much for the little advantage which would be gained. He agreed that public lighting should be taken up from the very commencement of the works. He thought, from past experience, that gas engines should not be used in connection with the generation of electricity for public supply as they had not been a success at Belfast and Leyton.

Mr. R. C. QUIN (Blackpool) agreed with Mr. Brown that for small towns to engage a consulting engineer was better than appointing a resident engineer to design as well as superintend the construction of the works. In the first place a small town could not afford to pay a first-rate man, and it required a better man to design a station than to run one. He would prefer a system of Dowson gas generation and storage of the gas in place of electric storage or in place of thermal storage.

Mr. S. E. FEDDEN (Sheffield) thought local authorities should get expert advice. He could not agree with Mr. Brown respecting triple concentric cables because with the triple concentric the insulating material has to be usually of lead and trouble would probably arise through electrolysis. He would like to know from Mr. Harris what kind of pitch he used, as pitch had a bad effect upon lead.

Mr. E. TREMLETT CARTER said that Mr. Boot seemed to think from the experience of Belfast and Leyton gas-engine stations, as a prelude to larger steam-engine stations, were a failure. He considered, however, that the results at these two places were quite the reverse. It is possible to commence by using gas engines on a small scale very profitably, and then afterwards to build a large steam generating works for the more extended supply. That gas engine stations can be run satisfactorily and economically year by year is proved, for example, by the large gas-engine station at Leicester, worked by the Midland Railway Co., where there is a larger output than at many small electricity works. Dowson gas, however, could not well be stored; it has so much free hydrogen which diffuses through the metal plates, and the useful part of the gas gets away. Dowson gas is not adapted to storage.

Mr. A. G. COOPER (Colne) said he considered it was best to appoin at resident engineer to construct the works, as he was on the spot, and knew the local conditions much better.

Mr. H. C. BISHOP (Wigan) said he did not agree with the statement that gas engines might be used as the thin edge of the wedge. He thought it was necessary before beginning to erect the works to ascertain the probable demand. He considered the limit of a gas-engine station in size, to work economically, was 400 kw. Up to this size of works they were all right, but for larger than this he said it was better to have steam.

Mr. C. S. VESEY BROWN (Lincoln), in his reply, said that in order to run works successfully they must be put down on sound lines by a man who had had experience which enabled him to say at once if a thing was good or bad. If an Urban District Council advertise, they get a string of names with recommendations, and unless they take special precautions they have very little idea as to whether the man appointed is sound enough to carry out the work. The suggestion that the man living on the place is able to see more of the locality and know more about it was all very well from the point of view of treating with the consumers, but it did not cover the stability and the soundness of the plant, buildings, &c., put down. He thought it was better to have a consulting engineer; and if they tried to carry out the work under the assistance of the gas engineer, surveyor, &c., who had not had sufficient experience, then they might expect the undertaking to be a failure. In a small town he thought it was advisable to put down a small gas station, and afterwards replace this by a larger steam station as the works increased. He thought that the refuse destructor was not as good as a storage battery.

Mr. G. M. HARRIS (Bray), replying, said that he was glad the question of keeping down the capital outlay had been mentioned, as this was an important point. In reply to Mr. Fedden he said the pitch used was ordinary pitch, and he did not think it would affect lead. He thought they could do without the lead altogether; it was not necessary when they had pitch.

NATIONAL PHYSICAL LABORATORY.

We reported in our issue of June 22 that the Richmond Town Council had appointed a deputation to wait upon the authorities and protest against the erection of the National Physical Laboratory in the Old Deer Park, Richmond. This deputation duly had an interview with Mr. Hanbury, the Financial Secretary to the Treasury, and in order to dispose of their objections, an influential deputation of those interested in the scheme waited on Mr. Hanbury on Thursday last week. Amongst those present were Lord Kelvin, Lord Rayleigh, Lord Lister, Sir Courtenay Boyle, Sir John Wolfe Barry, Sir M. Foster, M.P., Sir E. Carbutt, Sir N. Barnaby, Sir Andrew Noble, and Profs. G. F. FitzGerald, Rücker, Schuster, Clifton and Elliott.

Lord LISTER explained the interest that the Royal Society and all the scientific bodies in the United Kingdom had in the new laboratory.

Lord RAYLEIGH, who is vice-chairman of the General Board and of the Executive Committee, referred to the valuable work already being done at the Kew Observatory in the Old Deer Park cognate to that proposed to be undertaken by the new institution. Besides, there were very few sites suitable to the new laboratory, owing to the character of the work to be carried out, which necessitated isolation from mechanical and electrical disturbances. Owing to the electrical disturbances that could be produced by tramways no private site would be suitable.

In reply to Mr. Hanbury, Lord RAYLEIGH said it was difficult to say at what distances such disturbances would do harm, and

Sir COURTENAY BOYLE added that there was a scientific committee now considering that very point, in order to advise the Board of Trade upon it.

Mr. HANBURY pointed out that the site of the National Physical Laboratory was within about one-third of a mile from the road.

Lord RAYLEIGH, continuing, said that the same principle was recognised by the Greenwich Observatory, which was placed in the middle of a park, as also was the case with the Potsdam University and the International Bureau of Weights and Measures at Sèvres. Comment had been made on the provisional arrangements with the Woods and Forests for 15 acres of ground. One of the reasons that such a large area was chosen was in order that the two buildings might be a considerable distance apart. It was proposed only to cover about a quarter of an acre with buildings. Other sites had been suggested and examined, but they were all open to the objection that there was no security against disturbance, and most of them were unsuitable on other grounds. Instead of the work to be done at Kew likely to constitute a nuisance, it was to get away from nuisances that the executive committee sought to go to Kew. Quiet was exactly what was wanted for their own purposes. Many of the investigations he himself proposed to carry out could not be done at the Royal Institution, but had to be done at his own residence in Essex, where there was freedom from vibration.

Mr. HANBURY pointed out that the Woods and Forests had only power to grant a yearly lease.

Sir J. WOLFE BARRY said he was the representative of a society interested in applied science numbering 9,000 members, and that it was extremely important to establish this laboratory from the point of view of the trade of this country and of the huge commercial interests at stake. Kew possessed advantages which could not be obtained at any other place within a reasonable distance of London. It was easily accessible and quiet.

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Lord RAYLEIGH said that they were going to re-let part of the ground to the Mid-Surrey Golf Club. It would remain under the control of the committee of the laboratory, and the golfers would be on their good behaviour.

Lord KELVIN, Sir ANDREW NOBLE, and Prof. RÜCKER also spoke.

In reply, Mr. HANBURY said that he hoped the deputation were under no misapprehension whatever as to the strong desire of the Treasury to carry out the scheme for a physical laboratory. The money had been promised, and they were anxious to find a site. There was no doubt whatever as to the absolute importance to the country of having such a laboratory. That was not the question raised by the Treasury, or by any deputation. The real difficulty had been how far this undertaking would interfere with the amenities of Kew Gardens. It was desirable, so far as possible, to satisfy both the scientists and the lovers of nature. Undoubtedly there had been some alarm among a certain portion of the public that the laboratory might to a certain extent interfere with the amenities of Kew. He was bound to say that the impression gathered from the deputation to-day was that to a great extent that alarm was unnecessary. The previous deputation had represented to him the danger of the quiet being disturbed by the noise of the operations in the two proposed buildings, but from what had just been said he was satisfied that on that point, at any rate, there need not be any alarm. The most important point that had come out was whether, after all, on this site the laboratory itself was secured against electrical disturbance. He need not express any opinion upon that. They ought to wait for the report of the Board of Trade committee to see how far that would meet their requirements. He understood that if any extension of the buildings were required, it would be only to a little extent, and the public need not fear that the whole of the 15 acres would be built over.

PARLIAMENTARY INTELLIGENCE.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION'S BILL.

On Friday the Select Committee of the House of Lords, of which the Earl of Roese is chairman, commenced the consideration of the bill promoted by the Charing Cross & Strand Electricity Supply Corporation (Ltd.), to enable them to construct a generating station in West Ham, and to lay mains connecting their generating stations, to acquire lands, to construct a short line of railway, &c.

Mr. PEMBER, Q.C., for the promoters, said they had power to supply in the districts of St. Martin-in-the-Fields, the Strand, Finsbury, and the City of London. In the latter order there was a special provision that the company were to erect a new generating station for the City within two years on a site to be approved by the Corporation, which was not necessarily to be within the City boundary. The West Ham site had been so approved. The main factors in choosing a site was to have facilities for both land and water, carriage of coal, enormous quantities of which were consumed by a large electric undertaking. During the last year or two very large powers had been given to electricity supply undertakers to take their mains through intervening districts to connect up their areas of supply, as in the case of the Metropolitan Electric Company and the Central Electric Supply Company. In these circumstances it did not lie in the mouths of local authorities to object to their streets being broken up. The site selected under this bill had an area of 7½ acres. The surrounding premises were all of a business character, so that there was likely to be little public inconvenience. Opposition to the scheme was presented by the local authorities of West Ham, Mile End Old Town, Poplar and Whitechapel (through whose districts the mains of the company would run), and the Corporation of the City of London. Each one dealt with the breaking up of streets, to which they took exception. The City did not oppose the scheme in the other House. They were informed of the intentions of the company to apply for the site, and they approved of it; but they now opposed on a petition, the gist of which appeared to be that they objected to the proposal of the company to lay in the City mains, not only for the supply of the City itself, but for supplying places beyond. It did seem a little unreasonable that the City should be perfectly willing the company should have a generating station in West Ham, from which the company should lay mains, through the territory of other authorities, for the benefit of the City, and should at the same time object to the company taking mains through the City for the benefit of other people beyond.

Mr. SHIRESS WILL, Q.C., here took up the argument for the bill. He said: The Corporation went on to allege that whereas the Order of 1899 intended that the supply of electric energy to the City should be a separate and distinct undertaking the proposals of the bill overrode that intention to their disadvantage; and further, the effect of the bill, if passed, would be to render the supply by the company of electrical energy to the City subsidiary to the company's other undertakings. The bill, they held, authorised the company to break up and otherwise interfere with the streets of the City for the purpose of connecting their generating stations outside of the City, but imposed no obligation to use the mains and works for City lighting. The company having broken up the streets of the City under this bill could not be compelled to supply electrical energy to the City as provided by the Order of 1899, but could use the mains and works solely for the purpose of connecting with the other areas of the company, and so be enabled to dispose of some or all of their existing generating stations and realise considerable pecuniary advantage thereby without fulfilling their obligations to the Corporation. The granting of the powers contained in the bill would create a mischievous precedent, involving probably many similar applications from commercial companies who, for pecuniary considerations, might wish to establish generating stations outside London. As to the question of precedent, counsel proceeded, Parliament had approved of authorities going outside their areas; and in this case the City itself had approved. Then it was said no provision was made for the transfer to the Corporation of the mains and works referred to in the present bill. The answer to that was that the undertaking of the company as it affected the City would be kept quite distinct from the company's other works and could be transferred in the ordinary way at any time. As to breaking up the streets, the Committee would suppose from the statements in the petition that the company had no power at present to break up streets in the City; but by the Order of 1899 they had such power, and the only extra power sought was as to connecting the new station with the company's existing area of supply outside the City, by laying in a trough or tube a couple of extra wires.

Mr. W. H. PATCHELL, engineer-in-chief to the promoting company, said he had large experience in laying electric light mains in London streets. The company, in accordance with the order of last year, examined a number of sites in the City, but owing to the enormous price and great inconvenience involved it was found impossible to acquire one. Then they fixed on an ideal site at West Ham. On that site they proposed to erect two generating stations, one for the supply of electricity to the City and one for the supply of electricity to the company's other districts. Each station was complete in itself, and quite apart from one another, so that if ever the City elected to buy their portion of the company's undertaking they would be able to acquire their generating station. There would be five different sub-stations in the City, each of which would require a cable. There would be seven cables from the generating stations at West Ham to the City, five for the use of the City, the two others being carried through the City for the use of the West End. By the time the new station at West Ham was built a further supply would be required for the western districts of the company, and this extra supply it was intended should come from the new works. The same trench into which the company could put the five cables to supply the City would also contain the other two for the supply of the districts beyond the City; there would be no more breaking up of streets to put down seven cables than there would be to put down five. There would be no difficulty in laying the mains along the scheduled thoroughfares. With regard to the power in the bill to supply the local authorities through whose districts the mains passed, he said power was only sought to be allowed to supply them in bulk when requested; no power to compete was asked for. The company were now supplying in the whole of their district 206,090 8 c.p. lamps. It would not be practicable to carry the cables for the whole route along the route of the Great Eastern Railway Company. The main objection to carrying the trunk mains along the Great Eastern Railway was the fear of some railway accident which might injure them. The London Electric Company originally brought their mains along the line of the South Eastern Railway, but found it advisable to move them.

By Mr. RIGG, representing Mile End Old Town: You have taken advantage in this bill to get powers to carry mains from the West Ham station to the West End?—Certainly.

And power to supply in bulk to outside authorities, which is a power you had not got in the original order?—That is a fresh thing in the bill, but they are not exactly outside authorities; they are authorities through whose area we pass, and they need not take it unless they like.

But those authorities have electric lighting orders of their own?—I do not know that.

The only use of this power to supply in bulk will be to supply to somebody outside the authorities through which you go?—No, that is not intended at all. The only power we take to supply electricity in bulk is to those local authorities if they desire it.

By the CHAIRMAN: The voltage to be used on this main was not absolutely settled; it would probably be about 10,000.

Mr. LITTLER, Q.C., at this point said the opposition of the City was satisfied. A clause had been agreed to as follows:—

"New clause 14*a*.—The mains for supplying electricity to the City shall "be defined and appropriated to such supply, and such mains shall be subject "to the terms of purchase set forth in section 62 of the City of London "Electric Lighting Order, 1899, but if the local authority under the order "shall exercise their option of purchasing the generating station under the "provisions of section 2 of the Electric Lighting Act, 1888, instead of under "section 62 of the said order then the said mains shall be purchasable on "the terms set out in section 2 of the Electric Lighting Act, 1888. In the "event of purchase by the said local authority of the said mains the powers "conferred on the company by the section of this act whereof the marginal "note is 'Power to lay connecting mains,' shall so far as they are directly "applicable for the purposes of the undertaking under the City of London "Electric Lighting Order, 1899, be exercisable by the said local authority. "None of the streets of the City mentioned within the second schedule shall "be broken up under the powers of this act without the previous consent in "writing of the Corporation, which consent shall not be unreasonably with-"held, and such consent shall be presumed if no dissent in writing be received "by the undertakers from the Corporation within one month from the "receipt by the Corporation of the application for such consent. Any dis-"pute as to the withholding of such consent shall be referred to and finally "determined by the Board of Trade or by an arbitrator to be appointed "by the Board of Trade as the Board may see fit."

Mr. E. W. MONKHOUSE, C.E., for the bill, said he had had large experience in laying down electric cables in the public streets of Edinburgh, Westminster, Broad-street, Piccadilly, Oxford-street, and other crowded thoroughfares. He knew the proposed route from West Ham to the City. The roads were peculiarly broad, save at one part, and there would be no difficulty in taking the cables through them.

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Mr. READER HARRIS, Q.C., for the Poplar Board of Works, said all the local authorities were unanimous in opposing the measure, none of them deriving any benefit from the bill. He suggested that the promoters should go on with the construction of the generating station, but that for the cable route they should wait until next session. They would lose nothing by waiting, as the conduits would be laid in six months, and would be ready in time for the generating station. Next year they could come for power to carry the cables through the route the local authorities suggested in their petition, which would not be open to the charge of causing inconvenience.

Mr. O. E. WINTER, C.E., surveyor to the Poplar district, described the underground condition of the main road in Poplar, under which it was proposed to lay the cables. There were a large number of pipes beneath the surface, including trunk gas and water mains. To lay the cables along this route would cause great inconvenience. There was another route available through Poplar, running parallel to the proposed route, where the cable could be laid without interfering with trunk gas and water mains. He admitted that the Poplar local authority had themselves laid pipes for electric cables along Bow-road. It was said that the Poplar district would derive no benefit from the laying of these cables, but the cables would no doubt be rated, and the electrical supply of the promoters would, doubtless, be available to Poplar if their own supply went wrong.

Mr. J. KNIGHT, C.E., surveyor to the Mile End Old Town Vestry, said the County of London Company had given notice of intention to lay five lines along the main road, two on one side and three on the other, and in addition the local authority had an electrical undertaking of their own, and would have to lay down lines of pipes.

Mr. SHIRESS WILL: And do you propose to lay them down the main road?—We shall have to.

Mr. JAMESON, surveyor to the Whitechapel District Board of Works, said his Board did not object to the company's mains passing through the district to supply electricity in another district, but they did object to the pipes being laid in their main streets. It would not be physically impossible to lay the mains in the main thoroughfare as proposed, but it would occasion great inconvenience to the public.

Mr. LITTLER, for the Whitechapel Board, said two applications to lay mains in this main thoroughfare of Whitechapel on the part of two companys—one hydraulic and one electric—had been refused already. Moreover, Sir James Kitson's Committee, which had been sitting so long this session, dealt with this very point by deciding that where powers were given for the erection of a generating station outside the area of supply, the mains laid from the generating station to the area of supply should be laid in such a line of streets, and in such trenches and of such dimensions as might be agreed between the promoters and the road authorities through whose districts the mains were to be laid. His own clients and the other authorities concerned were willing that the generating station should be sanctioned, but asked that the other portion of the bill, as to laying mains in the intervening district, should not be authorised, in return for which the local authorities would undertake not to oppose an application by the company next session for a route other than that proposed. The local authorities would endeavour to agree with the company what this route should be, or, failing agreement, to submit to what the Board of Trade might direct.

Counsel for Poplar and Mile End assented.

Mr. PEMBER, in reply, said there was a growing tendency on the part of Parliament to treat electricity as one of the necessaries of life—as being on a par with water and gas—and that to do anything which would prevent electricity being easily and cheaply supplied to the people of London would be an extremely injudicious, unwise, and unstatesmanlike thing. These generating stations outside the area of supply saved an infinity of stations in the large and populous inner districts, and being much larger than they would be if constructed in each district, enabled the supply to be given much more cheaply. The essence of the present scheme was that the mains should be brought as straight as possible over the long distance between the generating station and the City because the principal expense attending the supply of electricity in this way was the length of cable laid. He must therefore decline to accept the arrangement proposed by Mr. Littler, because under it the company would be sent first up this street, down another, then back again, and so on, and by the time they had satisfied all these authorities they would have laid probably four or five times as much main as was now proposed, which would add enormously to the price at which electricity could be supplied.

The CHAIRMAN said: The Committee are of opinion that the preamble is proved.

The Committee then proceeded to the consideration of the clauses. On clause 8 Mr. READER HARRIS raised objection, alleging that, as submitted, it would give a perfectly unlimited right to the company to lay any number of pipes or mains through their districts, not merely for the supply of existing areas of supply, but for other districts which the company might in future obtain power to supply in.

Mr. SHIRESS WILL said he would limit the clause to the existing areas.

Mr. READER HARRIS then submitted a series of clauses for the protection of the local authorities, the chief of which was designed to restrict the amount of space which might be occupied in the roads by the company to not exceeding 2ft. 6in. square.

Mr. RIGG, for Mile End, contended that the general law could not apply to the local authorities outside the City, because "local authority" in the order clearly meant only the City.

Eventually the wording of the order was altered, with the consent of the promoters, so as to extend the protection of the general law to the outer authorities, the Committee declining to grant them anything further, or to give the clause asked for the purpose of restricting the space to be occupied.

The bill was ordered to be reported.

NORTH METROPOLITAN ELECTRIC POWER BILL.

The Committee of the House of Commons, of which Mr. A. H. Brown is chairman, met again on Monday to consider the clauses of this bill.

On clause 8, relating to the conditions of supply, by which it is provided among other things that authorised undertakers requiring a supply of electrical energy shall serve a notice on the company specifying the point at which the supply is required, the maximum power required to be supplied, and the purposes for which it is required to be supplied,

Mr. LEWIS COWARD (on behalf of the local authorities) asked the Committee to amend the clause by requiring the notice also to specify the form in which the supply is required.

The CHAIRMAN: The words of the clause are copied from the Durham bill.

Mr. MOON (for the promoters): It is not a notice to be given by the company at all but by the undertakers, who can give what notice they please to the company, If they like to state the form of the supply they can do so, but it would not impose any obligation on the company.

Mr. ROBERT HAMMOND, recalled, and asked by Mr. Lewis Coward why he attached importance to the insertion of the words "the form in which the supply is required," said his reasons had reference to the question of price. The price scheduled in the bill set forth what was to be paid for the energy, and it was an understood thing that the energy should be transformed from the high voltage at which it entered the district into the necessary voltage for use in the district at the expense of the undertakers. In order to make the clause perfectly clear, it should put on the undertakers the obligation to specify the form in which the supply is required for use.

Mr. TREVELYAN: Supposing that the authorised undertakers apply to this company for a supply of electricity at a certain voltage, will the company be bound to supply it at that voltage?—I think that obligation should be put on them. I was afraid that it was not quite clear.

By Mr. MOON: How will it assist you?—It would assist me in getting what I want, viz., the electricity at the voltage at which I can use it. I have read the clause carefully, and I think it would be improved by making it perfectly clear that it is the intention of the company to supply electricity at the required voltage.

Is it your view of the clause that it precludes the local authorities from asking for a supply of electricity at any particular voltage?—I am informed so.

Mr. MOON: That is a matter of construction on which the Board of Trade would be as capable of forming an opinion as you?—Perhaps so.

Mr. FORBES LANKESTER: Do the promoters, or do they not, intend to give the local authorities electrical energy transformed in the way they require? If their intention is to give it to us in that form, what objection is there to make it clear in the clause? If it is not their intention to give it in that form, we ought to know that.

The CHAIRMAN: Suppose a local authority want a voltage of, say, 200 volts, and they apply to this company to get it, and the company say "No, the voltage is 10,000," of course the authorities have no power, but simply to say: "You must transform it." It would be a question of terms.

Mr. FORBES LANKESTER: Then the question would arise, Who is to pay for the transformation? The intention of the promoters, as we understood, was to supply electricity to us in the transformed shape to any voltage we might require.

The CHAIRMAN: If the company supplied at 5,000 volts the Board of Trade would say that that must be transformed. It appears to me that the words are unnecessary. With the amendment we are satisfied with the clause.

Mr. Frere, on behalf of the Edmonton Local Board, and Mr. Forbes Lankester, on behalf of Wood Green, and Mr. Bartley Denniss, for Harrow, applied that a longer term should be granted than in the Durham case to enable the local authorities to have first choice to give a supply of electricity. It was asked that the act should not come into operation until Oct. 1, 1901, so that they might have time to apply to Parliament next session for powers, either alone or in conjunction with other authorities, to supply electricity in this district. It was pointed out that six of the local authorities had resolved to go for a joint scheme by provisional order, that the Tottenham bill had actually passed through the House of Commons, and that the Harrow Electric Lighting Order had been passed by the Board of Trade and received the assent of Parliament this session.

After the Committee had conferred the CHAIRMAN said they declined to grant the application.

On the clause prohibiting the company from supplying within the area of supply of any authorised distributors for use by the authorised users exclusively within that area, except with the consent of the distributors, Mr. Frere asked the Committee to strike out the word "exclusively," which he contended would defeat the object of the clause, which was to protect the local authorities and to enable them, if they were in a position to do so, to supply electricity to the tramways within their districts.

Mr. ROBERT HAMMOND, supporting the proposed amendment, said the tramways of the North Metropolitan Company passed through Edmonton, Tottenham, and Enfield, and the local authorities of those districts hoped to have the power of supplying the tramways with electricity, and thereby to improve the load factor. In the case under consideration the electricity would not be for the exclusive use of the districts of any of the three local authorities mentioned; of course it could not be stopped going somewhere else. By the retention of the word exclusively the whole object of the clause would be evaded.

The CHAIRMAN said the clause had been decided in the Durham case, and as there was no difference in this respect between the case of the North Metropolitan, the Committee could not accept the amendment.

Mr. HARPER asked for a special clause providing that the Middlesex County Council should have the same power of supervision as the local

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authorities over the opening and breaking up of the roads by the Electric Power Co., on whose behalf Mr. Worsley Taylor, Q.C., expressed his willingness to come to the same arrangement with the Middlesex County Council as was come to with the Durham County Council.

The Committee refused to insert Mr. Harper's clause, but offered to put in the Durham clause on the understanding that it obviated opposition in the House of Lords.

Mr. HARPER declined the concession.

The remaining clauses having been adjusted in accordance with the Durham precedent, the bill was reported for third reading.

ELECTRIC POWER BILLS.

The Committee of the House of Commons on Electric Power Bills resumed its investigations on July 6, when a long discussion took place on the clauses of the South Wales, Lancashire, and Durham County bills. The Chairman placed before counsel for the promoters of the three bills a clause drafted by the Board of Trade, and providing that if within a year of the date of the passing of the bill a company had not substantially commenced to carry out their powers, and if within three years they had not erected generating stations an order might be made by the Board of Trade bringing such companies powers to an end. Counsel expressed their willingness to accept the clause if the one year were altered to two and the three years to five. Counsel for the Lancashire bill, however, suggested that a clause in that measure providing that a certain amount of capital should be subscribed before the works were commenced should, under the circumstances, be struck out.

Further points having been discussed, the Chairman announced the Committee's conclusions as follows:—

"The decision of the Committee as to the South Wales Bill is that the standard dividend be not subject to revision, and the relation between price and dividend will stand. With regard to the question of overhead wires, in Durham only, in the districts of urban authorities, the local authority will have an absolute veto. In the districts of rural authorities the rural authorities will have only a qualified veto. With regard to the cessor of powers, two years and four years will be substituted for one year and three years. The provision in the Lancashire bill as to the subscription of capital will be struck out. In the South Wales bill the maximum price will be reduced from 4d. to 3d., in accordance with the offer of the promoters. In the Lancashire bill the nature of the cable will be left subject to the Board of Trade. The local authority will not have any power over the nature of the cable. As to the question of disuser of mains, three years will be substituted for one year, and the words 'or any part thereof' will be inserted. With reference to the obligation to supply, there will possibly be some draft amendments, and the penalty will be £10 a day, with a limit of £500 cumulative. The other points raised are only points of drafting, which will be settled after discussion between the Government draughtsmen and the agents of the bill."

On Monday the Committee held its final sitting. The clauses of the three bills were adjusted in accordance with the various decisions of the Committee and the measures were ordered to be reported to the House for third reading.

WIRELESS TELEGRAPHY.

In the House of Commons on Friday last, in reply to a question on the subject, Mr. RITCHIE said the wireless telegraphy communication between the East Goodwin light vessel and the mainland was established for experimental purposes only, and had now been discontinued. He was not aware of the exact nature of the system in use on the Borkum light vessel. The question of using a system of wireless telegraphy for communication with lighthouses and light vessels was before an inter-departmental committee, who had very difficult questions of patent rights to consider.

In the House of Commons on Monday, Mr. RITCHIE stated, in reply to a question by Sir R. Penrose-Fitzgerald, that the inter-departmental committee on the question of wireless telegraphy for life-saving purposes was appointed to consider and report (*a*) with respect to the provision and maintenance of communication between outlying lighthouses and light-vessels and the shore, and whether any, and if so what, extension and improvement could be made therein, special regard being had to a system of wireless telegraphy; (*b*) how far and subject to what conditions the means of communication with such light stations could be made available for private messages without affecting the efficiency and safety of the light-house service; and (*c*) how far the connections between shore lighthouses and post offices or coastguard stations should be made available for private messages. This committee had superseded that appointed in consequence of the recommendation contained in the final report of the Royal Commission on Electric Communication with Lighthouses and Light Vessels, and comprises representatives of the Board of Trade, Admiralty, Treasury, Post Office, and Trinity House.

In reply to a further question Mr. RITCHIE said the committee would endeavour to ascertain from the German Government and the German lifeboat authorities the nature of the system of communications with the Borkum light vessel which had been recently adopted.

WEST BROMWICH CORPORATION BILL.

On Tuesday a Select Committee of the House of Lords considered this bill for powers (*inter alia*) in respect of tramways and electric lighting. The South Staffordshire Tramways Co. opposed the clauses by which the Corporation asked for working powers over portions of the tramways outside the borough.

For the promoters, Mr. GERALD FITZGERALD stated that, as West Bromwich was entirely surrounded by large boroughs and urban districts, it was of the greatest importance to the artisan population that there should be a good system of tramway communication, and the Corporation attached great importance to that portion of the bill. The South Staffordshire Co. owned 5 miles of tramways within the borough, and the Birmingham and Midland Tramways Co. 2 miles or 3 miles. The Corporation asked for powers to purchase the outlying portions of the tramways beyond their boundaries, which would form good connections with the tramways authorised within the borough. In 1902 the Corporation would buy up the 5 miles of the South Staffordshire Company's within the borough, and other boroughs, such as Handsworth, Tipton, and Wednesbury, would have similar opportunities of buying up the South Staffordshire. He thought the opposition really came from the British Electric Traction Co., who were seeking to work tramways in the district.

Mr. A. D. GREATOREX, borough surveyor of West Bromwich, gave evidence with regard to the tramways.

Mr. LITTLER, Q.C., for the South Staffordshire Company, said the Corporation were seeking to pick out all the plums of his company's line, and to pay only old iron prices.

The CHAIRMAN announced that the Committee had decided not to give the Corporation power to work the tramways outside the borough. They would only have power to work within the borough.

MUNICIPAL TRADING.

The Lords and Commons Joint Committee on Municipal Trading met again on Friday last, the Earl of Crewe presiding.

Ald. SOUTHERN, of Manchester, continuing, stated that the Manchester tramways had at the outset been the property of the Corporation, and were constructed by them. They had determined to work the tramways themselves, and to adopt electric traction on the expiration in 1901 of the present lease of the company now working them. They had also made arrangements to work the tramways of certain urban districts adjacent to the city. The arrangement was that Manchester should pay a rent to the outside local authorities for the use of the tramways.

The CHAIRMAN: You know the objection that is taken—that you are speculating with the money of the Manchester ratepayers for enterprises outside your own area?—WITNESS replied that it was necessary to provide housing for the population displaced by the demolition of insanitary dwellings, and one way of doing this was to erect cottage dwellings outside the city, where land was cheap. This involved the necessity of some means of cheap and fairly rapid communication, and in the arrangement of tram routes this point had been specially considered.

Asked as to the electric undertaking of the Corporation, WITNESS said that in 1890 they obtained power to supply electric current within the central part of the city, and in 1896 the power was extended, and was to embrace the whole of the city. The works were completed in 1893, and the supply of current had since been continuous. The expenditure on land and works had been £641,821. The mortgaged debt amounted to £556,278, and the mortgage redeemed by sinking fund to £49,232. The income for 1899-1900 was £86,297, expenditure £49,905, gross profit £36,392, equal to 6·41 per cent. on capital invested. The number of consumers in 1894 was 412, and is now 3,249. The price in 1893 was 8d. per unit, or 2d. per unit and £3 per quarter per unit of demand. In 1900 these prices had been reduced to 5d. per unit for lighting, or 1½d. per unit and £1. 15s. per quarter per unit of demand. In 1898-9 the amount paid in aid of rates was £12,000. The Corporation had been authorised by Parliament to extend their operations into neighbouring districts, and had already arranged with several district councils. There seemed to be an impression that electrical power was chiefly sought by large consumers, such as colliery companies. In Manchester the reverse was the case, as it was the small consumers who wanted and took the power. In conclusion, witness said he did not wish to see municipal enterprises largely increased, but he thought it desirable that any enterprise which interfered largely with the public roads should be in the hands of the local authority.

Mr. D. S. WARD, alderman of Harrogate, said the Corporation had charge of the electric supply of the town. Their electric works had only been completed for about three years. After about 14 months' working the Corporation decided to reduce the price by allowing a discount of 5 per cent. to all consumers who paid their accounts within 15 days, and of 2½ per cent. to those who paid within a month. They also decided to adopt the Brighton system. The Corporation were exceedingly satisfied at having undertaken electric lighting themselves instead of putting it in private hands.

Mr. DAVIES, secretary of the Chesterfield Chamber of Commerce, said that body had made a speciality of the subject of municipal trading, and as a general result it came to the conclusion that the greatest objection to municipal trading was that it was not so much to be depended on for the supply of the commercial necessities of the community as private trading.

The CHAIRMAN: Have you any instances to give?—WITNESS: There is the case of Cardiff. The Corporation of that town started supplying electric energy some years ago. The works were not quite up to date, and there were some failures—I believe frequent failures. The Corporation, after taking the best advice they could, determined to get authority to extend their plant very materially. They deposited a bill for the purpose, but on the bill being submitted to the ratepayers of Cardiff at a poll a very large majority refused to proceed in the matter. Witness added that if London were to carry on all the undertakings that, say, Huddersfield was carrying on it would have at once to increase its indebtedness by £200,000,000, which was equal to nearly one-third of the National Debt.

On Tuesday Lord Provost CHISHOLM, of Glasgow, denied that the various undertakings carried on by the Corporation of that city were conducted for trading purposes. He said the Corporation tried to make them all pay, but the profits were applied not to reduction of rates but to the improvement or reduction in the price charged for the commodities supplied. They carried on both the gas and water undertakings to the

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great advantage of the citizens, and had reduced the fares on their tramways by from 30 per cent. to 50 per cent., besides providing a much better service of cars. They now carried 2,500,000 passengers a week on these lines, and the electric system of traction had been introduced. He did not believe that a company would have been as enterprising with reference to the tramways as the Corporation had been. The first aim of a company was undoubtedly to make profits, while the first aim of a corporation was to conduce to the comfort and convenience of the citizens. There was no disposition on the part of the Glasgow Corporation to apply any of the tramway profits to the reduction of rates.

The CHAIRMAN: What have you to say about electricity supply?—We obtained power to supply electricity within the city boundaries in 1890 and for some years the undertaking was carried on as the partner of the gas undertaking. Since it has been constituted a separate enterprise it has been carried on with much greater vigour. We have over 3,000 consumers. Our capital expenditure to May, 1899, was £3,888,589, and our revenue for the past year £44,000. The price charged for current averaged from 6d. to 2d. per unit, against 7d. per unit when the works were first opened in 1892. We have power to arrange with outside authorities but we have not yet completed arrangements with them.

Do you think that you have shown all reasonable enterprise in connection with your electric supply?—I think we might have gone ahead a little more vigorously at the beginning. A circumstance which, in my opinion, accounts for that dilatoriness was its being worked by a sub-committee of the Gas committee. Hydraulic power was supplied under the Corporation's Waterworks Act. They were pressed by manufacturers to supply it, and as the Corporation was extremely unwilling that there should be any interference with their streets by a private company they decided to supply it themselves. Their annual revenue on this account was £6,607, and their annual expenditure £7,715, showing a deficiency of £1,044. The loss was paid out of the surplus of the ordinary water enterprise.

On the question of telephones, WITNESS said the Corporation had obtained a licence to work a telephone system throughout the city, and were at present in course of establishing such a system. Their area would be identical with that of the National Telephone Co., with whose service they were dissatisfied. That was why they had obtained a licence of their own. The telephone had become a necessity of business life, and it was practically a monopoly, while to carry it out effectually required the use of the streets.

The CHAIRMAN: You propose to lay your wires underground?

WITNESS: Practically entirely. From exchange to exchange they will be underground, but to individual houses they will be along the roofs.

Did you give leave to the National Telephone Co. to break up the streets?—No. Witness went on to say that in his opinion when an undertaking met a necessity or had a monopoly, and required the use of the streets, as was the case with the telephones, a corporation was entitled to take it over and work it.

And you think you can undertake this better than an ordinary trading company?—Well, we have had proof for many years that the company cannot or will not do it, and we therefore intend to do it ourselves. The question never would have arisen but for the fact that there was the greatest dissatisfaction in the operations of the company. Glasgow employed 8,021 men, women, boys and girls in its various undertakings, including the police, the gasworks, and the tramways. He did not think there was any danger from having so many Corporation employés. They formed but an infinitesimal fraction of the whole body of voters. There were 132,000 electors in Glasgow, and he took it that only 6,500 of the Corporation employés were voters. There were always one or two close contests at the municipal elections.

Do you think that there is any danger of a combination between your employés, perhaps in conjunction with other workmen, to put pressure on candidates for municipal offices?—I do not think there is any real danger. I think that the other workmen would be quick to see that; as they contribute to the rates which support the police, and as they contribute to the success of the tramways and other undertakings, their interests are not the same as those of the Corporation employés.

Mr. R. H. SMITH, of Sheffield, general secretary of the Federation of Ironmongers' Associations, said several of the associations had considered the question of municipal trading. Owing to the sale of gas stoves and internal electrical fittings by municipalities, the retail trade had suffered very considerably, and prices had been very much affected.

The Committee adjourned till to-day (Friday).

BAKER-STREET & WATERLOO RAILWAY.

The Select Committee of the House of Lords, presided over by Lord Rosse, on Tuesday considered this bill, which has already received the sanction of the Lower House. The proceedings before the House of Commons Committee were reported in our issue of May 4, page 61.

Mr. WORSLEY TAYLOR, Q.C., for the bill, repeated his opening statement, and said the only opponent of the measure in their Lordships' House was the Metropolitan Railway Co., whose opposition was mainly based on fears of competition.

Mr. W. R. GALBRAITH, C.E., gave details of the scheme. He said in 1897 negotiations were entered into with the London & Globe Financial Corporation, and an agreement entered into by which that company were to receive the whole of the capital and to construct the line, equipping it and making it ready for traffic. A sum was also to be handed back to the company to meet contingencies in working. The Globe Company entered into agreements with Messrs. Perry to construct the line for £877,000, exclusive of land, equipment and engineering expenses, which, together with the £50,000 handed back to the Baker-street Company, had to be met out of the £889,000 remaining capital. The result would be that the Globe Company might or might not have in their pocket the sum of £152,000 on completion of the line. Every contractor reckoned to make 10 per cent. on large works, and he did not see why the London & Globe profit should be objected to as an extraordinary immoral procedure as it had been. An Act had been obtained last year for the deviation of the line at Waterloo, and for the construction of subways at Trafalgar-square, and capital powers of £80,000 granted for that purpose. The shaft had been driven more than half-way across the river, and the tunnels would be completed to Piccadilly-circus next month. Under the rejected scheme of last year they had proposed to pass under the Regent's-canal, and also to make an extension to Euston. They now only propose to go to Paddington, and to construct stations at Edgeware-road and at Bishops-road. The railway and subway had received the assent of the Great Western Railway Co. In order to connect the line with the proposed generating station, it was necessary to extend it from Waterloo towards the Elephant and Castle. The length of the southern extension with subway to meet the City and South London would be about three-quarters of a mile, and the cost, together with the short branch connecting with the generating station would be £263,000, and the total cost of the works under the bill £945,000. The Metropolitan Railway Co., as he understood it, did not fear the works so much as competition. Arrangements had been made to get the works carried out for the estimates in the same way as before. Witness was exhaustively cross-examined by Mr. Littler, Q.C., for the Metropolitan Railway Co. in regard to the agreements with the London & Globe Company.

Sir WILLIAM POLLITT, general manager of the Great Central Railway, said the railway was a good line to begin with, but the proposed extensions would considerably improve it and make it more advantageous to the public. It would connect the Great Central with the Great Western Railway, and enable people easily to reach the suburban districts. The extension on the south side would much improve the scheme, and any additional means of carrying the dense population cheaply and expeditiously was an enormous public advantage.

Mr. J. L. WILKINSON, general manager of the Great Western Railway spoke strongly in favour of the bill.

Mr. C. J. OWENS, general manager of the London & South-Western Railway, said the traffic from Waterloo was increasing more rapidly than from any other terminus. The western and northern extension were very necessary for the completion of the Baker-street Railway. The lack of communication between the great termini could only be remedied by underground electric railways.

For the opposition, Mr. JOHN BELL, secretary to the Metropolitan Railway Co. gave evidence. He said the line was a purely speculative one with ulterior objects. Future extensions were what were feared. He did not think the line would be financially successful, but would do a vast amount of harm to the Metropolitan Company without benefiting the promoters. He did not consider there was any necessity for the proposed extension to Paddington, and further extensions were probable if the present northern one was sanctioned. It was hard that the Metropolitan Company after having constructed their line at enormous expense, should now have their vested rights materially interfered with. The extension of the promoters' line to Paddington would establish competition at Bishop's-road, Praed-street, Queen's-road, and Royal Oak.

Sir J. WOLFE BARRY, C.E., corroborated generally the evidence of Mr. Bell.

Mr. PAGE, Q.C., for the promoters, said it had been put forward that the promoters were not a company, but they were incorporated under the Act of 1893, and further powers had been granted to them in 1896, and again last year, when Parliament had granted powers to the company to make a deviation at Waterloo, and to construct subways at Charing Cross, and to raise additional capital of £80,000.

On Wednesday, after hearing counsel, the Committee passed the preamble of the bill.

Yesterday the Committee considered the clauses of the Bill and rejected certain clauses put in by Mr. Freeman, Q.C., on behalf of the Metropolitan Railway Co.

LONDON UNITED TRAMWAYS BILL.

The Committee of the House of Lords, presided over by the Earl of Rosse, on Wednesday inquired into the merits of the tramway extension scheme of the London United Tramways Co. (Ltd.). The proceedings before the House of Commons Committee, when the preamble was declared proved with slight amendment, were reported in *The Electrician* for May 11, p. 106.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said the length of tramways which the company had already constructed, and for which they had obtained Parliamentary sanction, was 21m. 7f. 9c., and the system connected Hammersmith and Uxbridge, Hammersmith and Hounslow, and Kew and Hanwell. The additions now proposed would be in length 17m. 3f. 9c., and would run from Acton to Hanwell—to complete the line from Shepherd's Bush to Uxbridge—and would form an extension from Hounslow to Baber Bridge, from the London-road near Kew, and from Richmond to Twickenham, Hampton, Hampton Wick and Teddington. Practically the whole of the system, except one small piece in Richmond-road, was unopposed. At present the system was worked by horses, but the promoters proposed to use electricity, and intended to construct a large generating station in the Chiswick-road. Before long 10 miles of the system would be worked by electricity, and it was intended eventually so to work the whole of the tramways. Ealing originally opposed the scheme, as well as certain frontagers subsidised by one of the great omnibus companies. But Ealing had so far changed its mind that in the beginning of the present session it had itself proposed a tramway along the very streets in which it had declared that the line of the company would be an obstruction. Thinking, however, that the company's scheme was better than its own, the Council had now withdrawn this bill and was supporting the present proposal, which it had formerly opposed and had been instrumental in getting rejected. It was also hard for the

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promoters that a scheme which they had presented before the Light Railway Commissioners had been rejected, notwithstanding its approval by all the local authorities on the line of route, owing to the opposition of the London & South Western Railway Co., who were now, singular to say, favouring the proposal, having found out that the tramways contemplated would benefit them rather than the reverse. The nine local authorities affected by the present bill had cast on the promoters onerous responsibilities in the matter of carrying out improvements along the track of the tramway—improvements which would cost the promoters £120,000. The chief petitioners against the bill were the Middlesex County Council, who were, however, affected only in a few cases in which the local authorities had entrusted them with the maintenance of the main roads. He would therefore ask the Committee to allow the County Council to be heard only in respect of the sections of road under their control. One complaint made against the promoters of this bill was that they had bribed the clerks of the District Councils. This was simply not true, as he would prove up to the hilt.

Yesterday (Thursday) the CHAIRMAN said the question of alleged improper payments had first to be dealt with by the Committee. Attention had been drawn to the clause in the petition of the Middlesex County Council, in which it was said "and the promoters have made improper payments to the clerks of certain district councils and others." The Committee were anxious to know who the clerks in question were, and what were the particulars of the charge.

The charges were indignantly denied by the legal representatives of the District Council officials.

Lord R. CECIL, for the Middlesex County Council, said the measure before the Committee was an important one, and the charge made in their petition by the Middlesex Council was also serious and important. What surprised him was the apparent desire on the part of the promoters to avoid a full investigation. The clause of the petition ran :—

"The Company has, with a view to obtaining the consent of various District Boards through whose districts the proposed tramways will pass, taken an active part in the election of the District Councils, and in promoting the election of councillors favourable to the Company, and the Company has also, with a view to influence the inhabitants of the districts traversed by the tramways favourably towards the bill, published and circulated, or have been instrumental in publishing and circulating, a quantity of printed matter of a highly coloured character, calculated to create an extremely distorted and inaccurate view of the scheme and proposals embodied in the bill, and of the manner in which it will affect the districts concerned ; and the promoters have made improper payments to the clerks of certain District Councils and others."

The charge made was couched in general terms, as was usual in petitions. The district principally affected was the district of Teddington, the only other district implicated being Twickenham. The charge was that the promoters had made improper payments. In regard to Teddington an investigation had been made by the Chairman of the District Council, who had reported on the subject. In his report the correspondence between the tramway company and the Council and their officials was given, from which it appeared that, in addition to a sum of £70. 1s. 8d. paid by the promoters to the Council in respect of costs, 200 guineas had been given to the clerk of the Council without the Council's knowledge. This payment was made in respect of a light railway promoted last year by the tramway company, in effect the same scheme as that now before the Committee. The correspondence showed that an agreement had been drawn up between the promoters and the Teddington District Council, and that 200 guineas had been paid to Mr. G. H. Salmons, the Council's clerk, for the work he had performed ; that the chairman of the Council asked that the services so paid for should be specified, and whether it was the fact that a further sum of 100 guineas had been promised when the bill was got through ; and that the company were prepared to pay what was demanded. By request of Mr. Salmons a meeting between representatives of the District Council and the promoters was arranged to investigate the matter. It was stated at the meeting that Mr. Salmon's action had been misinterpreted, and the representatives of the Council held that it had been consistent with a resolution passed by the Council to the effect that the work of the clerk in connection with the agreement between themselves and the tramway company as to road widenings and improvements should be regarded as extra work, and should entitle him to remuneration such as was paid to the officials of other Councils.

The CHAIRMAN decided that the question raised was one to be fought out in a proper court.

Lord R. CECIL urged that the object of the promoters had been to secure the consent of the District Councils, which was as essential in the case of a light railway scheme as it was in the case of a tramway bill before Parliament. It was important, in his view, that the Committee should have an opportunity of ascertaining whether the promoters had conducted their scheme properly.

Mr. W. TAYLOR, Q.C., said this was one of the gravest matters which had ever come under his notice during a 30 years' practice before Parliamentary Committees. His learned friend could not give himself a *locus standi* by making a charge which might render certain district clerks liable to a criminal prosecution. The charges he made were not a ground of *locus*. He would ask what their lordships proposed to do. There was no shadow of doubt as to what the charge was.

Lord R. CECIL said that the Middlesex County Council claimed a general *locus* as being charged with the administration of the affairs of he county, and having before them a case in which it was sought to obtain tramway powers by improper means.

The CHAIRMAN : The Committee cannot go into the question of these libellous charges. I may say we do not see that the allegations made are borne out by the correspondence.

Lord R. CECIL : I regret very deeply that you should think so. He then addressed himself to the question of the *locus standi* of the County Council to be heard against the bill as the chief road authority in the county of Middlesex.

The CHAIRMAN said the Committee would only give the Middlesex County Council a limited *locus*.

Mr. CLIFTON ROBINSON, C.E. (managing director and engineer to the promoters), then gave evidence as to the enormous public advantage which would attend the proposed tramway extensions. He pointed out that the proposed generating station, which would be at Chiswick, would cover 3 acres of land, and would cost something like £150,000. He said that formerly the London County Council had imposed restrictions on the tramway company in favour of the conduit electric system, but they had had reason to change their views, and now favoured the overhead trolley system, as proposed in the bill. Parliament, the London County Council, and all the local authorities were in favour of the proposed system. The cost of the improvements which would be effected by the promoters would be £138,000. In Richmond-road alone the improvements would cost £40,000. The public, when the proposed lines were constructed, would be able to travel from Hammersmith to Uxbridge, a distance of 12 miles, for 6d., the workmen's fare being 3d. The fare from Hammersmith to Hampton Court, also 12 miles, would be 6d. The company had proved by experience at Middlesbrough, Bristol and elsewhere that these fares could be made remunerative. In the event of dispute as to the system of traction to be used, the settlement of the question would rest with the Board of Trade. The electric cars would be palatial, and would cost £1,000 each as against £200 spent on the horse car. The company proposed at once to spend £100,000 on cars. The speed of the cars would not be necessarily limited to 8 miles an hour. The speed would depend on the character of the road. At Middlesbrough they ran at 4, 6, 8, 10, and even 12 miles an hour. It would depend upon the Board of Trade what the speed should be along Richmond-road.

Other evidence in support of the bill having been given, the Committee adjourned

MERSEY RAILWAY BILL.

This bill, which authorises the Mersey Railway Company to adopt electric traction and which provides for the formation of a joint committee for working the Mersey and Wirral Railways, came before the unopposed Bill Committee in the House of Commons on Wednesday, and was ordered to be reported for third reading.

SOUTH LANCASHIRE TRAMWAYS.

The Bill of the South Lancashire Tramways Co., which has passed through all its stages in the Commons, came on Monday before a Select Committee of the House of Lords, presided over by Viscount Portman. The proceedings before the Commons Committee were reported in *The Electrician* for May 4, page 62.

Mr. WEDDERBURN, Q.C., said the promoters were all gentlemen largely connected with the commerce of the district, and there was no question of their ability to carry out the scheme. None of the local authorities opposed it, and they had settled with the London & North-Western Railway Co. and the other four railway companies in the district—the Great Central, the Lancashire & Yorkshire, the Wigan Junction Railway, and the Liverpool, St. Helens & South Lancashire. There was a petition of 30 ratepayers and inhabitants of Ashton-in-Makerfield, and he contended they had no *locus standi*. The local authority did not oppose, and there was a clear rule that individual ratepayers could not oppose against the decision of the local authority. The Wigan & District Tramways Co. also opposed. The petitioners objected to any authority whatever being given to the South Lancashire Company "to construct tramways in Wigan or the neighbourhood, or to the company interfering with the tramways of the petitioners or with the natural extensions of such tramways." That paragraph appeared to be founded on the misconception that the Wigan Tramways Company had some prescriptive right to get more than they had already got. Of course, they had no such right. They would apply for something, and get it if they could ; but when they went before Lord Jersey they would find themselves in a great difficulty if opposed by the local authority. Then another paragraph in the petition alleged that their scheme was not so laid out as to give to the public the facilities desired, and that it was so overburdened by the terms agreed with the various local authorities, that it must be over-capitalised, and could not be expected to make such a return as would enable the company to give a good and satisfactory service. But, he urged, the Wigan Company had nothing to do with this. So long as they opposed because they were promoting now a competitive scheme they had the right to be heard ; but they had no right to interfere with the terms that had been agreed. The only other petition was that of the Leeds & Liverpool Canal Co., which dealt with the reconstruction of bridges over the canal ; but this was simply a question of clauses.

The CHAIRMAN said the Committee could not alter the *locus* of the petitioners from Ashton-in-Makerfield.

Mr. WEDDERBURN then asked that the Wigan Company should be limited in their *locus*.

Mr. LEWIS COWARD, for the Wigan Company, contended they had the right to be heard against the preamble of the bill. When the bill entered the House of Commons there were no less than 61 clauses for the protection of the local authorities, and when it emerged these had been enormously increased. It was part of his objection that the promoters had burdened themselves with a sum of £70,000 to £100,000 so that there would be a very tight squeeze with the estimates. It should be able to show the onerous terms made with the authorities as to the lighting of the streets, the widening of the roads and so forth. It was difficult to say whether the promotors would ever be able to construct these tram-

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ways over the enormous length of route; then the consent of the local authorities had been obtained by arrangements of the most unheard of description.

Mr. BALFOUR BROWNE, Q.C. (for the promoters), said the bill had not been modified in any way. The clauses were entirely for the protection of the local authorities, and if the terms were onerous it was they who had to bear them, and not the Wigan Company. They had promised to light the roads along which their tramway passed by electricity. How could that affect the Wigan Company? He admitted they should be heard as to railways affecting their system, but he did not know what they had to do with the other tramways.

The CHAIRMAN said the Committee considered the opposition could go into the details of the bill.

Evidence was then called.

Mr. J. E. WALLER (Messrs. Kincaid, Waller & Manville) said his firm, in conjunction with Messrs. Preece & Cardew, were engineers to the promoters of the bill, and he personally had laid out the system now under consideration. The original length of the system was 67½ miles, but it was now 63¼ miles. It passed through a very populous neighbourhood and joined up a number of considerable towns between St. Helens, Bolton, Wigan, Leigh and Manchester.

Mr. BALFOUR BROWNE at this point said he had agreed with Mr. Coward that they would give up their line No. 14 or take powers to construct it and by a clause in the bill transfer these powers to the Wigan Company. They both desired to get to Ashton-in-Makerfield, and they (the promoters) could get there by line No. 15 and the Wigan Company by No. 14, or by their own projected light railway if the Commissioners passed it.

Mr. WEDDERBURN said in that case there was no opposition to the preamble of the bill, as the petition of the Leeds & Liverpool Canal Co. only referred to clauses.

After evidence had been heard on behalf of the Canal Company as to the bridges,

Mr. PEMBER, Q.C., for the Wigan Tramways Company, said their case was finally settled. The arrangement was that one of their light railways, parallel to No. 15 in the present bill, which they were proposing before the Commissioners, would not be persevered with, and the promoters of the present bill on their part would not proceed with their tramway No. 14 or anything like it, until November, 1902. By that time the Wigan Company would make up its mind as to whether they would construct the tramway which was wired to No. 14.

The CHAIRMAN then stated the Committee were of opinion that the new clause as to the Leigh bridge was sufficient, with the proviso that the South Lancashire Tramways Co. should pay any additional cost of altering necessitated by the widening of the bridge.

The Committee agreed to insert new clauses giving further protection to the Canal Company, including a clause ensuring that the South Lancashire Tramways Co. should be liable for any subsidence in the widening of the bridge. The preamble having been agreed and the clauses considered, the bill was ordered to be reported as amended.

SOUTH-EAST METROPOLITAN TRAMWAYS BILL.

The South-Eastern Metropolitan bill, which provides for the electrical equipment and operating by electricity of the tramway running from Greenwich to Catford, came on Tuesday before the Unopposed Bill Committee of the House of Lords. There was some difficulty in operating this line by electricity owing to its proximity to the Royal Observatory, but the promoters succeeded in satisfying the requirements of the authorities in respect to insulation. The opposition of the County Council asking for a veto on the system to be employed having been withdrawn, the bill now passed with amendments, and was ordered for report.

The measure has already passed through the House of Commons for third reading.

SHEFFIELD TRAMWAYS BILL.

The preamble of the Various Powers Bill of the Sheffield Corporation (which has already passed the House of Lords, and which provides for a considerable extension of tramways, to be eventually operated throughout by electricity), was on Tuesday last, after hearing evidence, approved by the House of Commons Committee presided over by Lord E. Fitzmaurice.

PRESTON TRAMWAYS.

On Monday the Select Committee of the House of Commons on Police and Sanitary bills, presided over by Lord E. Fitzmaurice, considered the bill of the Preston Corporation, by which, among other matters, powers are asked to reconstruct for the purposes of electrical traction the existing tramways in the borough, and to make new tramways, 11½ miles in length, also wholly within the Corporation boundaries. The bill has already passed the Upper House. As originally introduced it was sought to obtain powers under the bill to construct tramways outside the borough to Walton and Fulford, but these outside tramways were struck out of the scheme by the House of Lords.

Counsel having introduced the bill,

Mr. C. M. MACEY, C.E., said he was consulting engineer to a number of corporations. The original estimate for tramways had been £140,000 odd, but, by the omission of the outside portion of the scheme, the estimate had now been reduced to £113,000. In addition to that sum, however, £50,000 would be required for the electricity generating station, rolling stock, and car depôts. The cost of the generating plant, with transforming apparatus, would be £23,320. The overhead system would be used.

The Committee decided to pass the preamble of the bill so far as it related to tramways.

HASTINGS TRAMWAYS BILL.

This bill, which provides for the incorporation of a company, with a capital of £300,000 and borrowing powers of £150,000, with power to construct some 10 miles of tramways in the borough of Hastings, to be worked by electricity on the overhead system, having been reported to the House of Lords, now stands for third reading. The bill has passed through the House of Commons. The proposed tramways will be worked in connection with the authorised Bexhill and St. Leonards light railway, which the company is empowered to take over and construct.

PROVISIONAL ORDER TRANSFERS.

In the House of Commons last evening Mr. LOUGH asked the President of the Board of Trade whether he would explain why the Board of Trade insist on all transfers of electric lighting orders to companies being in a standard form, and refuse to allow variations required by local conditions, also on what grounds they refuse to allow the insertion of agreed provisions for the reduction of the maximum price either for public or private lighting; and whether he would consider the desirability of relaxing these departmental rules.

Mr. RITCHIE: The Board of Trade do not consider that deeds of transfer under electric lighting orders should contain any provisions other than those which are consequential on the substitution of a company for a local authority as undertakers. To go beyond this is to provide, under the colour of a mere deed of transfer, for matters which really require the approval of Parliament. Transferees are accordingly placed in exactly the same position with regard to price as they would have been had they obtained the order originally. The price for public supply is left to agreement, or, failing agreement, to arbitration. The price for private supply is not specifically fixed, but is left (as in the order) subject to a maximum, which may be revised periodically by the Board of Trade on the representation of the local authority. I see no reason for altering the existing practice of the department.

THE PACIFIC CABLE.

Sir EDWARD SASSOON asked the Secretary of State for the Colonies whether the Pacific Board had now definitely decided to commence the laying of their cable.

Mr. CHAMBERLAIN: The various Governments interested have accepted the recommendations of the Pacific Cable Committee, and tenders for the establishment of the cable will be called for immediately.

CITY OF LONDON ELECTRIC LIGHTING CO.'S BILL.

Royal Assent was given to this bill on Tuesday.

LEGAL INTELLIGENCE.

Workmen's Compensation.

In the House of Lords on June 26, before the Lord Chancellor and Lords Morris, Shand, Davey, Brampton and Robertson, an appeal action, "Powell *v.* Main Colliery Co. (Ltd.)," raised an important question under the Workmen's Compensation Act, 1897. The appellant was a miner who had been injured in the course of his employment, and had sent a letter to his employers within a week or two of the accident saying that he would claim compensation, but did not actually file his claim in the county court until nine months after the accident. Respondents pleaded that the action was consequently barred under the act, the claim not having been made within six months as there stipulated. The county court judge declined to accept this plea, and awarded 13s. 11d. weekly as compensation during total or partial incapacity from work, but the Appeal Court reversed his decision, and held that the notice of claim was not the letter but the filing of the application in the county court nine months after the accident.

The LORD CHANCELLOR said that the accident, which was the basis of this action, occurred in December, and in May appellant gave notice of it and made a claim for compensation until he was able to resume work. This claim was clearly made within the six months specified by the act. The sole argument urged was that the claim must be a claim in some form of legal proceedings. He could not, however, agree, nor did he think that such was the intention of the legislature. There was nothing in the statute to lead to the conclusion that the words "claim for compensation" were used in the technical sense suggested. He therefore held that the judgment of the Court of Appeal was wrong, and that the county court judge's decision must be restored. The act contemplated that no lawyer should be employed at all, and that the man who was injured should himself make his claim and go to the county court if it were refused. If Parliament had intended anything like a technical application of the words employed it would have said "plaint," "suit," or "writ," but it had not done so. This was a very important case, but undoubtedly the county court judge was right, and he moved that his judgment be restored.

Lord MORRIS took a different view from that of the Lord Chancellor, and was of opinion that respondents were right in their contention that a claim for compensation meant the initiation of proceedings by a request for arbitration.

The other law lords agreed with the judgment of the Lord Chancellor, and the appeal was consequently allowed by five to one, with costs.

Machray v. P. C. Middleton & Co.

The record was closed in the Aberdeen Sheriff's Court last week in this action, which was brought by Mrs. Frances Machray or Cameron and the trustees of the late John Cameron against Messrs. P. C. Middleton & Co.

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(Ltd.), Union-street, Aberdeen, to interdict defenders from carrying on the Cults electricity supply station in such manner as to create a nuisance. Pursuers aver that when the Cult works are in active operation at night the engines make an incessant throbbing noise, causing tenants and their families serious injuries consequent on the loss of sleep, disturbance, and otherwise. Defenders aver that there are other industrial works in the neighbourhood, and the operations complained of are not an excess of defenders' rights as contained in the titles of the feu, and that they do not create a noise amounting to a nuisance.

Acetylene Illuminating Co. (Ltd.) v. Midland Acetylene Patent Syndicate (Ltd.)

In the Chancery Division, on Wednesday, before Mr. Justice Farwell, this case was down for hearing.

Mr. MOULTON, Q.C., who appeared for the plaintiffs, said defendants had not put in an appearance. The action was one for infringement of patents for improvements relating to the manufacture of carbide of calcium for the production of acetylene gas under the influence of the tremendous heat of the electric arc. The defendants had undoubtedly infringed, but as soon as they were detected they promptly died. As defendants did not appear he asked for judgment against them, and for a certificate that the patent had been called in question in this action.

Mr. JAMES SWINBURNE said he had studied plaintiffs' patents relating to the manufacture of carbide of calcium. The invention was both novel and useful.

Mr. MOULTON then put in answers to interrogatories as to the infringement, and his LORDSHIP gave judgment for plaintiffs, with costs. He granted a certificate as asked, and directed an inquiry as to damages.

Joseph v. Williamson & Joseph (Ltd.).

An application on behalf of the second debenture holders in this failure came before Mr. Justice Cozens-Hardy on Saturday for judgment. Plaintiff was holder of second mortgage debentures, and was suing on behalf of himself and other debenture holders of the same issue. The defendants were trustees of a trust deed for securing the first mortgage debentures.

Mr. Justice Cozens-Hardy made the order as asked, which was for an inquiry into the amount of the liability of the company to the second debenture holders.

River Plate Electric Light & Traction Co. (Ltd).

Mr. Justice Cozens-Hardy on Tuesday allowed the petition of Messrs. Glyn Mills, Currie & Co. for the winding-up of this company to stand over until next sittings.

Re Isle of Man Tramways & Electric Power Co. (Ltd).

In the Manx Chancery Court on Wednesday an order was made for the compulsory liquidation of the Isle of Man Tramways & Electric Power Co. (Ltd.). The order was not opposed by the new board of directors, who had been unable to make arrangements to place the company in a satisfactory financial position. Mr. W. H. Walker was appointed liquidator.

Gutta-Percha Corporation (Ltd.).

In the Chancery Division on Wednesday an order to wind up the Gutta-Percha Corporation (Ltd.) compulsorily was made by Mr. Justice Cozens-Hardy on a shareholders' petition. A resolution to wind up voluntarily had already been passed for reconstruction, which proved abortive. The granting of the order by Mr. Justice Cozens-Hardy was accompanied by some severe remarks upon the management of the company since its incorporation.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—A lengthy and lucid report on the system of charging for electric current has been prepared by the city electrical engineer (Mr. J. Alex. Bell). At present the maximum demand system of charging is in operation (6d. per unit for the first hour's maximum demand and 3d. after for lighting, and 3d. and 1d. for power), and Mr. Bell favours its retention. It had been urged (he reports) that the present initial price of 6d. per unit was unduly hard on those shopkeepers who were short-hour consumers, but it was on account of those short-hour consumers that the Council had been forced to expend a large amount of capital on new plant. All future reduction of charges for some time to come Mr. Bell considers should be on the lower scale, and the initial price of 6d. should be retained. Mr. Bell considers the adoption of the maximum demand system has tended largely to the present flourishing condition of the undertaking; 62 per cent. of the consumers benefited by the rebate system during the year. In 1899 the units generated amounted to 655,479, of which about 600,925 were sold to consumers.

Asylum Lighting.—The managers of the Poplar and Stepney Sick Asylum have invited Mr. F. J. Warden-Stevens to state his terms for preparing an electric lighting scheme for the asylum.

The report of Mr. D. Mackenzie, chairman of the Edinburgh Electric Lighting committee, as to the proposed cost of an electric lighting installation at the Fife and Kinross Asylum, Springfield, has been issued. The capital expenditure is estimated at £3,150, and an annual income of £350 for 30 years would meet interest, working expenses, and total cost. The present cost of gas lighting is about £400 per annum. Acting upon this report, the Lunacy Board have decided to obtain estimates.

Barking.—The question of altering the charges for electric current was discussed at the last meeting of the Council. Mr. Marriott moved that the resolution passed in April to abandon the maximum demand system of charging be rescinded, and, as the voting was equal, the chairman gave his casting vote against the motion, and the April decision stands.

Bath.—The Works committee have reported that they are not in a position to suggest any alteration that would appreciably diminish the cost of the electricity works, but recognise that if the four old engines are replaced by new ones, a considerable saving in the cost of fuel would be effected. At the meeting of the Electricity committee last week, it was stated that the laying of new mains had made considerable progress. A discussion followed as to the best means of increasing the number of private customers. It was resolved that local wiring contractors be required to have their business premises or private houses wired and connected to the mains; any wiring contractor so connected, who engages a canvasser to be employed for canvassing for electric lighting, to be allowed a commission of 1s. for every 16 candle-power lamp wired, according to the Corporation regulations, by such contractor, and connected by the authority in private houses during each quarter. On the motion of Mr. Bush, it was agreed that a report be presented on the possibility of the committee arranging to put in fittings on the understanding that they should be paid for at so much per quarter, or a certain sum added to the charge per unit.

Batley.—Sanction to a loan of £22,231 for electric lighting and traction has been applied for.

Beckenham.—Sanction to a loan of £7,000, re-payable in 10 years, has been obtained by the Council for wiring premises in the district. A provisional agreement has been entered into with the British Insulated Wire Co., and the consulting engineer (Mr. R. P. Wilson) has been retained to supervise the work at a fee of 2½ per cent. on the actual amount expended.

Belfast.—The electrical and gas undertakings are in future to be under the control of one committee—the Lighting committee. The relations between the old electric and gas committees were always of the most harmonious character, but all the same the amalgamation seems a retrograde step.

Bethnal Green (London).—An electric lighting scheme, estimated to cost £96,000, is at present under consideration by the Vestry. Mr. R. Hammond is consulting engineer.

Bexhill.—The Council have unanimously decided to apply for sanction to borrow £7,772 for electricity supply extensions as recommended by their consulting engineer, Mr. A. H. Preece.

Broughty Ferry.—The scheme for the erection of electricity works has been dropped by the Burgh Commissioners for the present.

Bury (Lancs.).—The accounts of the electricity department for the year to March 31 have been issued. The revenue, including £3,033. 5s. for the supply of current for private consumption and £473. 19s. 10d. for public lighting, amounted to £3,582. Generation expenses came to £901. 5s. 5d., and with distribution charges, management expenses, &c., the total annual expenditure was £1,753. 3s. 4d., leaving a gross profit of £1,981. 19s. 11d. After paying interest (£900. 11s. 1d.) and sinking fund instalment (£807. 14s. 2d.) there was a net profit of £183s. 14s. 8d., which has been transferred to the general rate account. Last year there was a deficit of £336. The total capital expenditure to date is £34,395, and borrowing powers of £15,605 have not yet been exercised. There were 228,546 units of current generated, 161,469 units were supplied to private consumers, 45,505 units to public lamps, 6,421 units to contract, and 6,939 units used on the works. There are 193 consumers, representing an equivalent of 14,733 8 c.p. lamps connected, an increase of 54 consumers and 4,458 lamps during the year. The number of public arc lamps is 31, an increase of 13 over 1899, and the total maximum supply demanded was 197kw.

Cardiff.—The report of the expert (Mr. H. R. J. Burstall) on the 300kw. Ferranti alternator, which was the subject of the recent action between the Corporation and Messrs. Ferranti, has been presented. Mr. Burstall states that the alternator has now been finished and adjusted to his entire satisfaction, and as the whole of the work decided to be done under the terms of settlement had been carried out, the machine was ready to be taken over by the Corporation. The resident engineer (Mr. N. Applebee) also reported that the engine worked well and satisfactorily, and could be taken over now. The Lighting committee consider the reports satisfactory, and have decided to take over the alternator.

Carlisle.—The electric tramways were officially inspected by Mr. A. P. Trotter, on behalf of the Board of Trades last week, and the lines were opened for traffic on Saturday.

Chambley (Quebec).—The Chambley Water Power Co. are stated to be about to add very largely to their present plant, in order to develop additional power at the St. Terres Rapids. The Chambley

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works have at present 7,800 H.P. available, and the extensions now contemplated will increase this to 20,000 H.P. A portion of the extensions are nearing completion, and the whole will be finished at the end of next year.

Charges for Electric Current in London.—The County of London Company have issued an opportune notice relating to charges for electric current in their districts (St. Luke's, Clerkenwell, Eastern and Western Holborn, Putney, Roehampton, Wandsworth, Clapham, Streatham, and Tooting). The circular states that, notwithstanding the heavy increase in the costs of production due to the rise in the price of fuel, the company are not advancing their charges for electricity supply—viz., 3d. per unit for all current in excess of 1½ hours' average daily consumption of the maximum demand, the first 1½ hours being charged at 7d. per unit. Current for power is supplied from the company's continuous-current or two-phase mains at a uniform rate of 2½d. per unit.

Chesterfield.—Owing to the brisk demand for electric current for private lighting, the Electric Light committee have decided to let the question of public arc lighting stand over for the present as the capacity of the existing plant is only equal to the demand for private consumption.

Companies to be struck off Register.—Notice is given that the following joint-stock companies will be struck off the register unless cause is shown to the contrary within three months:—

Battery & Motor Co.	Gravier Dynamo Syndicate.
Brit. Assoc. of Medical Electricians.	Highgate & Finchley Tramways Co.
Canton (Waipori) Mining & Electric Power Co.	Improved Incandescent Electric Lamp Co.
Capital & Counties Elec. Supply Co.	Kerbey Bowen.
Colbridge Electric Lighting Co.	Light Railway Contract Co.
Cruto Incandescent Lamp Agency.	Llandudno Electric Supply Co.
Electric Free Wiring Syndicate.	London Electrical Carriage Co.
Electric Meter Co.	London Electrical Coupé Co.
Electric Racing Horse Maze (Pioneer) Syndicate.	London Electrical Van Co.
Electrolytic Separation Syndicate.	London Health Electrical Institute.
Eliéson Lamina Accumulator Co.	Maxim Motor Co.
European Electric Finance Co.	North London Electric Supply Co.
	Peerless Accumulator Syndicate.

Cork.—An inquiry has been held here into the application of the Corporation to borrow £20,000 for electric lighting. The Cork Electric Tramways & Lighting Co. has been authorised by the County Council to extend their mains to Douglas and Ballintemple.

Crewe.—The Council on Tuesday considered a recommendation from the Electric Lighting committee to apply for sanction to borrow £10,000 further for extending the electric lighting area. Mr. Jervis objected to further expenditure until they had some results from their present outlay of £27,000. "If electric lighting was going to be a loss in Crewe he did not see why they should increase that loss by extending their area"—not very conclusive reasoning, but it determined the Council to refer the report back with a recommendation that the extension scheme be not proceeded with.

Crieff.—The Council is to consider at it next meeting an application by the North British Electricity Supply Co. for consent to a provisional order.

Croydon.—The salary of the Borough electrical engineer (Mr. T. H. Minshall) has been increased to £450 per annum, rising by annual increments of £25 to £600.

Darlington.—The Council and the Imperial Tramways Co. are at loggerheads over the proposed scheme of light railways of the latter. The Council have notified the Light Railway Commissioners that if the company are not prepared to carry out the scheme in its entirety as proposed by the company and supported by the Corporation at the inquiry before the Commissioners in August last (with the modifications subsequently agreed to), the Council will themselves consider the expediency of making an application for a new order at an early date.

Dorking.—Offers are to be invited for the Council's provisional order.

Dublin.—Readers of the *Daily Nation*, a leading Dublin print, were alarmed on Tuesday to learn that the city on the Liffey was in "Cimmerian gloom." What is described as an utter collapse of the Corporation's electric light undertaking proves, however, to be a very small affair indeed, and gives us wonder how the newspaper man came in possession of his "facts." Shorn of all its journalistic trimming, what really occurred was that through a fault in one of the old rubber arc cables the public lighting of one side of a street was affected. This fault has not yet been remedied, and one side of the street is accordingly still in "Cimmerian gloom." No private lighting was in any way affected.

Dundee.—A hitch occurred early in the week in connection with the delivery of the cars for the Perth-road route of electric tramways. Five cars were despatched from Preston by Messrs. Dick, Kerr & Co. on Saturday last and were due to reach Dundee on Sunday, or, at latest, on Monday. On reaching Hellifield, a junction on the Midland Railway 60 miles south of Carlisle, the cars were detained. The cause of delay was that the height gauge of the English railways is somewhat higher than that of the Scotch lines, and the cars could not, resting on the trucks on which they were loaded at Preston, get beyond Carlisle. When the cause of delay was ascertained, some fear was felt that the cars could not arrive in time for the Board of Trade inspection which was due to take place yesterday (Thursday). Mr. Tittensor, burgh electrical engineer, of Dundee, and Mr. Dean, Messrs. Dick, Kerr & Co.'s representative, at once came south and were able to extricate the cars and get them to Dundee, where they arrived safely yesterday morning in time for the Board of Trade inspection, and the line was duly passed.

Eccles.—Messrs. Medhurst, Kitchin & Page have been appointed consulting electrical engineers in connection with the Corporation electric tramway scheme.

Electric v. Gas Lighting.—The following communication from Mr. Bernard M. Drake appeared in the *Daily Express* of 29th inst.:—

My attention has been called to an article in your paper of June 29, which has evidently emanated from someone who has a rival axe to grind. Now that gas has been raised in price and electric current is being produced on a larger scale, those interested in gas are finding the competition more serious, but they may rest assured that electric light, like everything else, will advance on its merits, and that no misleading statements such as those contained in your recent issue are likely to retard its progress. As a matter of fact an ordinary incandescent lamp, if of good quality and made with a good vacuum, can be grasped with the naked hand for any length of time. There are doubtless bad electric lamps as there are bad petroleum lamps, and, I might add, bad gas incandescent mantles, and surely it is not fair on this account to condemn the whole industry. Although I will not go so far as to say it is impossible to produce a fire by electric light, the fire insurance statistics show that it is infinitely safer than any other form of illuminant.

"Faraday House Journal."—The June issue of the Faraday House *Journal* is to hand. In addition to the usual notes several articles by Faradians are contributed. A gossipy article, entitled "Faradians at the Front," gives an interesting record of a number of the young men now serving with the troops in South Africa.

Glasgow.—The accounts of the tramway department, which were abstracted in our last issue, were approved by the Corporation last week. The recommendation in favour of increasing the salary of the tramways manager (Mr. John Young) from £1,250 to £1,400 per anuum, and that of the chief engineer (Mr. Wm. Clark) from £450 to £500 per annum were approved.

The agreement between the Corporation and the Burgh of Govan with reference to the conversion to the overhead trolley system of the Govan tramways, which are to be worked in conjunction with the Glasgow tramway system, was approved at the Corporation meeting last week. The lease is for 21 years after termination of existing lease in 1914. The Corporation of Glasgow are to carry out the work of converting the lines (including renewal of permanent way, laying ducts and cables, erection of overhead work, &c.), finding the capital therefor, and to undertake to maintain the whole lines, cables, and overhead construction, and leave them in good working order at the termination of the extended lease; but the lines and all overhead electrical construction in the streets to remain the property of the Govan Commissioners during the whole period of the extended lease. The Corporation to continue to pay interest and sinking fund upon the capital are expended by the Commissioners under the existing lease till the termination of the extended lease, and the Corporation are also to pay all owners' assessments on the Govan lines as from the date when these are worked electrically.

Gloucester.—Mr. A. Dickinson has been appointed consulting engineer to advise the Streets committee in its negotiations with the tramways company for the introduction of electric traction.

Halifax.—The accounts of the electricity department for the year to March 31 have been issued and show a total income of £16,069. 6s. 10d., compared with £8,957. 8s. 6d. for the previous year. Expenditure reached £7,067. 15s. 1d. (compared with £4,330. 1s. 5d.), leaving £9,001. 11s. 9d. (against £4,627. 7s. 1d. last year) to meet interest, sinking fund instalment, &c., amounting to £3,512. 10s. 3d. The net profit was £5,489. 1s. 6d., of which £2,000 has been transferred to the district fund and the balance (£3,489. 1s. 6d.) to renewal account. The total capital expenditure was £91,085. 18s. 1d., an increase of £18,616. 5s. 8d. during the year. There were 515 customers, representing an equivalent of 45,403·8 c.p. lamps connected, compared with 381 customers and 32,020 last year. The number of units sold amounted to 1,371,333, and of this number 1,289,210 units were supplied to private consumers by meter, 82,123 for public lighting, and 20,131 were used in the works. The total number of public lamps is 42, an increase of 10. Electric current was supplied at 5d. per unit for lighting and 2d. for power, subject to discounts. Current for tramway working (895,024 units) was supplied at 2d. per uuit.

Havana (Cuba).—Notwithstanding the occupation of Cuba by the United States, the country continues in an undeveloped state. The only public works of importance which show any marked degree of progress are the tramways of the city of Havana, which are now being considerably extended and converted to electrical lines.

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Hastings—The accounts of the Electricity department for the year ended Dec. 31 were presented to the Council last week. The profit on the year's working was £537. 11s., and the capital expenditure £78,916. 2s. 4d. The report was considered satisfactory, especially as it was anticipated that a loss would be made on the first year's working by the Council. The Waterworks-road electricity station is to be discontinued. Extensions of the lighting mains, estimated to cost £1,232, have been authorised.

Hereford.—The accounts of the first year's working of the electricity department were presented and approved at the meeting of the Council last week. The gross profit was £268, but after allowing for interest and sinking fund there was a deficit of £532.

Heston and Isleworth.—Edmundson's Electricity Corporation, who are erecting electricity works at Twickenham, have offered to supply electric current in these districts.

Ilkeston.—An application of the Council to borrow £18,271 for electric lighting has been deferred by the Local Government Board until a site for a generating station has been acquired. The Board of Trade have consented to the application of the Council to postpone for twelve months work in connection with their proposed tramway scheme.

Imports of Electrical Goods into the United Kingdom.—The accounts relating to the trade and navigation of the United Kingdom show that the value of electrical goods and apparatus imported during June was £86,171, against £78,350 in preceding month. The total for the six months ended June 30 was £420,253.

Inverness.—The Council have decided to abandon their electric lighting scheme. The matter has been before the Council for about 18 months and was originally taken up in order to keep out private companies. An electric lighting scheme was drawn up by the Council's consulting engineer (Mr. E. G. Craven), late of the Brush Company, whose tender for the supply and erection of plant was recommended for acceptance. Various disputes arose in connection with these tenders with the result that the Council have recently indulged in several acrimonious debates. However, matters were brought to a head on Monday when a ratepayers' petition was presented, asking the Council to abandon the whole scheme and allow a private company to supply what demands there might be for electric current. The payments to date on account of the project amount to over £1,100.

Leamington.—The directors of the Midland Electric Light & Power Co. have refused the offer of £17,000 made by the Corporation for the purchase of the company's undertaking. The position in regard to electric lighting matters in this town is complicated, as both the Corporation and the company are in possession of provisional orders, but the Corporation order lapsed if terms of purchase were not arranged by 12th inst. We are informed that the Corporation will not take any further action in the matter.

Leyton.—An inquiry has been held into the application of the Council to borrow £7,388 for electric lighting extensions. The application was supported by the clerk (Mr. R. Vincent) and the electrical engineer (Mr. F. Harman Lewis). There was no opposition.

Light Railway Orders.—The Board of Trade have, after modification, confirmed the Highbridge, Wedmore and Cheddar Light Railway order.

The Light Railway Commissioners have submitted the Nuneaton and District Light Railway Order to the Board of Trade for confirmation. Objections by Aug. 3.

The Rhyl and Prestatyn Light Railway Co. have notified Rhyl Council that they hope to have their light (electric) railway scheme complete by April 1 next.

Strenuous opposition is to be offered to the Swansea Corporation light (electric) railway scheme by the Swansea Improvements and Tramways committee.

The Board of Trade on Wednesday considered the order for the construction of light (electric) railways from Colne to Trawdon and from Colne to Nelson and Barrowford. Clause 13 empowered the Corporation to supply electricity to the promoters of the railway, but Sir Courtenay Boyle said he did not consider that any Light Railway order could give such a power, and the clause was struck out. Another question arose on the clause giving the Corporation of Burnley power to work and maintain the light railways granted by any of the three orders, but it was agreed to postpone consideration of the clause till the town clerk of Burnley had the opportunity of appearing. For the promoters, Mr. Wedderburn applied to increase the authorised capital of the company to £103,000, with borrowing powers of £36,000, as the price of labour and material had increased since the estimates were framed. The chairman sanctioned the increase, and Sir Courtenay Boyle said he would report on all the orders to the Board of Trade.

London County Council.—At Tuesday's meeting £53,837 was loaned to Fulham and £8,580 to Islington for electricity supply works. Shoreditch have applied for £26,000, but the Finance committee reported that sufficient information had not been supplied to justify the borrowing of £4,095 of this amount, and therefore recommended that a loan of £21,905 be granted. This was agreed.

Lyndhurst.—The Parish Council have expressed approval of a scheme for the erection of electricity works, and also for the construction of an electric tramway from Lyndhurst to the railway station. The consulting engineer for the scheme is Mr. C. J. Wharton.

Malton.—*Correction.*—In our issue of July 6 we stated that an agreement had been entered into between the Malton Council and "the Northern Electric Supply Association." This should have been "the Northern Counties Electricity Supply Co. of Newcastle-on-Tyne," who have obtained a provisional order for Malton.

Manaos (Amazonas).—The Manáos Railway Co., an American syndicate, has recently constructed an electric railway here, of a total length of about 14 miles, at an outlay of from £120,000 to £150,000. The rolling stock consists of 22 passenger cars and 15 waggons for sand, luggage, &c. There is a good and frequent service of cars. The company's concession is for 99 years, and includes similar enterprises within the city during that time. On the lapse of the concession the property reverts to the Government. The company receives an annual subsidy of 200 contos of reis (about £6,500) from the State Government.

Manáos is extremely well lighted by arc lamps, and many of the private houses have electric light. This plant was first installed by an American syndicate, and subsequently purchased by the State Government, to whom it now belongs.

The telephone is making progress. The Empresa Telephonica Manáos has a capital of 220,000 milreis. The number of subscribers is: Public offices, 47; private houses, 168.

Middleton.—An agreement has been entered into with the British Electric Traction Co. for the supply of electric current for the electric tramway which is being constructed from Oldham through Middleton to Manchester. The Council have received sanction to a loan for the erection of electricity works.

Motherwell.—Sanction to borrow £30,000 for electric lighting has been received by the Burgh Commissioners.

Newington (London).—The salary of the resident electrical engineer (Mr. J. R. Blaikie) has been increased from £250 to £300 per annum.

Newport (Mon.).—The Corporation have authorised the Tramways Committee to accept tenders for rails and fish-plates for the Corporation-road electric tramway route, and Ald. Moses and two other members of the Electricity committee have been added to the Tramways committee to assist in deciding as to the most suitable form of electric traction.

Norway.—A report on the trade of Norway for 1899, from Mr Consul-General Dundas states that at Arendel a German company had subscribed £50,000 capital for electrical and other engineering developments including calcium carbide works. A calium carbide factory has also been established at Kragerö, and other industrial enterprises are utilizing water-power-generated electric power. A great development in this utilization of the waters of the country is a feature of the moment, a miscellaneous array of industrial undertakings seeking the advantages which this cheap motive power offers. The electricity supply works of Fredrikshald are now completed and current is available for light and power. In the Frederikstad district the Kellner-Partington Paper Pulp Co. has erected two extensive power stations at the river side, a carbide factory, an electric railway, and other mechanical works. The two stations are equipped for an output of 2,000 H.P. and 5,000 H.P. respectively, these units being employed in the manufacture of calcium carbide; 1,200 H.P. is utilised in the generation of current for electric light and power, and so great is the demand for current that the larger of the two stations is already being extended, so that it may house a plant of double the present capacity, room being even then available for a further extension up to 24,000 H.P. Messrs. Schuckert & Co., of Nuremberg, are large shareholders in this undertaking. Extensive calcium carbide works are being erected at Skiensfjord, where this new industry will be carried on on a very extensive scale. The municipal authorities of Stavanger have recently acquired waterfalls within a short distance where plant will be installed for generating current for light and power to the extent of about 1,700 H.P.

Nottingham.—The accounts of the Electricity department for the year ended March 31 have been issued. The total receipts amounted to £18,419. 17s. 5d., and the annual expenditure to £8,746. 5s. 3d., leaving a gross profit of £9,673. 12s. 2d. After paying interest on loans, sinking fund instalment, and applying £2,000 in aid of general district rate, the balance (£151. 15s) has been carried forward. The total expenditure to 31st March was £161,097. 15s. 2d., an increase of £38,704. 16s. 3d. during the year. The number of units generated is estimated at 1,603,579, and of this number 1,470,280 were supplied to private consumers, 20,904 for public lighting, and 16,180 were used on the works. The number of public lamps is 15, and the total maximum supply demanded was 1,578kw.

Oran (Algeria).—This town is now in possession of an excellent service of electric tramways, which is made the most of by the inhabitants. The country is excessively hilly, and the tramways have proved a boon.

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Plymouth.—The National Telephone Co. has obtained the consent of the Council to put their wires underground.

Porto Rico.—Excellent opportunities prevail in this newly-acquired territory of the United States for the establishment of electric railways in the interior towns, water power being abundant and easily available. Many plans are already being prepared for the construction and equipment of these inland lines, the working in all cases to be by electricity. A mountain range traverses the island from end to end, and the numerous streams which abound in these mountains present no engineering difficulty in their concentration. There is only one railway on the island consisting of four sections. The concession which was originally granted to establish the railway throughout the island has lapsed, and the United States authorities have refused to recognise its further validity. New roads are being built and a good field for electrical enterprise will shortly present itself. There is already a successfully working electrical lighting installation in the city of Ponce, the capital of the company working the project being £10,000, all locally subscribed. The cash dividend for 1899 was 22½ per cent.

Presentation.—On Monday the staff of the Brush Co., at Loughborough, made a presentation of a recording barometer and a travelling clock to Mr. F. S. Ransome on the occasion of his marriage. The presentation was made by Mr. F. E. Andrews, the works secretary.

Richmond (Surrey).—The Council have granted permission to the National Telephone Co. to place their wires underground. This permission gives the company the last link of a complete underground route from Twickenham to London, via Barnes and Mortlake. Consent has been given on the following terms:—

The company to pay the Corporation an annual sum of £50 in respect of the main route, and to pay for all other underground distributing routes in the district at £15 per mile. The company also to pay an annual rent of 10s. for each large and 5s. for each small junction-box placed by them. The arrangement to be determinable on 12 months' notice.

Sheffield.—The Electric Light committee have appointed Mr. S. E. Fedden chief engineer and manager of the electric supply department. The wiring and fittings and trading departments and factory are to remain under the commercial manager, who is to be head of the clerical staff under the direction of the chief engineer and manager.

Shoreditch (London).—An interesting report from the Finance committee was presented to the Vestry last week. The chairman (Mr. Kershaw) stated that in view of the heavy rate of interest now charged by the London County Council the committee had considered a suggestion submitted by the clerk (Dr. H. Mansfield Robinson) of raising the £50,000 required for electric lighting extensions by the issue of small bonds or mortgages to ratepayers and others, and they recommended the Vestry to approve of the proposal and refer it to them to consider the best means of issuing the loan. After discussion, and with the assent of Mr. Kershaw, the report was referred back by 27 votes 12.

Sleaford.—The Council have applied for sanction to borrow £7,000 for carrying out the electric lighting scheme proposed by Mr. E. Bremner Smith. The bill confirming the Council's provisional has received Royal Assent.

Smethwick.—The Midland Electric Corporation for Power Distribution have offered to give a supply of electricity in bulk in the district, and to pay the Council 10 per cent. of the gross receipts, provided the company obtain a supply concession for 15 years. The Corporation will have the power to take over the undertaking at the end of that period at cost price less depreciation. No decision has yet been given, as the Council propose to purchase the local tramways, and have not settled whether to lease the lines or themselves work the undertaking.

Smyrna (Turkey).—Latest reports from this district confirm a statement that anything connected with electrical working is taboo in the Turkish Empire. The import of any article is prohibited even to the dry cells used for electric bells. In one case elaborate electro-medical appliances for one of the chief hospitals were rendered useless, as after the passing by the Customs authorities no cells or coils were allowed to enter. In another case, a contractor wished to erect a lightning conductor over a large factory. As, however, the wires were similar to those in use for telegraphic work, they were not allowed to be erected and had to be reshipped.

Southport.—The accounts of the electricity department were presented and approved by the Corporation on Tuesday. The net profit amounted to £1,779, against £2.027 last year. The decrease is ascribed to the increase in the price of coal. £1,500 of the surplus has been applied in aid of the rates, and £279 carried forward. There were 607,002 units sold to private consumers, against 501,005 last year. Large extensions of the plant were carried out during the year, and extensions of the buildings are now being made. In the report of the borough electrical engineer (Mr. Charles D. Taite) it is well pointed out that although the profit for the year has fallen short of what was anticipated, and while the price of coal will necessarily cause a heavy increase in expenditure during the current year, these are only temporary checks. Current will be required for the Corporation electric tramways, and an appreciable reduction in the cost of generation will consequently ensue.

Stafford.—The total receipts of the electricity department for the year ended March 31 were £1,772. 15s. 7., and the expenditure £983. 0s. 8d., leaving £789. 14s. 11d. to meet interest (£560. 9s. 2d) and sinking fund instalment (£604. 6s. 2d.), so that there was a deficit of £375. 0s. 5d. on the year's working, compared with £81. 13s. 3d. The total revenue per kilowatt capacity of plant was £8s. 19s. 1d., and the working expenses £1. 19s. 4d. The revenue per 8 c.p. lamp connected was 4s. 2d. The charge for current for lighting is 7d. per unit for the first hour's maximum demand and 3d. after, or, alternatively, a uniform rate of 5d. per unit. Supply for power purposes is given at 3d. per unit. There are only four public arc lamps. There were 118,341 units generated during the year, 83,311 units sold to private consumers, 3,469 units for public lighting and 6,477 units were used on the works.

Stimulating Demand for Electricity Supply.—Mr. Henry Lyon, of Glasgow, writes:—

In the Papers read before the Municipal Electrical Association, at Huddersfield, there is much truth, but I am surprised that Ald. Potter and Mr. H. Collings Bishop should have omitted in their Papers to point out certain lines on which a day load can be created in summer time to balance the heavy winter load.

There are several ways of increasing the demand for electricity which would benefit electricity supply and the general consumer. Mr. Bishop urges that the following are amongst the means which promise well: (1) Low price; (2) Sliding scale giving long hour consumers a lower rate; (3) Free use of meters; (4) Free connections; (5) A "free" wiring system; (6) A system of wiring on the instalment plan; (7) Special low rates for current used for motive power, heating, and manufacturing purposes; (8) The hiring out of motors, arc lamps, heating and cooking apparatus (including inspection and repairs); (9) To enable short-hour consumers with a large number of lamps connected to obtain current at a lower rate than the maximum, and to reduce at the same time the load demanded from the station.

All the above, if carried out with careful thought and explained to the public clearly, would be effective, but I regret to say that up to the present few central station engineers have thought out what this means. They seldom point out how the motor can be applied by small tradesmen, or give him an idea of what the cost will be for his individual requirements. There are many applications of electricity that have never been brought before the public, and if corporations and the supply companies do not deal with these matters how are the tradespeople to learn the advantages of electric working?

I wish particularly to point out that in No. (7) Mr. Bishop omits the supply of electricity for refrigeration and cooling purposes. Now why omit cooling apparatus for the summer load, and refrigerating machinery for food stuffs, for the making of ice cream, cooled drinks, &c., &c? These all mean something in their separate uses to the small tradespeople, including the butcher, fishmonger, poulterer, hotel keeper, publican, restaurateur, dairyman, confectioner, fruiterer, &c. These tradesmen pay heavy rents, have to make use of every atom of space, and to guard against nuisance from vibration, black smoke, smell, &c.

Refrigerating by electricity means a six months' run of practically 24 hours, equal to 12 hours continually throughout the year. Now if the price per unit can be reduced to a sufficiently low rate (say 1d. per unit for refrigerating) the way is clear. Perfectly satisfactory refrigerating machines are now on the market, of various sizes, making from 1 cwt. of ice upwards, and these can be used also to cool a chamber to any degree suitable for any of the trades mentioned. These electric refrigerators have no motor, but use the current direct.

After two years' continual experimenting with both electric and gas refrigerators for small retail tradesmen, I find that with gas at 3s. per 1,000 c.f. feet, and electricity at 1d. per 1,000 watt hours, the cost of running either machine is just about equal. For example, a No. 3 machine making 3 cwt. of ice in 24 hours will consume 90 cu. ft. of gas per hour = 2,160 cu. ft. in 24 hours (at 3s. per 1,000 = say, 6s. 6d.). A No. 3 electric machine doing equal work in 24 hours would require about 78 units and not exceeding 80 units; this, at a summer day and night load of 1d., would cost at most 6s. 8d. for a 24-hour run. A machine that will make 3 cwt. of ice in 24 hours will give a cooling effect of 6 cwt. of melting ice, therefore to cool a room, using ice at the rate of 6 cwt. in 24-hours (ice at 2s. per cwt.), would cost 12s. per 24 hours, showing a saving of 6s. per 24 hours. But the great advantage of a refrigerator is, of course, that a room can be kept at any degree within the compass of the apparatus, which cannot be effected by the use of ice.

Swindon.—An enquiry has been held into the application of the Swindon New Town Council for power to borrow, among other sums, £3,100 for purchase of a site for an electricity generating station.

Venice (Italy).—The harbour authorities have placed an order for six electric cranes, ranging from 1½ tons to 3 tons, with the Schuckert Co. of Nuremburg.

Walsall.—On the application of Messrs. John Russell & Co. (Ltd.) it has been decided to extend the electric lighting mains and to provide two transformers at an estimated cost of £5,178, subject to the firm becoming responsible for an annual payment for electric current of £300 for 10 years. The Local Government Board proposed to defer sanctioning the borrowing of £15,000 until the sites of the transformer stations had been chosen, but the town clerk

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has been instructed to point out that such a course would seriously delay the proposed extensions.

Water-Power Utilisation.—The British Consul at Bilbao states that in the province of Guipuzcoa a large development of the "hydro-electric industry" is a feature of the time. There are in all 34 factories actually working with water power; 57 additional concessions have been applied for, representing about 11,525 H.P.

Whitechapel (London).—The scheme for the extension of the electricity undertaking drawn up by the consulting engineer (Mr. Arthur Wright) in April last has been adopted and arrangements are being made to carry out the work at an estimated cost of £44,670. £20,500, balance of £60,500 originally applied for, is to be borrowed from the London County Council.

Whitefield (Manchester).—An agreement has been entered into with the Manchester Corporation for the transfer of the Whitefield provisional electric lighting order.

Willesden.—The scheme for a combined lighting and tramway electricity works, drawn up by the electrical engineer, Mr. E. T. Ruthven Murray, in view of the large size of the works and the capital involved, was submitted to Mr. E. Manville for an opinion. He has now reported, endorsing Mr. Ruthven Murray's proposals. On Monday the scheme, with certain alterations embodied in a supplementary report by Mr. Ruthven-Murray, was unanimously recommended by the Electricity committee for acceptance, and will come up for consideration at the next meeting of the Council. The system proposed is a high-pressure three-phase one with motor generators in sub-stations, where the current will be converted to continuous. An interesting feature is the employment of double-current generators at the power house, which can be used either to generate continuous current for the distributing circuits near the station, or three-phase current to be transformed to high pressure, or to supply current for both purposes at the same time. The estimate approved by the committee for the electricity works is as follows :—

Land, railway sidings and buildings	£55,080
Works and sub-station equipment	42,667
Mains and street work	34,517
Public lighting	2,838
Meters and house connections (1st year)	3,000
Total	£138,102
Add for bills of quantity, surveyor's charges, and contingencies	5,522
	£143,624

It is proposed that application be made for sanction to borrow this sum, and that repayment of any portion of the capital outlay may be postponed until the supply of electrical energy is available. The committee also recommend that Parliamentary powers be obtained for the construction of tramways over two routes, whose aggregate length is about 4 miles of single track. The estimated cost of these lines is £53,247. Assuming the two schemes to be carried out in combination, and taking account of the profits from the tramways, the committee estimates a deficiency of £2,658 at the end of the first year's working and £304 at the end of the second year's working, irrespective of sinking fund on the loan between the actual borrowing and the commencement of supply and exclusive of the additional cost of street lighting.

Whitby.—Messrs. Preece & Cardew have been appointed consulting electrical engineers in connection with the proposed municipal electricity scheme.

Worksop.—An inquiry will be held on Tuesday into the application of the Council to borrow money for electric lighting.

NEW BOOKS AND EDITIONS.

"THE ELECTRICIAN" READING CASE.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

The Electric Lighting committee of the Vestry of *St. Mary, Islington* (London) require tenders for relaying York and other stone, and providing new York and other stone where necessary, over the electric conduits and mains which may be required during the ensuing three years. Further particulars are set out in an advertisement, and specifications may be obtained at the electricity department, 50, Eden-grove, Holloway, N. Tenders to the vestry clerk (Mr. Wm. F. Dewey), Vestry Hall, Upper-street, N., by noon of 25th inst.

Darlington Corporation require tenders for arc lamp posts and brackets. Specification may be obtained from the town clerk (Mr. Henry Steavenson), and specification can also be seen at (but not obtained from) the offices of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Further particulars are set out in an advertisement, and tenders must be delivered at Mr. Steavenson's offices before 28th inst.

Sunderland Corporation invite tenders for coal-conveying plant for their electricity station. Specification may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), and tenders (addressed chairman of Lighting committee) must be delivered at the office of the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon of 27th inst. An advertisement contains further particulars.

Aston Manor District Council require tenders for the supply and erection of electricity generating plant, particulars of which are set out in an advertisement. Specification, &c., may be obtained at the offices of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, and tenders (addressed to Chairman of Health committee) must be delivered at the Council offices, Aston Manor, not later than noon of 24th inst. Mr. Joseph Ansell is clerk to the Council.

Halifax Corporation invite tenders for combined steam engine and alternator, alternators, static transformers, induction motors, rotary converters, and three-phase extra high-tension switchboards. Specification may be obtained from the borough electrical engineer (Mr. H. F. Street), Foundry-street, Halifax, and tenders must reach the town clerk (Mr. Keighley Walton) by noon of Tuesday, 31st inst. An advertisement contains further particulars.

Hull Corporation invite tenders for an electric lighting installation at the Springhead pumping station. Forms of tender may be obtained from the water and gas engineer (Mr. F. J. Bancroft), Broadley-street, Hull, and tenders should be delivered to the chairman of the Water and Gas committee, Town Hall, Hull, before 10 a.m. of 23rd inst. An advertisement contains further particulars.

Hull Corporation require tenders for five high-tension continuous-current rotary transformers, with switch gear and accessories. Further particulars are set out in an advertisement, and specifications may be obtained at the city treasurer's office. Tenders to chairman of Electric Lighting committee, Town Hall, Hull, by noon of July 26.

Salford Electric Light committee invite tenders for nine transformers and 4½ miles of low-tension concentric cable. Specification may be obtained from the borough engineer (pro tem), Mr. F. A. Wilkinson, Walness-road, Broughton, and tenders (addressed to chairman of committee) must be delivered to the office of the town clerk (Mr. L. C. Evans) before 10 a.m. 27th inst. Further particulars are set out in an advertisement.

Salford Corporation invite tenders for laying cables, tramway feeders, and street lighting. Specifications may be seen or obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh & Sillar), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, but can only be seen at the latter offices. An advertisement contains further particulars, and tenders must be delivered to the town clerk (Mr. L. C. Evans) by Aug. 13.

Salford Corporation also require tenders for overhead equipment for tramways, exclusive of steel poles. Tenders to town clerk by July 16,

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Manchester Tramways committee invite tenders for the electrical equipment of 150 cars. Specifications may be obtained from general manager, Tramways department (Mr. J. M. M'Elroy), Town Hall, Manchester, and tenders to chairman of committee, by Saturday, 21st inst. An advertisement contains further particulars.

Sheffield Corporation invite tenders for twelve months' supply of transformers for their electricity department. An advertisement contains additional particulars, and specifications can be obtained from the chief engineer and manager (Mr. S E. Fedden), to whom tenders should be delivered before 21st inst.

Rugby District Council invite tenders for taking a lease of their provisional electric lighting order (1898). Applications to Mr. T. M. Wratislaw, clerk and solicitor, Council offices, Rugby, by Aug. 1. See advertisement.

Tenders are required for electricity generating plant at the *Mullingar* (Ireland) Lunatic Asylum. Forms of tender from Mr. J. W. Edmundson, 35, Capel-street, Dublin, and tenders to the Board by 23rd inst.

Blackpool Corporation invite tenders for trolley poles, cables, and trolley wire, boosters, switchboards and storage battery. Tenders to chairman Electric Lighting and Tramways committee by July 23.

Wimbledon District Council require tenders for supplying and fixing telephones at the isolation hospital. Tenders to clerk by 18th inst.

Southend Council invite tenders for electric traction plant, about 1,180 tons of steel rails, 46 tons of steel fish-plates, &c. Tenders to town clerk by July 25.

Beckenham District Council invite tenders for "free" wiring. Tenders to clerk (Mr. F. Stevens) by 4 p.m. of July 16.

Grays Thurrock District Council require tenders for electricity generating plant. Tenders to clerk by noon of Aug. 9.

Trimdon (Co. Durham) Parish Council invite tenders for public lighting by electricity or acetylene gas. Tenders by July 17.

London County Council require a 2-ton overhead traveller. Tenders to clerk by 19th inst.

Tenders are invited for the electric lighting of *Hapton* from Sept. 1 to April 30 next. Tenders to clerk, 16, Hammond-terrace, Padiham, by 31st inst.

Bradford Corporation invite tenders for steel girder and steel trough rails and fishplates. Tenders to town clerk by 28th inst.

Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment for overhead traction. Tenders to town clerk by Aug. 31.

Tenders are invited by the *Liverpool* Select Vestry for an electric light installation of about 100 lights at the Parish offices, Brownlow Hill. Tenders to clerk by 19th inst.

The Director of Contracts, *Valetta* (Malta), invites tenders for dynamo and engine oil by July 28.

Tenders are invited for the electric lighting of *San Martin de Valdeiglesias* (Spain) for 20 years at the upset price of 3,500 pesetas (about £110) for the supply of lights equivalent to 2,400 candles. Tenders were invited in February last, but no offers were received. Some alterations have now been made in the terms.

Application has been made, accompanied by particulars of project and pledge of security, for the concession of an electric tramway in *Barcelona* (Spain), from the Plaza de Cataluña to the suburb of Vallcarca, with one branch. Further applications will be received up to 28th inst.

The *Russian* Government are inviting tenders until 28th prox. for the public telephone service of Warsaw, St. Petersburg, Moscow, Odessa, and Riga.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Brighton Corporation for the supply of incandescent electric lamps for one year from July 1. The prices given are per lamp of either 8 c.p. or 16 c.p. in their respective voltages :—

	115 volt.		230 volt.	
	s.	d.	s.	d.
Zurich Incandescence Lamp Co. (*accepted*)...	1	3¾	1	3¾
(less 2½ per cent. discount.)				
Berrenberg Electric Lamp Syndicate	1	0½	1	5
Edison & Swan Co.	1	0	1	0
Sunbeam Lamp Co.	0	9½	1	1
General Electric Co.	0	8½	1	0
Crystal Electric Lamp and Rose & Bird	0	8	1	0
Krupka & Jacoby	0	7	0	10
Brush Co.	0	7	0	9½
A. Hunt & Co.	0	6	0	9
English Industrials	0	7	0	9½
Polland & Co.	0	6	0	9

Derby Sanitary Authority has accepted the tender of Messrs. Newton Bros. for an electric lighting installation at the Infectious Diseases Hospital, at £165. 7s. 4d. Four tenders, ranging in amount from that of the accepted to £236, were received.

London County Council have received the following tenders for the supply of plant, &c., for the electric lighting of Farmfield Reformatory :—

Oil Engine.—Bilbie, Hobson & Co. (Hornsby-Akroyd engine), £257; Priestman Bros., £312. 5s.; Crossley Bros., £324.

Wiring.—Tamplin & Makovski, £309. 14s. 6d. (for wood casing, and £360 steel tubing; Strode & Co., £349 and £373; Concentric & General Contract Co., £360 and £440; F. A. Glover & Co., £407 and £450; A. H. Wood, £484 and £530; E. P. Dickson, £678 and £700.

Dynamo.—Thomas Parker (Ltd.), 700 revs. unfixed, £165, 900 revs., £143; Electric Construction Co., 620 revs., fixed, £139; India Rubber Co., 600 revs., unfixed, £130, fixed, £136; Siemens Bros. & Co., 720 revs., £182.

Battery.—Chloride Co., 25 amp., £159; 70 amp. short, £183; 60 amp. long, £327. Electrical Power Storage Co., £144, £158 and £278 respectively.

In all cases the lowest tender was accepted.

The Council also accepted a quotation of £174 per mile from the British Insulated Wire Co. for certain cable, of which a small quantity was likely to be required.

The tender of Messrs. R. Dawson & Son (Ltd.) has been accepted for wiring the new cottage homes at Penkhull, for the Stoke-on-Trent Guardians, at £470.

The following tenders have been received by the Bradford School Board for an electric lighting installation at the Carlton School :—

G. A. Steinthal (*accepted*)	£265	Collinson Bros.	£315
Rhodes & Webster	365	G. F. Cook & Co.	196
Alfred Sykes	316		

Cheltenham Town Council have accepted the tender of Messrs. Collins & Godfrey for extensions to the electricity buildings at £1,875.

The tender of the British Insulated Wire Co. has been accepted by the Newington (London) Vestry, for supplying and laying mains in the side streets in the district, at £9,026. 5s. 6d. A full list of tenders appeared in our issue of June 22, p. 346.

Lambeth (London) Vestry have considered the undernoted tenders for additional electric lighting work at the Kennington-road baths :—

Walter Mossop & Co. ..... (*accepted*)	£48	15	6
Geipel & Lange	90	10	0
Woods & Co.	67	0	0

The tender of Messrs. Rosser & Russell (£81. 5s.) has been accepted by the Middlesex County Council for the supply of radiators and an electric fan for the record room at the Westminster Guildhall.

Southport Corporation have accepted the tender of Messrs. S. Z. de Ferranti (Ltd.), for the supply of five 30kw. transformers at £82. 15s. each.

Plymouth Corporation have accepted the tender of Messrs. Wakeham Bros. for the erection of a sub-station in Armada-street, for £1,858.

Newport (Mon.) Corporation have accepted the tender of Messrs. A. Krauss & Son for constructing the Corporation-road tramway route at £13,362. The tender is exclusive of rails. Messrs. A. S. Morgan & Co. also tendered at £14,162. The borough engineer's estimate was £13,993.

Hastings Corporation have accepted the tender of Messrs. Babcock & Wilcox for the supply of a new 250 H.P. boiler, with superheater, for £150, the firm taking back two 40 H.P. boilers at the Waterworks-road station and two boilers (140 H.P. and 160 H.P. respectively) at the Earl-street station.

APPOINTMENTS VACANT AND FILLED.

Bolton Corporation invite applications for the post of electrical engineer to take charge of their electric lighting and tramway undertakings. Further particulars are set out in an advertisement, and applications must be delivered to the town clerk (Mr. R. G. Hinnell) not later than 30th inst. The Corporation are offering a salary of £500 per annum, with annual increments of £50 to a maximum of £700. As stated in our last issue the Electric Lighting committee unsuccessfully endeavoured at the last moment to retain Mr. Ellis's services by offering him an immediate increase of £150 per annum.

Fulham (London) Vestry invite applications for the following appointments in connection with their electric lighting and refuse destructor works :—Destructor superintendent, chief clerk and three shift engineers. Further particulars are set out in an advertisement, and applications must reach the clerk (Mr. W. J. H. Denselow), Town Hall, Walham-green, London, S.W., before 25th inst.

Ilford Urban District Council are prepared to receive applications for the post of clerk of works for their electric light station and cable laying. Salary £3. 3s. per week. Applications must be sent in by Monday, 10th inst to Mr. John W. Benton, clerk to the Council offices, Ilford. See advertisement.

The Governors of the Birkbeck Institution invite applications for the position of head of the physics department. Further particulars are given in an advertisement, and applications must be sent to the principal, Bream's-buildings, Chancery-lane, E.C.

A chief lecturer in electrical engineering is required for the Salford Royal Technical Institute. An advertisement contains additional

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particulars, and forms of application may be obtained from the secretary (Mr. Richard Martin) up to 24th inst.

A junior demonstrator in physics is required for the South Western Polytechnic, Manresa-road, Chelsea, S.W. An advertisement contains further particulars, and forms of application may be obtained from the secretary.

An assistant is required in the engineering department of the Merchant Venturers' Technical College, Bristol. Applications to registrar by Aug. 13. See advertisement.

The governors of the Technical Institute, Wandsworth, London, S.W., require a qualified teacher to take classes in electric testing and wiring. Applications by July 19.

A demonstrator and assistant lecturer in physics is required for the University College of South Wales and Monmouthshire, Cardiff. Applications to secretary, by Sept. 9.

Darlington Corporation require a borough electrical engineer. Applications to town clerk by July 21.

Mr. D. Robertson, of Glasgow, has been appointed lecturer in electrical engineering at the Bradford Municipal Technical College.

Mr. G. L. Andrews, B.Sc., assistant engineer to the Hull Corporation tramways, has been appointed chief engineering assistant to the Sunderland Corporation tramways.

Mr. Hubert Pooley, of the Dunfermline gas works, has been appointed manager of the gas and electricity works at Stafford in succession to Mr. J. F. Bell, resigned.

Mr. A. E. Cramb, of Huddersfield, has been appointed assistant electrical engineer at the Hampstead Vestry's electricity works.

BUSINESS NOTICES.

Messrs. W. Probert & Son, brass founders and electric fittings makers to the trade, have removed from Tower-road, Aston, to more extensive premises at the Crescent, Sorith-road, Hockley Brook, Birmingham.

Mr. George Hatch, of. 5, Upper Thames-street, London, E.C., informs us that for family reasons his business has been registered as a private limited company under the title of George Hatch (Ltd.). The management continues as heretofore.

BANKRUPTCIES, LIQUIDATIONS, &c.

A report just issued by the committee of inspection appointed on June 14 by the principal creditors of Messrs. Laing, Wharton & Down (Ltd.) (in liquidation) states that an inspection of the stock, plant, and machinery, with a view to realising same to the best advantage, has led the committee to the unanimous opinion that the assets should be sold by public auction, "as the present condition of the trade is such that better prices than usual will probably be realised, firms being glad to avail themselves of the opportunities offered by auctions to obtain certain of their requirements without delay." It is pointed out that the whole of the assets of the company are in the possession of the receiver for the debenture holders, who is entitled to sell the same subject to the approval of the High Court. The receiver has, however, accepted suggestions from the committee, who have recommended that the stock, plant, and machinery should be sold by auction.

Claims against the Midland Electrical & General Engineering Co. (Ltd.) must be sent by Aug. 13 to Mr. W. B. Winnicott, 20, Fletcher-gate, Nottingham.

The Electric Automobile Syndicate (Ltd.) is to be wound up voluntarily. Mr. A. Brown, 28, Great Eastern-street, London, E.C., is liquidator.

In the bankruptcy of J. E. Stott (trading as James E. Stott & Co.), electrician, 10, Wood-street, Byram-arcade, and 9, Westfield-road, Huddersfield, the trustee, Mr. T. H. Kaye, has been released.

In the failure of C. H. Kitching, electrical engineer, &c., 20, St. Hilda-street, 172, Beverley-road, and 42, Chariot-street, Hull, the trustee, Mr. J. H. Fox, has been released.

The following are the principal creditors in the sequestration of the estate of Wm. Ramsay & Co., electrical and gas engineers, 195½, Argyle-street, and 11, Jamaica-street, Glasgow :—

Edison & Swan Co.	£206	Guest & Chrimes	£25
Brownlie & Co.	151	W. T. Henley's Telegraph Works Co.	23
Falk, Stadelman & Co.	147	International Electric Co.	23
J. Barwell	34	C. Schultze & Sohn	18
Edwards Bros.	28	Sun Electric Co.	17
Wright-Butler Lamp Manufacturing Co.	28	Wm. McGeoch & Co.	16
Dobbie, Forbes & Co.	26	I. Frankenburg	15

Sales by Tender.—Leeds Corporation are open to receive tenders for two horizontal Fowler engines of 400 I.H.P., two sets of Greenwood and Batley dynamos, one spare armature to fit any dynamo, and a switchboard and instruments. The plant at present in use in connection with the Corporation's system of electric tramways. Will be available for removal about February next. Further information can be obtained from Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W.

The premises and plant of a long-established engineering business in Edinburgh are advertised for sale in an advertisement in another column, or partnership might be arranged. Applications to 550, Messrs. Keith & Co., advertising agents, Edinburgh.

Fire—A small fire occurred at the Prescot works of the British Insulated Wire Co. late on Monday night. A drum of cable in a drying-oven caught fire but the fire was promptly extinguished by the company's own brigade. Little damage was done to the premises but a good many drums of cable in course of manufacture were spoilt by smoke and water. This will involve a few days' delay in the delivery of this particular order, otherwise no inconvenience or delay will arise.

Mather & Platt Plant.—A third edition of a useful pocket catalogue relating to the electrical engineering machinery manufactured by Messrs. Mather & Platt (Ltd.) of Manchester, is just published. The book has been carefully revised and some additions made.

Condensers for Steam Engines—A very complete catalogue of condensers for steam engines, comprising the ejector and evaporative types made and supplied by Messrs. T. Ledward & Co., 25, Queen Victoria-street, London, E.C., is just issued, and, besides giving illustrations of the apparatus, is accompanied by notes and instructions for fixing and working, which steam users will find of service. Among the list of firms to whom these ejector condensers have been supplied are many leading electrical engineers and contractors and municipal electricity supply stations of the kingdom. Some useful tables are also given.

E.P.S. Small Storage Batteries.—Mr. J. W. Barnard notifies us that the increased demand for E.P.S. small storage batteries has necessitated his taking additional premises at No. 6, Great Winchester-street, London, E.C., where he will have increased facilities for keeping an adequate stock ready at all times for immediate delivery.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 4 to July 10, with the ports of destination :—

Africa—Alexandria, £51; Cape Town, £297; Durban, £375; East London, £207; Port Elizabeth, £329. *Argentina*—Buenos Ayres, £93. *Australasia*—Christchurch, £44; Melbourne, £770 (including £408 telegraph cable); Sydney, £464. *Belgium*—Ostend, £11. *British Guiana*—Demerara, £150 (telegraph material). *Ceylon*—Colombo, £35 (telegraph material). *Chili*—Valparaiso, £50. *China*—Shanghai, £167 (including £126 telegraph material). *Denmark*—Copenhagen, £478 (telegraph wire). *Germany*—Hamburg, £320 (telegraph material). *Holland*—Amsterdam, £51. *Hong Kong*, £5. *India*—Bombay, £68; Calcutta, £706; Madras, £14. *Japan*—Hiogo, £1,466; Yokohama, £449. *Malta*, £66. *Russia*—Libau, £10; St. Petersburg, £250. *Siam*—Bangkok, £180. *Sweden*—Gothenburg, £25; Stockholm, £225 (telegraph material). Total £7,356, against £18,854 in the corresponding week last year (July 5 to July 11).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 25, 1900.

7,737. A. Tribelhorn. London. Improvements in and relating to arc lamps.

7,753. R. Thompson and J. Dunphy. London. Coupling for electric or other wires.

7,759. L. Pauer and J. de Kutschera. London. Improvements in electrically-operated submarine working devices.*

7,768. E. W. Junguer. London. An improved negative accumulator electrode.*

7,777. G. Marconi and Marconi's Wireless Telegraph Co. (Ltd.). London. Improvements in apparatus for wireless telegraphy.

7,781. C. G. Robinson. London. Improvements in apparatus for wireless telegraphy.*

7,782. C. G. Robinson. London. Transmitting and receiving switch for wireless telegraphy.*

April 27, 1900.

7,784. G. Davis. London. Improved system of distribution and collection of current for electric traction.

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7,792. H. C. Longsdon and S. Dale. Keighley. Improvements in electrically-operated brakes for centrifugal drying machines or hydro-extractors.
7,795. H. W. Calderbank. Manchester. Improvements in electric light fittings.
7,805. J. K. Grindrod. Rochdale. Method of and apparatus for utilising or converting wind force or pressure into electrical energy or work.
7,807. G. W. Holt and A. J. Hallam. Birmingham. Improvements in and relating to electrical switches and electrical accessories generally.
7,851. O. Riebensahn. London. Improvements in and connected with electric incandescent lamps.*
7,861. J. Brown. London. Improvements in or relating to electrical reciprocating apparatus.

April 28, 1900.

7,881. J. Lenderyon and T. S. M. Wyatt. Monmouthshire. A direct-acting magnetic brake electric arc lamp.
7,897. E. H. Tyler and A. G. Hansard. London. Improvements in surface contact systems of electric traction.
7,941. W. H. Beck. London. Improvements in electrical safety fuse apparatus. (H. Privat, Germany.)

April 30, 1900.

7,957. C. A. Allison. London. Improvements in coin-controlled X-ray apparatus. (F. Neugebauer and F. Distelhorst, United States.)
7,979. A. J. Boult. London. Improvements in portable electric lights. (E. R. Gill, United States.)

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

5,975. Parkinson. Magnetic separating machines for extracting iron and steel particles from borings and turnings of brass and copper and other non-magnetic metals, also from charcoal and earths.
6,002. Schafer, Renz and Lippold. Receiving apparatus for so-called Hertzian waves for transforming same into perceptible signs.
7,776. Drake & Gorham. Method of adapting candelabra for the electric light.
8,904. Wise (Buckingham). Method of and means for preventing electric sparking at contacts in circuit, including electro-magnet coils or other coils or conductors in which a self-inductive or sparking capacity exists.
9,134. Mouterde. Electric accumulators.
9,245. British Thomson-Houston Co. (Ltd.) (Cox). Electric maximum demand indicators.
9,811. Heyl-Dia. Manufacture of insulating material for electric cables and the like.
9,981. Joseph and Ehrenreich. Means for driving sewing and other machines by electricity.
10,081. Levy. Electrical resistances.
10,133. British Thomson-Houston Co. (Ltd.) (Potter). Systems of control for electrically-propelled vehicles.
10,301. Routledge. Overhead systems for electrical transmission of energy.
10,468. Aitken. Party telephone line systems.
10,536. Accles. Electrical contact devices for explosion engines fired by electricity.
11,244. Blumenberg. Compounds for battery solutions.
11,446. Heyl-Dia. Electric cables.
11,693. Callender's Cable & Construction Co. (Ltd.) and Callender. Apparatus for connecting branch circuits to electric mains.
11,843. British Thomson-Houston Co. (Ltd.) (Union Elektricitäts-Gesellschaft and Zani). Devices for starting electric induction motors.
11,901. Poole. Electrical brush-holders.
11,983. Smith. Attachments for collectors in electric tramways with slotted conduits.
11,984. Smith. Poles for supporting overhead wires in electric tramways.
12,235. Rankin (Ludington). Machine for filling cases or packets with cigarettes or the like.
12,274. Oppenheimer (Actien-Gesellschaft, Mix & Genest). Magneto-generators.
12,420. Braun. Wireless telegraphy.
12,667. Johnson (firm of Hartmann & Braun). Earthed coverings or electrical tubular conductors.
12,788. Hertel. Method and means for increasing the conductivity of carbon to be used in electric cells and dynamo-electric generators and motors.
12,874. Applegarth. Glass globes, screens, covers or the like for electrical incandescence and other lamps, and in means for manufacturing the same.
13,074. Schoop. Apparatus for electrolysis.
13,105. Jandus Arc Lamp & Electric Co. (Ltd.) and Jones. Electric arc lamps.
13,226. Rose and Hall. Construction or arrangement of appliances for underground or conduit traction by electricity.
13,230. Söderlund and Ekvall. Apparatus for supporting pendent globes applicable to the globes of enclosed arc lamps.
13,233. Gehre. Apparatus for periodically producing electric current by wind power.
13,256. Smith. Means of lessening the danger attendant upon the employment of overhead conductors in electric tramways.
13,270. Sinclair and Aitken. Telephone exchange systems.

COMPANIES' MEETINGS AND REPORTS.

Electric Construction Co. (Ltd.).

The seventh annual general meeting of this Company took place yesterday under the presidency of Mr. James W. Barclay (deputy chairman of the Company) in the unavoidable absence of Sir Daniel Cooper, Bart., G.C.M.G.

The SECRETARY (Mr. James Gray) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the accounts and report require few remarks of mine to recommend them for your adoption. The results on the whole are very similar to those of last year. The general outcome is that we have to deal with a profit of £21,729. 1s. 9d., and this we propose to do by paying the fixed preferential dividend and distributing 6 per cent. to the ordinary shareholders, carrying the balance of £4,777. 1s. 9d. to the credit of next year's profit and loss account. The cost of maintaining the works, renewing and upholding the plant, adequate provision for bad debts, and other liabilities, and adding £5,000 to the general depreciation account, come all out of profits as usual. You will observe that for the past seven years we have applied £33,000 of our profits in reducing the capital account, while the works, I am sure, have now more capacity for earning dividends than ever before. The figures in the profit and loss account are very much the same as last year. The expenditure has always a tendency to grow, and it is our business to limit the increase to what is necessary for maintaining due efficiency. The balance-sheet shows the expenditure, so far, on the extensions. Of the additions to plant and furniture during the year, £5,798 has been for additional tools in the old works, and the balance of £9,785 is made up by payments to account of plant for the extensions. If explanations respecting any other accounts are required, I shall be happy to give them. At our last general meeting you were informed that we had contracted for additions to our workshops, including, of course, plant to equip them, which costs a good deal more than the buildings. The structure of the additional shops has been finished, and is now being filled with tools and appliances of the latest improved description for facilitating the outturn of work and for reducing the amount of hand labour in the process of construction. When the shops are finished I do not hesitate to say they will be in every respect the best in the United Kingdom for manufacturing large electrical machines. During the last seven years the size of the machines we are required to produce has very largely increased, but while it is unsafe to predict the developments which may take place in electrical machinery, practical considerations lead to the conclusion that the limit of size has nearly been ascertained, and we are of opinion that our works will be able to cope with the largest machines that will be demanded. As mentioned in the report, we have, during the past year, successfully completed the equipment of the City and South London Railway extensions with plant and appliances of exclusively British manufacture. This seems to be a sufficient answer to those who assert that British manufacturers cannot produce the best machinery for electric traction. The system adopted on the City and South London Railway to meet the condition of distributing power over a considerable length of line from one generating station has not been borrowed from the United States, and it was indeed, I believe, prophesied by some of our Transatlantic competitors that the system would prove a failure, but those prophets seem to have forgotten that the Electric Construction Corporation equipped the Liverpool Overhead Electric Railway before there were any overhead electric railways in America. We have never failed in any work we have undertaken yet. These facts should encourage British corporations to have more confidence in their own countrymen and not accept implicitly the assertions of interested rivals. You have no doubt also observed in our report with much satisfaction that the relations between the Board and employés of all classes are thoroughly harmonious. While anxious to do our best for our shareholders we do not forget the interests of those on whose cordial co-operation so much of our success depends. Confidence between employers and employed is a plant of slow growth, but we believe that seven years' experience has taught our employés that their Directors have their interests also at heart, and, in consequence, a feeling of *esprit de corps* has grown up, and each man feels an individual interest in, and is proud of, his connection with the Company. As to the future, we are full of orders, so much indeed that we are pressing forward the completion of our new shops to enable us to execute them without undue delay. The prices at which we are booking orders give promise of fair profit, although we may, of course, complain that competition does not allow us the profits we would like, and that we think we ought to have, but our new extensions will after a time give us an increased output larger than the proportion of increased standing charges they involve, and the saving thus effected will probably be divided between ourselves and customers. Gentlemen, I think you will recognise that your Directors are endeavouring to keep abreast of the times, and I have no doubt that the skill and capacity of our establishment will give us results at least as good as our neighbours. On the whole, then, I believe that our position in the manufacturing world is becoming more and more firmly established, and that we may regard the future with confidence. In illustration of what the Board are doing and the spirit in which they manage the works, I may tell you that we have sent to Paris at a moderate expense some 20 or 30 of our leading men in order that they may see in the exhibition there what is being done in the electric machinery world abroad. This will give them an opportunity of comparing what we turn out with what is produced on the Continent. Our insular position, perhaps, induces us to believe that in the Midlands they turn out a good deal better machinery than is made in any other part of the world. I am inclined to believe that the experience which these men will have in Paris will open their eyes to the keen

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competition we have to meet from our competitors abroad not only in regard to manufacture, but also in regard to prices. Our manager, Mr. Blackburn, assures us that he thinks the company will get very good value for their expenditure in having sent these men to Paris. I now move the adoption of the report and accounts.

Sir HENRY C. MANCE, C.I.E., seconded the motion.

In answer to Colonel BUTTANSHAW,

The CHAIRMAN stated that the Madras Electric Tramways came into the Company's hands in the course of business. The company which employed this Company to carry out the contract was unable to complete it, and the property passed into the hands of trustees for the debenture holders. The Tramways Company had ample opportunity of retaking possession, but the directors of that company lost the confidence of their shareholders in Madras, and the undertaking, therefore, passed into the hands of this Company. The price of these tramways per mile was, perhaps, less than half the cost of any other electric tramway in the world. The Directors believed that the traffic, which was steadily developing, would yield a profitable return to the Company. At the same time they would not lose an opportunity of passing the concern over to some other parties, because it was not in this Company's line of business.

Dr. DRYSDALE inquired whether there were any orders for electric tramways in this country.

The CHAIRMAN replied that the Company made a large amount of generating plant for tramways, but they did not make the tramway cars, which formed a separate part of the business. The Company had their fair share of the construction of the heavy machinery.

The motion was carried unanimously.

Sir Daniel Cooper and Sir James Pender were re-elected directors, and the retiring auditors were re-appointed. A cordial vote of thanks to the Chairman and Directors terminated the proceedings.

City of London Electric Lighting Co. (Ltd.).

At an extraordinary general meeting of this company, held on Wednesday, a resolution authorising the directors to borrow any sums not exceeding in the whole £400,000 in excess of the amount of the debenture stock of the company outstanding and the premium payable thereon on redemption was approved.

The chair was taken by Sir DAVID L. SALOMONS, who reviewed the recent history of the company, and explained that the present issue was necessitated by the large amount of capital expenditure involved in the extension of the company's business. He said that it was absolutely essential that more capital should be found to pay off outstanding liabilities on capital account, and to provide for their increasing business, otherwise the company could not continue its operations. With regard to the position of the shares on the market, the chairman said that, notwithstanding the course of recent events, the company had a good property; but the directors recognised the present position of the market, and that it was not possible to issue their remaining 10,000 £10 shares at par. As they could not issue them at a discount, they had sought another form of raising the necessary money, and recommended the shareholders to increase the borrowing powers of the board in the manner suggested in the resolution. In reply to an amendment that the question of raising additional moneys should be postponed for a fortnight, the chairman said that by the end of the year a large sum of money would be required to meet liabilities accruing. They were under Parliamentary obligation to supply electric current, and if they were to fail, or if their contractors came forward and they could not pay them, the position of the company would be a serious one. The whole point was that their business had expanded. The unfair treatment they had received on the part of the Corporation of the City of London had no doubt seriously affected the value of their shares. That was not the fault of the directors. They had fought tooth and nail and were still fighting to get a just recognition of their rights. They were face to face with serious competition and it was their duty, and it was necessary, that they should get their new works pushed forward. He asked the shareholders to have confidence in the directors and leave it to them to raise the money in the best way possible. All the directors required was to be in a position to pay existing liabilities and to meet all actual requirements for continuing the supply of current next winter. They had asked for a sum which would keep them going for some time. Every year they had something like 60,000 extra lamps to provide for. In fact, since the issue of their last circular a few days ago, 3,000 further lamps had been applied for. This meant continuous capital expenditure, and he took it that the point to be insured was that the capital should be expended in a manner that would eventually bring them an adequate return as far as ordinary man could forsee.

Mr. G. HERRING said the money was not required to settle up past matters. It was required because the business was expanding, and there was, consequently, no necessity for any doleful talking. He would point out that their original idea was to provide for a total of 350,000 8 c.p. lights, whereas they had now connected 483,000, and applications for a further 3,251. They could not continue to make provision for this large number of connections without capital expenditure.

The amendment was negatived and the original resolution agreed to.

A SHAREHOLDER asked if any information could be given as to the position of the litigation now going on between the company and the City of London Corporation.

The CHAIRMAN said, strictly, such a question was not in order, but he would point to the fact that they had a judgment in their favour by Mr. Justice Farwell. The City authorities had, however, appealed and that was just how the matter stood. The appeal would not be heard until the autumn, he expected.

A vote of thanks to the chairman and directors terminated the proceedings

Electrical Power Storage Co. (Ltd.).

The eleventh ordinary general meeting of this Company was held yesterday (Thursday), Mr. J. IRVING COURTENAY presiding.

The SECRETARY (Mr. David Smith) having read the notice convening the meeting,

The CHAIRMAN said: You will see from the report, that after paying debenture interest and adding about £1,250 to our reserve and contingent funds—which now amount to the substantial sum of £13,000—a balance of £4,620. 16s. 1d. remains available for distribution. Out of this sum the Directors recommend a similar dividend to that which has been paid for the last seven years—namely, 5 per cent.—which will absorb £4,362. 8s. 5d., leaving £258. 7s. 8d. to be carried forward. The new buildings are now being utilised to their full extent, and indeed so much has the business increased that even these additions are found hardly sufficient. As stated in the report, the development of the business has necessitated the introduction of further working capital, and a call of £1 per share has been made during the year on 3,132 ordinary shares, on which only £3 per share had been previously paid. The works are in good condition, and the increase in their capacity has resulted in considerable economies in production. The average price which we paid for our staple article—lead—during the financial year under review was 22 per cent. in excess of that paid in the previous year. I may add that the persistent rise in the prices of raw materials has necessitated our adding a further 5 per cent to our list prices for manufactured goods. This increase came into force on the 1st of the present month. The rise in prices of raw materials is a condition which at the present time has to be faced by nearly every commercial manufacturing company and firm. There has been no falling off in the severe competition which exists in the storage battery industry. We think, therefore, that we have reason to be satisfied with the result of the year's trading, especially when it is remembered that, besides increasing our reserves, as already mentioned, we have thoroughly maintained the buildings, plant, and tools of the Company at a cost of £1,646. 6s. 5d., and have written off £748. 3s. 9d. for depreciation, both of which sums have been provided out of the year's revenue. I intimated at the last meeting the intention of the Directors to send an exhibit to the Paris Exhibition. This has been done, and though the exhibit is not a large one, we have endeavoured to make it as effective as possible. We hope thus to direct special attention to the Company's traction types of cells, and, as a consequence, to increase our market for these goods. The cost of this exhibit has also been debited to the revenue of the year. The special type of battery which we have introduced for power and tramway stations has proved a great success. The battery, which we installed now two years ago in Liverpool for the first experimental tramway line of the Corporation, has proved so satisfactory that during the present year we have obtained contracts for six additional batteries for use in various parts of the city in connection with the different tramway routes. These contracts were obtained by us at a figure in excess of that quoted by our competitors, owing to the satisfactory working of the first battery installed. A battery of a similar type has been installed for the Bradford Corporation during the present year, and we have also obtained an order from them for a duplicate battery, in addition to which, amongst many others, we have installed batteries for the Corporations of Birkenhead, Bury St. Edmunds, Doncaster, Gloucester, and Wigan, the Metropolitan Electric Supply Co., and the Royal Mint. The works were never busier than they are at present, and among the more important contracts which we have now in hand are two large batteries for the Liverpool Overhead Railway; also batteries for the Corporations or Urban District Councils of Barnes, Birkenhead, Doncaster, Horsham, Ilford, Motherwell, Rotherham, and Walsall. As you are no doubt aware, since the last meeting, the London Electrical Cab Co. has ceased operations, and has been put into the hands of a receiver for the debenture holders. This is unfortunate in the interests of electric traction, but I can state emphatically that the non-success of the cab company was in no way due to any failure of the Faure-King batteries to do their stipulated work, and resulted from causes entirely unconnected with the accumulators. I am glad to say, however, that I have been informed that arrangements are now in progress by which electrical broughams, fitted with the latest improvements and E.P.S. batteries, will shortly be available in London. I cannot conclude without referring to the death of our esteemed colleague, Mr. Frank King, and paying a tribute to the work carried out by him during the many years he was manager of the Company. To his organising ability, and his skill as an electrical engineer, eapecially in connection with accumulators, I consider the Company in large measure owes its present prosperous condition. He has left an impress of his energy and industry on the accumulator business generally, which I feel certain will preserve his memory for many years to come. In some respects the year just closed has been an anxious one for the Directors and the staff, but I trust that with the return of peace, prices will settle somewhat. Electric lighting and traction are being taken up all over the country on an ever-increasing scale, and as accumulators are now recognised as an essential element for economical working I think the future of the Company looks bright. I now move the adoption of the report and accounts.

The resolution was carried unanimously.

Mr. F. Green was re-elected a director, and the auditors having been re-appointed, a vote of thanks to the Chairman and Directors terminated the proceedings.

Eastern Telegraph Co. (Ltd.)

The report of the directors of this company for the half-year ended March 31st states that the revenue for the period amounted to £543,683. 18s. 2d., from which are deducted £128,072. 1s. 4d. for

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ordinary expenses and £27,939. 17s. 9d. for expenditure relating to repairs and renewals of cables, &c. After providing £6,075. 7s. 1d. for depreciation of spare cable and £7,794. 8s. 1d. for income tax, there remains £373,802. 6s. 11d., to which is added £33,660. 3s. 4d. brought forward, making £407,462. 10s. 3d. From this there has been paid: Interest on mortgage debenture stock, £27,590. 16s. 1d.; dividends on preference stock, £30,946. 16s. 8d.; interim dividend of 1½ per cent. on ordinary stock, £50,000; leaving £298,924. 17s. 6d., out of which the directors have placed £10,000 to reserve for maintenance ships, £5.000 to reserve in connection with removal of head office, £2,000 to reserve fund for insurance of goods in transit, and £150,000 to general reserve. The directors now recommend a final dividend on the ordinary stock for the year ended March 31st of 1½ per cent. and a bonus of 2 per cent., amounting together to £130,000, payable 19th instant, tax free, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year. The balance of £1,924. 17s. 6d. is to be carried forward. The revenue includes £26,039. 10s. dividends for the half-year on the company's shares in other telegraph companies.

The section of cable between Ascension and St. Vincent was completed on Feb. 22nd, providing, with the existing lines of the Western Telegraph Co. and this company, a third route to the Cape. Landing rights having now been granted, arrangements have been made for improving this route by laying a direct cable between St. Vincent and Porthcurnow, Cornwall, viâ Madeira.

An agreement has been concluded between the Eastern Extension Telegraph Co. and the Governments of South Australia, Western Australia and Tasmania for establishing, in conjunction with this company, direct cables between South Africa and Australia, viâ the islands of Mauritius, Rodrigues and Cocos to Perth, with an extension to Adelaide. The section between Durban and Mauritius will be laid by this company. It has also been arranged to lay a cable between Ascension and Sierra Leone under a subsidy from Her Majesty's Government. The order for the whole of these cables has been given, and they are in the process of manufacture.

In connection with these important extensions the tariff between the Colonies of South and Western Australia and Tasmania and Europe was reduced from 4s. 9d. to 4s. per word on May 1st, with proportionate reductions for Government and press telegrams. The agreement with the above Australasian Colonies also provides for future reductions under certain conditions to a minimum of 2s. 6d. per word. There will also be substantial reductions in the tariff between the contracting Colonies and South Africa when the new cables between Durban and Perth are completed.

The company's new cable-repairing steamer "John Pender" has been completed and placed in commission.

The company has subscribed £500 to the Mansion House Fund for the City Imperial Volunteers, £500 to the Indian Famine Relief Fund, and £500 to the Transvaal War Fund.

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)—A meeting of this company was held on Friday last. The chairman (Mr. John R. Wigham, J.P.) said: The profit for the year has been £17,260, against £11,267 last year. During the year the capital has been increased to £200,000, the full amount at present authorised. There has been also a further issue of debentures, making the total £75,000. A large item of £121,000, sundry debtors and advances to subsidiary companies, appears among our assets. The advance to subsidiary companies, which forms a large proportion of this item, represents money spent in connection with our various companies, in exchange for which we are entitled to get shares or debentures. There is another large item—investments at cost, £111,000. This represents shares and debentures in our various companies, taken at actual cost. The directors recommend a dividend of 6 per cent. on the ordinary and on the deferred shares, to write £5,000 off goodwill, and to carry forward £4,152. The progress which our various stations have been making during the year is, in nearly every case, beyond our expectations. This rapid increase has necessitated large extensions, and most of our work during the past year has been in the direction of such extensions, only a few new works having been commenced. We have, however, been able to secure powers for Grantham, Stamford, Twickenham, Bishop Auckland, Weybridge, and Redruth, and have practically secured a concession for an electric tramway between Redruth and Camborne, which will be worked in connection with their Redruth electricity station. Additional capital is required to meet our extending business, and it is proposed that the capital of the company be increased from £200,000 to £400,000, and that £100,000 be issued at once, as 6 per cent. preference capital. The directors' report was adopted, and resolutions approving the increase of capital afterwards approved.

GREENWOOD & BATLEY (LTD.)—The annual meeting was held on Tuesday. The chairman (Mr. Arthur Greenwood) moved the adoption of the report (an abstract of which appeared in our last issue). He expressed regret that the results of the year's working were not more favourable. Their business was a special one, and success was dependent upon its various branches being fully occupied. Their general engineering tool trade had been well employed. Other departments had not, however, been fully occupied. They had tried to find not only new markets, but new manufactures to offer in these markets, and considered that the electrical branch was that to which they must now look to make up the loss of work in other departments. This branch was making sound and steady progress, and had increased year by year. He felt that to this branch they must look for their future success, both in obtaining orders and in realising profits. At the last meeting he spoke of the De Laval steam turbine, in which the company had taken a large interest, and he was glad to report a successful development of this branch. Dividends at the rate of 7 per cent. per annum on the preference and of 2½ per cent. on the ordinary shares were declared.

NEW COMPANIES, STATUTORY RETURNS, &c.

ANTI-COLLISION ALARM TELEGRAPH CO. (LTD.)—This company was registered on June 28, with a capital of £1,500, in £1 shares, to adopt an agreement with Thomas Bell, and to acquire and develop any inventions, patents, &c. The subscribers are A. W. Higgs, R. White, I. Bridge (engineer), C. Geddes (engineer), C. J. Copeland (consulting engineer), G. A. Harradon, and J. Taylor (engineer).

DOE PORTABLE ELECTRIC LIGHT AND POWER SYNDICATE (LTD.)—This company was registered on July 3, with a capital of £40,000, in £1 shares, to a quire certain inventions relating to galvanic batteries, to enter into an agreement with a company of the same name, and to carry on the business of electrical engineers, electricians, suppliers of electric light and power, &c.

IMPROVED ELECTRIC GLOW LAMP CO. (LTD.)—This company was registered on July 2, with a capital of £40,000, in £1 shares, to acquire the business carried on by a company of the same name, and to carry on the business of electrical and general engineers, electro-platers, lamp and electrical plant and fittings manufacturers, &c. The first directors are, F. L. Gardner, F. H. Bowman, H. N. Tennant and, A. Gaskell.

MIDDLESEX AND HERTFORD ELECTRIC LIGHTING & POWER CO. (LTD.)—This company was registered on June 30, with a capital of £100, in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for light, power and other purposes, &c. The subscribers are, D. J. Robertson, V. B. D. Cooper (civil and electrical engineer), Lieut. F. H. E. Shipton, R.N., M. N. Ridley (civil engineer), F. O. Smith, M.R.C.S., C. Crawshaw, and A. Toch.

NEW GENERAL TRACTION CO. (LTD.)—According to the annual return to May 30 the capital is £370,000, in 50,000 preference and 24,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up and paid on the preference shares. The ordinary shares are considered as fully paid.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—The annual return to May 9 gives the capital as £200,000, in £1 shares, 171,504 of which have been taken up. £1 per share has been called up and paid on seven shares, and £171,497 is considered as paid on the remainder.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The annual return to May 22 has been filed. The capital is £132,520, in 53,008 shares of £2. 10s. each, 45,008 of which have been taken up. £2. 10s. has been called up on each of eight shares. £112,500 is considered as paid on 45,000 shares.

WESTERN TELEGRAPH CO. (LTD.)—The annual return to May 23 has been filed. The capital is £2,500,000, in 250,000 shares of £10 each, 207,930 of which have been taken up. £10 has been called up and paid on each of 130,000 shares, and 77,930 shares are considered as fully paid.

WYCOMBE BOROUGH ELECTRIC LIGHT & POWER CO. (LTD.)—The annual return to May 9 gives the capital as £30,000, in 6,000 shares of £5 each, 2,020 of which have been taken up.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since June 14, 1900). Price of silver 28 1/16d. per oz. (July 12). Consols (2½ per cent.) 99½—99⅝ for money, 99 15/16—99 31/32 for account; 2½ per cent. 98½—99½ (July 12). Stock Exchange Settling Day: Consols, Aug. 2; Stocks and Shares Continuation Days, July 25 and Aug. 13; Ticket Days, July 26 and Aug. 14; Pay Day, July 27; Mining Share Carry-over Days, July 24 and Aug. 11.

W. H. ALLEN, SON & CO. (LTD.)—The business of the well known engineering firm of Messrs. W. H. Allen, Son & Co., Queen's Engineering Works, Bedford, has been converted into a limited liability company. Particulars of the registration were given in our last issue (p. 424), but the title of the company was incorrectly given as W. H. Allen & Sons (Ltd.). The correct title is as above.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—An extraordinary meeting was held last week authorising the increase of the capital of the company to £50,000.

CALCUTTA TRAMWAYS CO. (LTD.)—The report of the directors for the year ended Dec. 31 states that the contract for the electrical equipment of the lines has been concluded with Messrs. Dick, Kerr & Co. for a sum not to exceed £170,000, to include the whole of the electrical requirements, but not the buildings. The subscriptions to the issue of £250,000 4½ per cent. debenture stock offered for public subscription on March 26 last were satisfactory, and the company is now in possession of ample funds for its present needs. Since active measures have been taken for the conversion of the lines to electric traction numerous applications have been made for extensions in various directions, and these applications are receiving careful consideration.

CAPE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 5 per cent., tax free, has been declared.

CROMPTON & CO. (LTD.)—A dividend at the rate of 9 per cent. per annum for the half-year (tax free) will be proposed at the forthcoming general meeting of this company, making, with the interim paid in January, 7½ per cent. for the year. £12,000 is added to reserve.

DIRECT UNITED STATES CABLE CO. (LTD.)—A final dividend of 5s. per share and a bonus of 2s. per share (both tax free) is recommended payable 31st inst., making, with the three interim dividends already paid,

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a total distribution of 3½ per cent. for the year to June 30. £10,000 is placed to reserve and about £3,700 carried forward. The transfer books will be closed from 10th to 24th inst. inclusive.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The financial papers announce that the directors of this company have declared a dividend of 4s. 6d. per share on the ordinary shares, making, with previous distributions, 5½ per cent. for the year.

NATIONAL TELEPHONE CO.—The transfer books of the preference and ordinary shares will be closed from 16th to 26th inst. inclusive, preparatory to the payment of dividend for the half-year to June 30.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended June 30. The share transfer books are closed from July 18 to Aug. 1 inclusive. The amount of electricity sold during the quarter ended Midsummer, 1900, is returned at 1,035,927 units, estimated to produce £18,474, against 817,642 units, which produced £14,751, for the corresponding period of last year.

SOCIETE ANONYME BELGE D'ELECTRICITE.—This company has just been formed to take over the Brussels branch of the Allgemeine Elektricitäts Gesellschaft of Berlin.

SOUTH STAFFORDSHIRE TRAMWAYS CO. (LTD.)—A dividend of 2s. 5d. per share on the preference shares has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has ordered the provisional certificates for £100,000 5 per cent. second debenture stock of the *Edison & Swan United Electric Light Co. (Ltd.)* to be quoted in the Official List. Application has been made to the committee to appoint a special settling day in and to grant a quotation to the further issue of £125,000 3½ per cent. mortgage debenture stock of the *Metropolitan Electric Supply Co. (Ltd.)*, and to allow 20,000 £10 fully-paid 7 per cent. cumulative preference shares (Nos. 1 to 20,000) of the *British Aluminium Co. (Ltd.)* to be quoted in the Official List. The latter is a renewed application.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—The transfer books of this company will be closed from 9th to 17th inst. inclusive preparatory to the payment of an interim dividend of 12s. per share.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—Subscriptions were this week invited for 23,361 £5 5 per cent. cumulative preference shares at par (balance of 40,000 shares), to provide capital for putting the company's cables at Buenos Ayres underground.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	July 7	4,649	+ 315	26	114,840	+ 6,756
Blackpool Corporation...	„ 5	822	+ 235	14	8,140	+ 1,757
†Blackpool and Fleetwood	„ 7	801	- 247	1	801	- 247
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 8	472	+ 41	14	6,892	+ 1,437
Brisbane Trams	May 23	1,703	+ 396	20	37,131	+10,490
*Bristol Trams & Carriage	July 6	3,222	+ 68	1	3,222	+ 68
*Buenos Ayres & Belgrano	June 10	2,166	+ 50	23	52,113	+ 4,366
City & South London Ry.	July 8	1,447	+ 410	1	1,447	+ 410
Cork Elec. Trams	„ 5	526	+ 87	27	10,074	+ 1,143
Dover Corporation	„ 7	235	+ 16	14	2,868	+ 262
Dublin & Lucan Rly. ...	„ 7	112	+ 22	1	112	+ 22
Dublin United	„ 6	3,150	+ 344	1	3,150	+ 344
Dublin Southern Dist....	„ 6	847	- 30	1	3,847	- 30
*Glasgow Corporation ...	„ 7	9,409	+ 198	...	...	...
Hull Corporation	„ 7	1,312	...	...	...	...
*Liverpool Corporation...	June 30	7,740	+ 338	26	188,741	+22,879
Liverpool Overhead Rly.	July 9	1,687	+ 148	1	1,687	+ 148
*Sheffield Tramways	„ 8	2,418	+1,003	27	55,526	+18,255
*South Staffs. Trams....	...	...	...	...	...	...

* Partly electrical. † Aged at 8 days last year.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 4.	Price Wednesday, July 11.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 11. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	60 63	60 63	5 17 0	Feb., May, Aug., Nov.	60	...
£3,088,640	Stock	30/0	Do. Preferred	113½ 114½	113½ 114½	5 5 9	„ „	114½	114
£3,088,640	Stock	27/0	Do. Deferred	12¾ 13½	12¾ 13	10 7 9	„ „	12 13/16	...
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	10 ½	102
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	7⅛	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	6 1 3	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100¾ 104¾	100¾ 104¾	4 6 7	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	...	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	10⅜	...
£4,000,000	Stock	5%	Eastern Ordinary	148 153	148 153	4 12 5	Jan., Apr., July, Oct.	151¼	148
£1,826,888	Stock	3½%	Do. 3½ per Cent. Preference Stock	97 100	97 100	3 10 3	„ „	9 ¼	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) ...	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	6/6	Eastern Extension	14⅜ 15½	14⅜ 15½	4 11 10	Jan., Apr., July, Oct.	15	14⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 117	112 117	3 9 2	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 13 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	100⅞ 103⅞	100⅞ 103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11 9/16	11 5/8
180,042	10	3/0	Do. 6 per Cent. Preference	15 15⅜	15 15¼	3 18 8	„ „	15¼	15 1/8
150,000	10	5/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July.....	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	93 101	93 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	53 57	52 56	4 9 3	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	126	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	99½	...
30,008	2½	...	West Coast of America	¼ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 14 7	January and July.....	...	...
88,321	10	1/0	West India and Panama	5/8 ¾	5/8 ¾	...	May and November ..	⅝	⅝
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	6¾	13/16
4,669	10	6/0	Do. 6 per Cent. 2nd Preference.....	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	...	...	4 15 3	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜ 15¼	14⅜ 15¼	4 11 10	Mar., June, Oct., Dec.	14⅜	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1903)	103 106	104 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,850	1 /0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¼ ⅓	¼ ½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National	5 5½	4⅞ 5½	5 17 1	February and August	4 15/16	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 15	13 15	4 5 9	„ „	13⅝	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5½	5 5½	4 15 3	„ „	5 1/16	5
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	97 100	3 10 0	June and December ...	99	98
171,504	1	0/3	Oriental	⅝ 1⅛	⅝ 1⅛	4 8 11	April and October.....	...	...
58,000	5	2/6	United River Plate	5 5½	5 5½	7 14 7	July	5⅛	...
16,639	5	2/6	Do. 5% Cumulative Preference	5 5½	5 5½	4 10 11	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 4.		Price Wednesday, July 11.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending July 11. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜	⅝	⅜	⅝	...	...	1/16	⅜
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅝	12⅝	11⅝	12⅝	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 3	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¼	6¾	6¼	6¾	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9½	10½	9½	10½	4 5 9	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	" "	5⅞	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6	7	6	7	[illegible]	March	6 7/16	6⅜
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107	110	107	110	4 1 8	June and December	109	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8½	9½	8½	9½	4 4 3	February and August	...	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½	13½	12	13	4 12 4	January and July	12¾	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 11	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9	10	8½	9½	4 4 3	...	9	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12½	11½	12½	4 16 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	108	111	108	111	4 1 1	...	109¾	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6¾	7¼	6¾	7¼	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1	1½	1	1½	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	93	100	98	100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	14½	15½	14½	15½	3 4 6	April and October	16½	14½
£320,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111	114	111	114	3 19 11	June and December	113	111
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95	98	96	98	3 11 6	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6	6½	6	6½	3 16 11	"	...	...
300,000	1	8%	Rand Electric	⅝	¾	⅝	¾	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165	185	165	185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1	" "	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14	15	13½	14½	4 16 8	February and August	14⅝	14⅛
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85	95	85	95	...	—	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3½	4½	3½	4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	11	12	12	13	5 8 4	March and September	11⅞	11⅝
			ELECTRIC MANUFACTURING &c. COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅝	⅞	⅝	⅞	8 0 0	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅜	⅝	⅜	⅝	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16	3/16	⅛	3/16	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99	101	97	99	4 4 2	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	6	6½	6	6½	4 13 4	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅞	5⅜	4⅞	5⅜	...	...	4 13/16	...
90,060	2	1/2¾	Brush Electrical Engineering	1⅝	1⅞	1⅝	1⅞	4 5 1	September	1 11/16	...
90,000	2	1/2¾	Do. 6 per Cent. Pref. Non-Cum.	2	2½	2	2½	5 6 8	"	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109	114	109	114	3 19 10	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	103	101	103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13½	14½	13	14	5 7 2	" "	13⅝	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	5¾	5½	5¾	4 6 11	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	114	110	114	3 13 11	November and May	...	...
300,000	1	0/9¾	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅝	5 16 5	...	1⅛	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/9¾	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1/9¾	Crompton and Co. (Nos. 1 to 32,098)	3½	4	3½	4	4 10 9	January and July	3¾	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	93	101	98	101	5 0 0	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
99,261	5	1/9¾	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2	2½	7 3 9	February and August	2	...
17,189	5	2/9¾	Do. (£5 paid)	3½	4½	3½	4½	6 13 4	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91	93	91	93	4 6 0	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs. (50% pd.)	...		49	52	...	...	...	...
26,100	5	5/11¼	Edmundson's Electric Corporation Ord. (fully pd.)	4½	5	4½	5	6 0 0	Half-yearly	...	...
£75,000	Stock	...	Do. 4½ per Cent. First Mort. Deb. (red.)	101	104	101	104	...	...	...	...
112,100	2	1/2¾	Electric Construction Co. (Limited)	2	2½	2	2½	5 6 8	January and July	2 3/16	...
25,000	2	2/9¾	Do. 7 per Cent. Cumulative Preference	3	3½	3	3½	4 0 0	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	103	104	107	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13½	14½	13	14	6 15 9	February and August	...	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5½	5¾	5½	5¾	3 18 3	" "	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 13 11	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21⅜	20⅞
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	35	39	35	39	4 12 4	March and July	36	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101	104	101	104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½	11½	10½	11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½	11½	10½	11½	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½	7½	6½	7	4 5 9	" "	6⅜	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	108	105	107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½	18½	17½	18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103	105	103	104	4 17 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd & new	22½	23½	21½	23½	3 3 10	February and August	23½	22¼
25,000	10	4%	Do. Cumulative Preference (fully pd.) xd & new	10½	10¾	10½	10¾	...	...	10¾	10½
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd & new	118	120	118	120	3 6 1	February and August	120	118
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½	10¾	10½	10¾	4 13 0	May and November	...	...
30,000	10	11/0	British Elec. Trac. Ord. (Nos. 1 to 30,000)	14	15	14	15	4 0 0	...	14½	14
15,000	10	8/7½	Do. (Nos. 60,001 to 75,000)	14	15	14	15	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref.	12	13	12	13	4 12 4	February and August	12⅝	12 9/16
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	126	123	123	4 0 4	...	124	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	120	123	121	124	...	...	121½	...
40,000	5	2/8 3/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5	5½	5	5½	5 14 4	...	5 5/16	5
27,500	5	...	Do. "B"	4	4½	4	4½	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	100	103	102	105	4 17 1	...	104	102
£120,000	Stock	13/9	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	38	41	96	99	...	...	...	...
206,297	10	3/0	Central London Ordinary	9½	10½	9½	10	3 0 0	June and December	10	9⅝
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	64	66	64	65	2 16 9	February and August	65	64½
37,500	10	1/5 7/16	Do. (Nos. 22,501 to 60,000)	6	7	6	7	2 2 0	" "	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	" "	...	...
£200,000	Stock	5%	Do. (1896)	132	137	132	137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123	128	123	128	3 2 6	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½	23½	22½	23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	⅛	3/16	⅛	3/16	32 0 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	3/16	¼	3/16	¼	24 0 0	" "	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅞	10⅜	10	10½	4 17 6	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9¼	9⅝	9	9⅜	4 5 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½	13¾	13½	13½	3 14 1	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¼	3¾	3¼	3¾	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4¾	5½	4¾	5½	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅝	10⅞	10⅝	10⅞	4 13 0	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	12	12½	11½	12½	...	...	11½	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	93	101	97	100	3 0 0	June and December	99	97

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,157. [No. 13. Vol. XLV.] FRIDAY, JULY 20, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 15 cents, or 20c., or 70pf.

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NOTES.

MORE than usual interest attaches to the statement of the Marquis of TWEEDDALE at yesterday's meeting of the stockholders of the Eastern Telegraph Co. His graphic *résumé* of the progress of the company since the amalgamation in 1872 showed the uniformly comprehensive grasp of the telegraphic situation by the directorate. Without resulting in undue profits, the policy maintained has enabled the stockholders to reap a moderate reward for their confidence. No small measure of the success of the Eastern and associated Telegraph Companies is due to the personality of the chairman, the Marquis of TWEEDDALE, who has been associated with submarine telegraphy for over 30 years, and the announcement of his resignation must have come almost as a shock. The full report, which appears on another page, gives his lordship's reasons for this step, and it only remains to be said that all acquainted with the noble Marquis will be gratified that, by his retention of a seat on the Board of Directors, his connection with submarine telegraphy has not been wholly severed. It says much for Sir JOHN WOLFE BARRY that, after only a short association with the directorate, he should have been unanimously selected to succeed the Marquis of TWEEDDALE as chairman of this great undertaking.

THE action of light on magnetism is the natural corollary of the action of magnetism on light, as disclosed in the Faraday and Zeeman effects. But converse Faraday or Zeeman effects have not yet been obtained, and the only experiments hitherto described which show some influence of light upon magnetisation are those of BIDWELL. These were made in 1889. He brought iron bars into a peculiarly sensitive state by heating, magnetising, and demagnetising them in such a manner that their susceptibility in one direction was greater than their susceptibility in the opposite direction. He then found that their magnetisation in a magnetic field was facilitated by the action of light, and also their demagnetisation on the cessation of the field. But the same effects were produced by mechanical action, and it is doubtful whether we have here the case of a pure action of light at all. We have certainly not to deal with any magnetic action such as would follow from the electromagnetic theory of light. In the current number of the *American Journal of Science*, however, Mr. J. H. HART announces that he has obtained a distinct effect of light on the demagnetisation of thin iron films deposited upon glass by a cathode discharge. These, as we know, are extremely difficult to demagnetise or reverse. Light polarised in a plane containing the magnetic axis had, however, a strongly demagnetising effect, and light polarised in a direction normal to it a distinctly feebler effect.

AT the recent convention of the Municipal Electrical Association, during one of the discussions, the question was debated as to the suitability of the gas engine as a means for pioneering electricity supply in areas of small or moderately large size. The question was raised in Mr. VESEY BROWN'S Paper on "Electricity Supply for Small Towns," the author recommending local authorities who own gasworks "to lay down a network of distributing mains and instal a gas engine plant to the extent of, probably, 150 kilowatts as a pioneer undertaking, and, if the demand requires, then to put up a steam generating station." This recommendation was dissented from totally by Mr. BOOT, of Tunbridge Wells, who considered gas-engine stations a failure, and partially by Mr. COLLINGS BISHOP, of Wigan, whose experience at the Leyton gas-driven electricity station, he said, had taught him that a station of this type should only be erected where the demand was not only initially small but was likely to remain small. At Leyton, steam plant has been adopted for the larger works necessitated by the increased demand for current. The practice at Belfast has been in a similar direction. Coatbridge long ago exchanged its gas engines for steam plant; while out of its many vicissitudes Morecambe has also emerged with a steam-driven station. Can any good, then, be said for the gas engine as the mainstay of any small electricity works?

SOME years ago, when the practice of using gas engines was newer and less understood than at present, we published a series of descriptions of the few stations of this

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type then in existence (see *The Electrician*, Vol. XXXV.) Although at that time the gas-driven station was under a depressing cloud, chiefly owing to the ill-luck with gas plant at Morecambe and Coatbridge, we were able to produce evidence fully supporting the view we expressed, that the gas-engine station was not essentially a failure. In each and every case the want of success arose from contingencies which had a purely local character. There appeared nothing whatever to condemn the gas-driven station as an engineering mistake or a financial failure; and besides accounting in every instance for the individual failures, we were able to point to actual examples of really successful gas-driven electricity works. The admirably equipped station belonging to the Midland Railway Co., which supplies current for lighting the railway stations and yards at Leicester, was one of the instances cited; and the uniformly successful career of this station since that date is further proof of the correctness of our conclusions. Indeed, it is not possible for any competent engineer to go carefully into this question without being greatly impressed with the numerous advantages gas-driving possesses over steam-driving in certain combinations of circumstances which are of by no means rare occurrence. Mr. Vesey Brown is certainly justified in pressing its claims upon the attention of local authorities who are the owners of gasworks. It is probable that it may also safely be recommended to local authorities who do not own and supply gas; for one of the cheapest methods of running a gas-driven station, where the necessary fuel can be obtained at a moderate price, is to use the Dowson gas generator.

The question that is uppermost in our mind at present, however, is not the practicability of running a gas-driven station, but the local conditions which justify this practice. Is the gas-driven station, in fact, only to be used where the demand for electricity must always be within the somewhat narrow limits of good gas-station practice; or, may not the gas engine be used as the "thin edge of the wedge"—the pioneer, in small beginnings, of great things to come? In other words, does it pay to lay down gas engines first, and later, when the load has grown large, to replace these with steam plant? Opinions differ, but we are disposed to believe that in many cases it would pay to do so. It is contended, in opposition to this view, that the replacement of gas plant by steam plant would overload the capital account of the works. This ignores the fact that there is always a ready market for second-hand gas plant that has been well cared for; moreover, in steam-driven stations, where very small beginnings are made, the steam plant is often too small in size to be of real use when the works require to be greatly extended. In either case, therefore, a certain amount of plant usually must be got rid of. But the chief recommendation of the gas engine over the steam engine, for small pioneer work, is the simplicity and comparative insignificance of the experiment. Little capital is risked in putting down a gas engine and dynamo on the gas works, or on any cheap convenient site; much more elaborate, however, and costly is the experiment of erecting a steam-engine station. Moreover, on the almost toy scale of pioneer work in villages and small towns the works costs with gas-driving can be kept down to a much lower figure than with a steam engine, especially where a storage battery is erected so that the station need be run only a few hours daily.

Questions of law are continually arising as to the relative rights of the Post Office, National Telephone Co., and local authorities as telephone caterers to the general public. The dispute as to underground wires in the metropolis must be held responsible for a great part of the £25,000 referred to in another column as having been spent by the National Telephone Co. in repairing their wires after the disastrous snowstorm last February. At a recent discussion on municipal telephony at Huddersfield, in which the Council decided to apply for a telephone licence, Ald. Calvert is reported to have said, "there could be no doubt that Huddersfield or any other municipality would be able to use the National Telephone Co's wires in other towns if their messages went over the trunk lines," this statement being supported by the town clerk. We are by no means certain that the views of these two gentlemen are correct. The company has a right to charge terminal fees for effecting a connection between a trunk wire and one of their own subscribers; and if, for instance, the company raised to a prohibitive figure the terminal fee charged to callers attached to municipal exchanges, at the same time absolving their own subscribers from such fees, they would hardly, we think, be exceeding their legal rights. After all, it would be only fair that the supporters of a movement which has prevented the metropolitan system from being perfected by the use of underground wires throughout should be made to contribute, if only in the form of high terminal fees, to the costly repairs inseparable from an overhead system in a large town.

Personal.—Lord Kelvin has been elected Master of the Worshipful Company of Clothworkers for the year 1900-1901.

Institution of Junior Engineers.—A visit will be paid to the generating station and depôt of the Central London Railway at Shepherd's Bush, on Friday next, the 27th inst., at 6 30 p.m.

Electrical Engineers (R.E.) Volunteers.—Among the prisoners of war unconditionally released, and now at Ladysmith, are Sappers D. F. Colson, R. Peart, C. E. Landon and E. M. Sellon.

University College, London.—The 1900-1901 session will commence on Oct. 2. Some particulars of the course of instruction given in electrical and mechanical engineering, &c., are given in an advertisement.

Durham College of Science.—Complete courses in instruction are provided at this college for science students. Special facilities are offered for the study of applied chemistry, mining and all branches of engineering. The course of lectures begin on Oct. 8.

Civil List Pensions.—Among the Civil List pensions granted during the year ended June 20, 1900, are the following: Mr. C. J. Wollaston (£100), in recognition of his services in connection with the introduction of submarine telegraphy; and Mr. R. Tucker (£40), in consideration of his services in promoting the study of mathematics.

Cable Interruptions:—

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

Central London Railway.—In the description of the exciter sets on page 433 of our last issue, it should have been stated

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that each exciter set consists of a vertical enclosed tandem compound engine directly coupled to a multipolar continuous-current generator, both engine and generator being of the "Thomson-Houston" standard type. Also, in the first line of column 2 of the same page read "Thomson-Houston" instead of "Westinghouse."

Society of Model Engineers.—The fourth monthly meeting of the Liverpool Branch of the Society of Model Engineers was held at the Balfour Institute, on July 4th, when a very fine collection of models was on view, and Mr. Hastings gave an interesting description of the engine of his new model torpedo boat. The next meeting will be held in the recreation room at the Balfour Institute, Smithdown-road, Liverpool, on August 1st., at 7·45 p.m., when another exhibition of models will be held, and a general discussion will take place on any difficulties experienced by members in connection with their work.

University of Birmingham.—At a meeting of the Council of the University of Birmingham on Wednesday, under the presidency of the Vice-Chancellor, the offer of 25 acres of land by Lord Calthorpe and his son as a site for the new scientific department which it is proposed to establish, was announced by the reading of letters from the Right Hon. J. Chamberlain and Lord Calthorpe. Mr. Chamberlain said he sincerely trusted that Lord Calthorpe's example would find many imitators, and pointed out, as especially worthy of the consideration of generous donors, the desirability of establishing schools of mining, railway and engineering, metallurgy, and technical instruction in pottery and glass manufacture. A resolution was then passed expressing the Council's high appreciation of the gift. The chief condition attached to the gift is that the University shall pay a share of the cost of building a new road, which will be rendered necessary in order to facilitate communication with Birmingham.

Society of Chemical Industry.—The annual general meeting of the Society of Chemical Industry took place on Wednesday in the lecture theatre of the Royal Institution. Prof. Chandler, of New York, who is president for the year, devoted his address chiefly to the subject of technical education. The most striking feature of the American system of technical education was that most of the technical colleges had been founded and were maintained by gifts of money from wealthy citizens In 1899 in that country there were 9,784 students pursuing professional courses in the schools of engineering, and 1,487 of these graduated during the year, receiving the degree of civil, mechanical, electrical, or mining engineer. In his address Prof. Chandler also referred to the progress made in electro-chemistry, alluding to the methods adopted for the reduction of aluminium in the manufacture of carborundum and artificial graphite. Mr. J. W. Swan has been elected President of the Society for next year, and Glasgow has been chosen as the place for the annual general meeting.

Southport Corporation Tramways.—A system of 6 miles of electric tramways was formally opened at Southport on Wednesday, the ceremony being followed by a luncheon to which the chairman and members of the Tramways committee had invited a large number of ladies and gentlemen. The lines are chiefly single track and are operated on the overhead trolley system, current being supplied by a continuous-current generating set, which has been added to the corporation electricity works. On the previous day the lines had been inspected by Mr. A. P. Trotter for the Board of Trade, and Mr. Trotter expressed his satisfaction with them generally, except with regard to some details in the overhead equipment, which he directed to be altered, chiefly in the disposition of some of the guard wires and anchor wires. Mr. Trotter also held an enquiry on behalf of the Board of Trade as to the application of the Southport Corporation to borrow £40,000 for the extension of their tramway system. There was no opposition to the proposal, and the evidence obtained at the enquiry will be reported to the Board of Trade in the usual manner.

Institution of Electrical Engineers—Students' Section.—A circular-letter has this week been addressed to the students of the Institution of Electrical Engineers informing them that the Council of the Institution proposes to grant £5 to each of 20 selected students to assist them to visit the electrical exhibits in the Paris Exhibition. Intending candidates must fill up and return an application form (issued with the circular) before 10 a.m. on Saturday, July 28. In the selection, the Council will give preference, other things being equal, to those who being still students of the Institution have either, or both, read Papers before the Students' Section, or been members of the committee of that section. The conditions of the grant are as follows :—

1. The selected student shall spend at least six days in Paris, the visit to commence not earlier than Aug. 27.

2. He shall write an essay or a Paper on the exhibits in a special section allotted to him, and shall send the Paper to the secretary of the Institution before Nov. 15, 1900.

The Paper submitted shall, like all other Papers presented to the Institution, become the property of the Institution. If approved by the Council it may be read at a meeting of the students' section, and, if so read, will be eligible for the usual Institution premiums offered for such Papers.

Visit of the American Institute of Electrical Engineers to England.—Mr. W. G. McMillan, the Secretary of the Institution of Electrical Engineers, is sending out the following circular to members :—

VISIT OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, AUG. 12 TO 14.

It is expected that many members of the American Institute of Electrical Engineers will accept the invitation of this Institution to spend a few days in London on their way to our joint meeting in Paris on Aug. 16. Arrangements are in progress for: (*a.*) A trip up the Thames in electric launches from a starting point to be reached by railway, with a luncheon at a riverside hotel, on Sunday, Aug. 12. The price of tickets will depend upon arrangements now in progress, but will not exceed £2. 2s. each, it is hoped that it will be considerably less. (*b.*) A Dinner in London on the evening of Monday, Aug. 13. Price of tickets about 25s., inclusive of wine. (*c.*) Visits to works in and around London on Monday and Tuesday, Aug. 13 and 14. It is hoped that ladies will accompany members both on the river trip and at the dinner. In order that a true British welcome may be given to our guests, the Council hopes that a large number of members and of ladies may take part in the river trip and in the dinner. Before they can complete arrangements it is necessary, however, to know how many to provide for.

We have also been notified that the subject for discussion at the joint meeting of the Institution of Electrical Engineers and the American Institute of Electrical Engineers, to be held in the American Pavilion in the Paris Exhibition on the morning of Thursday, Aug. 15, is : "The Relative Advantages of Alternate and Continuous Current for a General Supply of Electricity, Especially with Regard to Interference with Other Interests." We understand it is specially desired to discuss how far interference with other undertakings, rather than ordinary commercial and industrial conditions, will come to be a determining factor in the selection between continuous and alternating currents.

The Northampton Institute.—A prospectus just received discloses a new departure at this technical institute. Engineering day courses are to be instituted, divided into three departments—viz., mechanical engineering, electrical engineering, and horological engineering. In each of these departments the work consists of lectures, exercise classes, laboratory work, and drawing office and workshop practice, and each department is divided into two sections, fairly elementary and more advanced. Thus in the mechanical department the aim is to give all-round training in the fundamental principles of modern mechanical engineering practice, and in the second part of the course special attention is to be devoted to the design and application of automatic machinery. In the electrical engineering department the first part of the course will train students in the ordinary work of electric lighting and power distribution, whereas in the more advanced course special attention will be devoted to electric traction and electro-chemistry. In the horological engineering a larger proportion of time than in the other departments will be given to workshop practice, and the students will be specially trained in the details of automatic tools. The courses are intended for students who desire a good technical training either before or after their apprenticeship in an engineering works, and also as a preparatory to higher technical instruction. The entrance examination will be held on September 26th and 27th, the results being made known on September 29th. The session will open on October 1st. Dr. R. M. Walmsley, the principal, will be pleased to give further information to intending students.

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THE PARIS EXHIBITION.—I.

(BY OUR SPECIAL CORRESPONDENT.)

Electricity plays undoubtedly the most important part in the Paris Exhibition of 1900; and this would be the case even without the large display of electrical apparatus and machinery on view from all countries. The exhibition is lighted by electricity; electric power is freely supplied to all exhibitors who desire it for motive power; the inclined elevators, the moving platform and the railways, which convey visitors from one part of the exhibition to another, are all electrically driven; and the great attraction of the evening is the electrical illumination of the grounds, the façades of some of the buildings and the "Porte Monumentale," the outline of the Eiffel tower, and the "Château d'Eau" with its fountains. This last item, the illuminations, is by no means unimportant, and is one of the finest features of the exhibition. It is no mere vulgar blaze of light, nor is it a combination of praiseworthy individual efforts, each made without regard to harmony or contrast; the whole is carried out on an enormous scale, and at the same time so artistically that the result surpasses in beauty anything of its kind ever attempted before. It is useless to try to give an idea of this work of art by stating the number of lamps employed or by photographic records, for it is one of those things that must be seen to be appreciated at its full value.

It will be as well to commence this series of articles with an indication of the configuration of the exhibition, and the positions of those portions of greatest interest to the electrical engineer. Then will follow descriptions of the supply system of the exhibition, and an enumeration of the prominent features of the various systems of transportation. The account of the individual exhibits (and, in fact, the whole of these articles more or less) must be regarded as nothing but notes, for it would be obviously impossible, for reasons of space, even if it were likely to be of general interest, to enter minutely into every detail or to mention by name every exhibit and every exhibitor.

Fig. 1 is a map showing the general arrangement of the exhibition, and how the various sections are disposed. It omits, however, the section at Vincennes which is by itself at a distance of 5 or 6 miles from the Champ de Mars and includes railway and tramway material and rolling stock, automobiles and plant for manufacturing and utilising acetylene gas. The electrically-driven moving platform and the third-rail electric railway run round what may be termed the inner boundary of the exhibition. They both follow the same route, but run in inverse directions. Figs. 2 and 3 are views taken at different parts of the moving platform, the latter also giving a good view of the third-rail railway and an idea of the architectural beauties of the Italian pavilion in the Rue des Nations. A technical description of the platform will follow in a future article. For the present it will suffice to point out that it is in reality a combination of three platforms, clearly seen in Fig. 2. The part on the extreme left is stationary, that next to it is moving along at a speed corresponding to a slow walking pace, and the wider platform on the right moves at about twice the speed of the intermediate one. Access to the platform is obtained in some cases by an ordinary stairway, in others by an "inclined elevator"—that is to say, a kind of

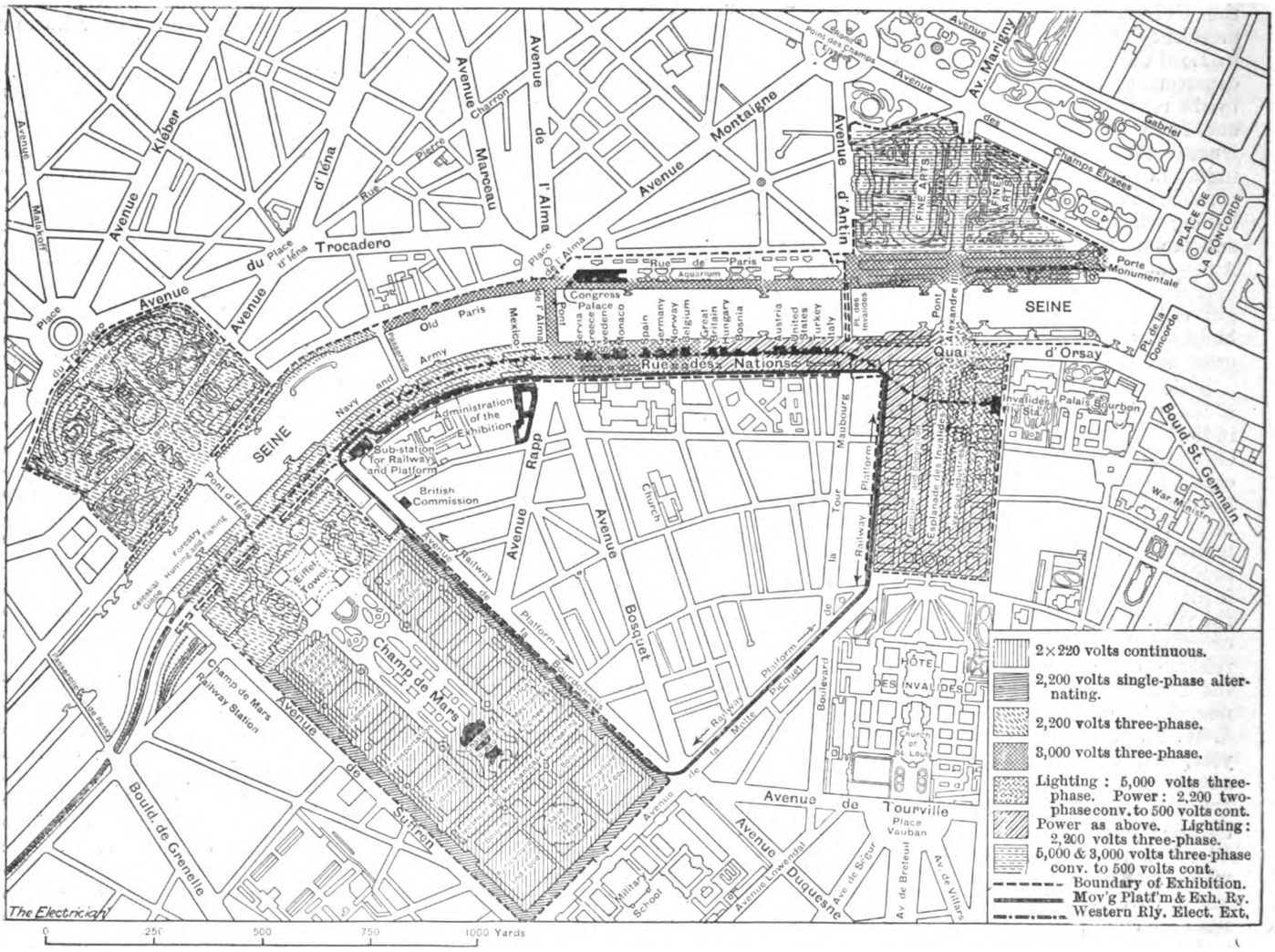

FIG. 1.—MAP OF PARIS EXHIBITION, SHOWING MOVING PLATFORM AND RAILWAYS, POSITION OF THE VARIOUS SECTIONS AND DISTRIBUTION OF SYSTEMS OF ELECTRIC SUPPLY.

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narrow moving carpet, inclined at a fairly wide angle to the horizontal. Several examples of these elevators are to be seen in different parts of the exhibition. An under-

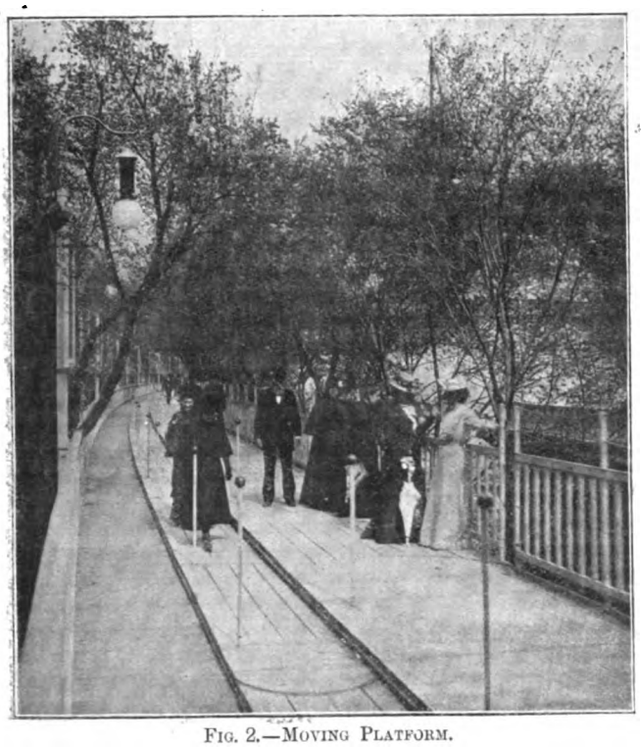

Fig. 2.—Moving Platform.

ground electric railway, which is to be permanent and to serve ultimately as an extension of the Western Railway of France to that part of Paris on the left bank of the Seine, at present runs only from the station in the Champs de Mars to the Invalides station at the other end of the exhibition. It is marked by a chain-dotted line in the map. A steam railway forming a branch line from the "Ceinture" railway runs to the same Champs de Mars station, and there is also railway communication with the intermediate station by the Pont de l'Alma from the St. Lazare railway station. The moving platform and the two electric railways obtain their current from a substation in the exhibition, the generating station being at Moulineaux 3 miles lower down the Seine.

The boundaries of the exhibition itself are indicated in the map by a dotted line. Just as in 1889, the main portion of the exhibition is in the Champs de Mars, in the middle of which is the Eiffel tower (which has for the occasion changed its dull red tint for a festive golden or gingerbread colour), and it is in this part that the electricity section is located. The Fine Arts section in the neighbourhood of the Champs Elysées and the Place de la Concorde, the various treasures on the Esplanade des Invalides, the already famous Rue des Nations in which are the "pavilions of the foreign powers," the lively Rue des Paris, in which those attending the Palais des Congrès in the daytime will seek a less intellectual if equally interesting entertainment in the evening, the fine military and naval exhibition on the bank of the Seine opposite to "Old Paris," and a picturesque solution of the Eastern question in the gardens of the Trocadero, all these must be visited; but it is only the electrical features of the exhibition that can be dealt with in these articles.

The front of the Palais de l'Electricité, shown in Fig. 6, is imposing, with the fine Château d'Eau, or water castle, in the centre. Although the two buildings are the work of different architects (M. Hénard and M. Paulin), they are in perfect harmony. The Château d'Eau may be described as Louis XV. style, and is rather heavier in its lines than the electricity building. It forms a series of basins, out of which cascades

Fig. 3.—Exhibition Railway and Moving Platform.

of water fall, and, from the miniature lake below, its fountains throw up jets of water to meet the floods pouring down from above. Unfortunately, the whole of this water display is not always offered to the public in the daytime; but at night, when the cascades and fountains are illuminated in constantly

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changing colours, the effect is magnificent. The lace-like façade of the Palais de l'Electricité is well represented in our illustration. At night-time it is picked out with electric lamps, and then, as well as in the daytime, is one of the most pleasing

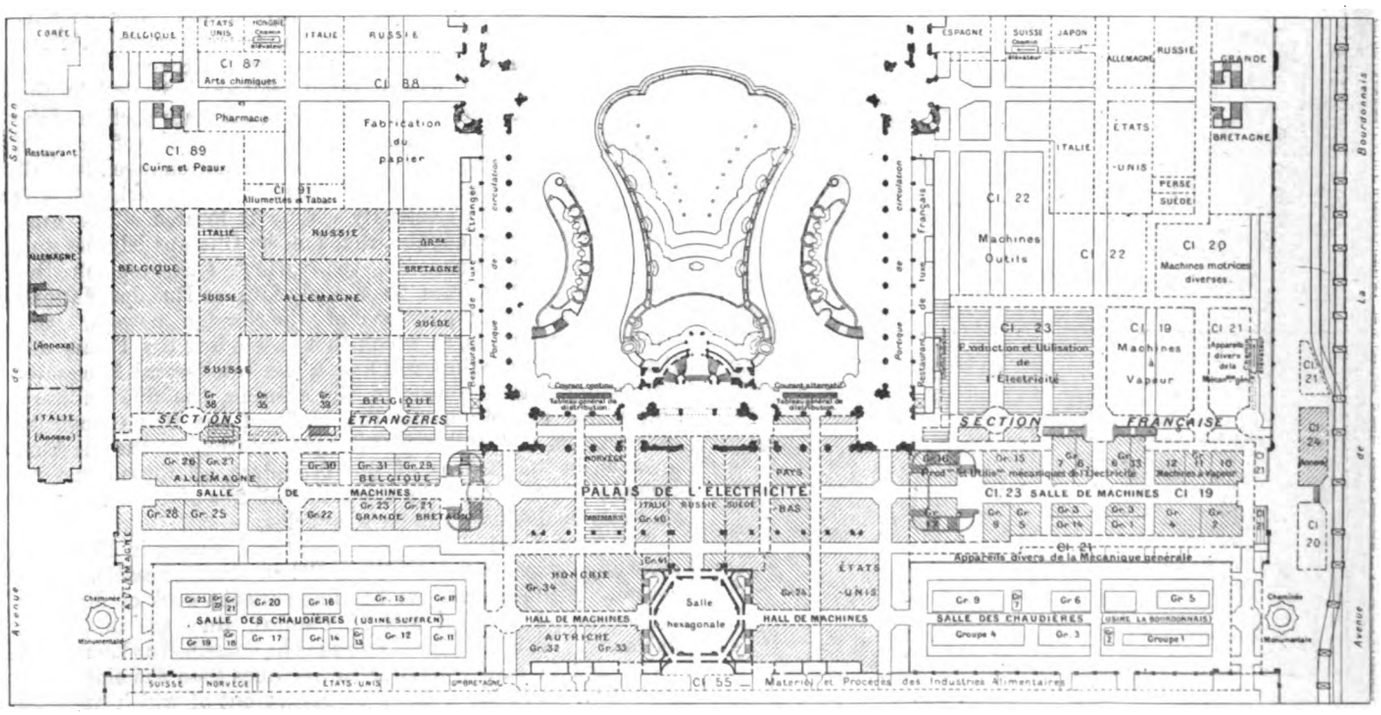

FIG. 4.—GROUND PLAN OF THE ELECTRICAL AND MECHANICAL ENGINEERING SECTION.

pieces of architecture in the exhibition. The Château d'Eau is surmounted by an allegorical figure representing "Humanity conducted by Progress advancing towards the Future and treading underfoot Routine and Hatred," and on the highest point of the electricity building is symbolised the genius of electricity standing erect in a car and brandishing the torch of progress.

being either by doors under the galleries facing the Château d'Eau on either side, when one first reaches a low dark corner of the large hall, beneath the gallery, or else at the top of an incline leading round the Château, giving access to the gallery at a part where no immediate view is afforded of the fine collection of machinery beneath. From other parts of the gallery, however, an excellent idea of the *ensemble* of the heavier electrical machinery can be obtained, for in this building the

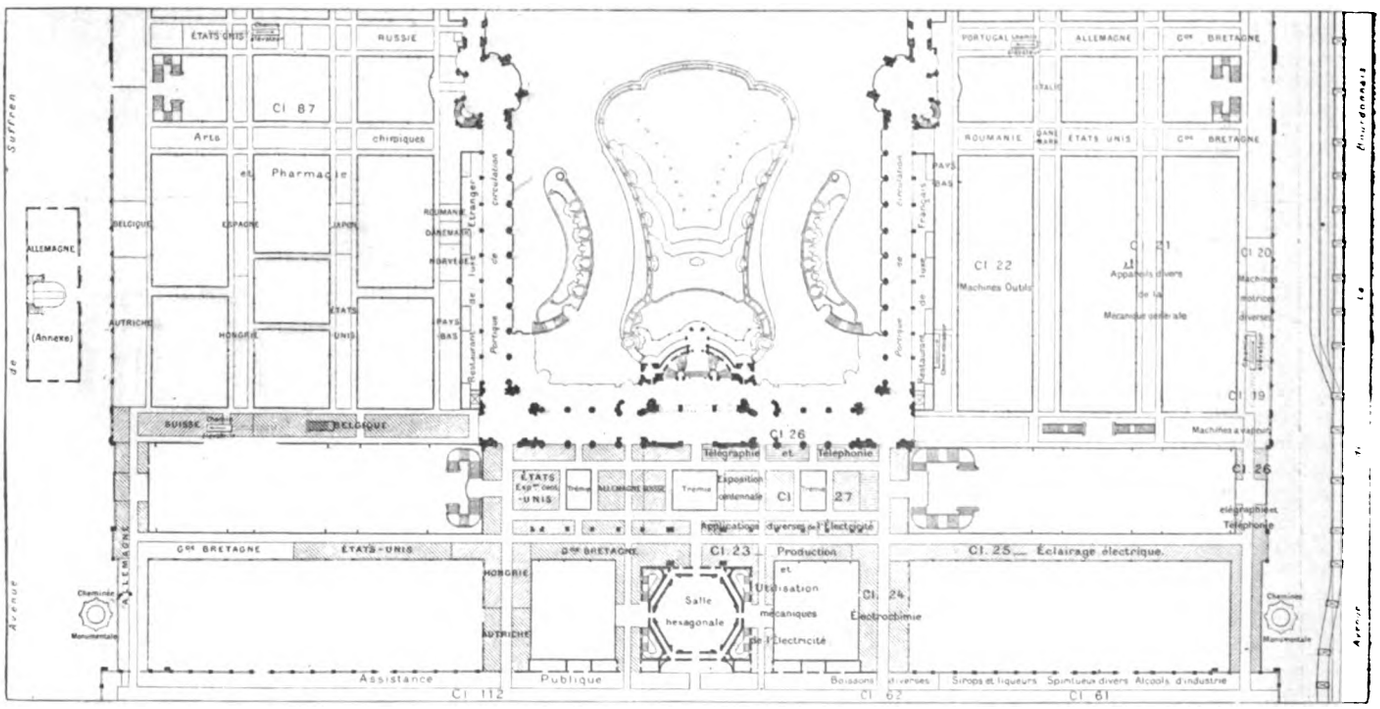

FIG. 5.—PLAN OF GALLERY.

Figs. 4 and 5 show the electrical and mechanical engineering sections within this palace. The entrance is disappointing, machinery generating current for the light and power service of the exhibition is situated, as well as that which is merely intended as an exhibit. On the gallery are the objects of a lighter and less bulky nature. The general arrangement on the ground floor is that the French machines are to the

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left of the building, entering from the Château d'Eau (that is to the right hand in Figs. 5 and 6), and the British, German, Swiss, and Belgian machines to the right. The boilers are in two houses by themselves behind the electricity building. An "overflow" collection of German machinery, gathered around a huge 4,000 H.P. three-phase fly-wheel alternator, is held in a building marked "Allemagne Annexe" to the extreme left in Figs. 4 and 5. The United States occupies rather an unfavourable position in the centre of the main building, overshadowed by the gallery and immediately behind the Château d'Eau, but it is also represented by machines of American design in the French section; and in proximity to the United States exhibits in the centre and back of the ground floor are the Austrian, Hungarian, Italian, Russian, Swedish and Dutch machines.

The nearest entrances to the electricity section are those in the Avénue de la Motte Picquet, and near the ends of the Avénues de Suffren and de la Bourdonnais, but the visitor should not fail, on one occasion at least, to enter the exhibition by the Trocadero, in order to enjoy the magnificent *coup d'œil* of the whole of the Champ de Mars, with the Château d'Eau and the Palais d'Electricité in the background, the various smaller palaces to the right and left, and the gardens in the centre dominated by the huge but not ungraceful shape of the Eiffel tower. The next article will deal with the light and power supply within the exhibition.

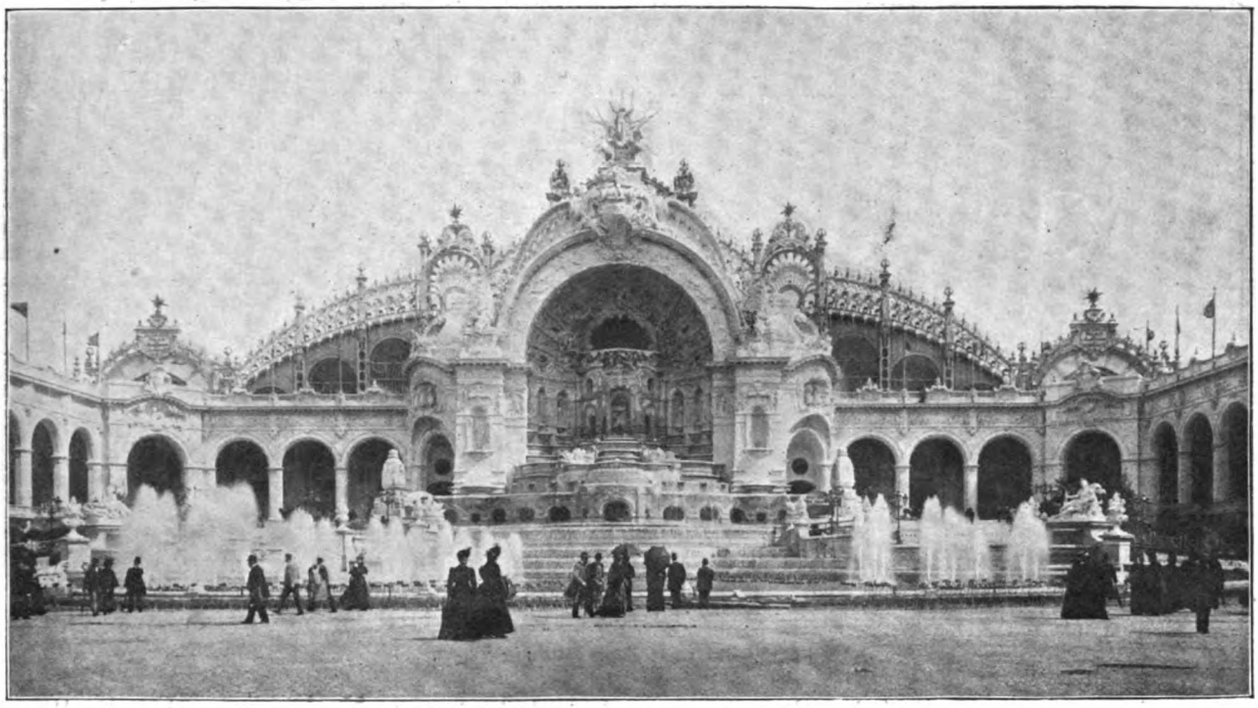

FIG. 6.—FRONT OF THE PALAIS DE L'ELECTRICITÉ AND THE CHÂTEAU D'EAU.

THE WORKS OF THE ST. HELENS CABLE CO.

The St. Helens Cable Co. is a development of the old-established St. Helens firm of wire drawers, W. J. Glover & Co., the new name having been adopted on the establishment of a factory for electrical cables and wires in Warrington. The new works at Warrington are those which will be of greater interest to our electrical engineering readers, as it is there that the copper wire and cable manufactured at St. Helens is converted into cable for electrical purposes. We will therefore commence our article with a description of these works, and follow this description with a brief account of the processes carried on at the wire-drawing works, although of course these should by right come first in order when relating the history of an electric cable.

The works at Warrington cover an area of 10,000 sq. yds. and are contained mainly in a large two-floor building. They are situated on the banks of the Mersey and adjoining the Warrington station of the London and North-Western Railway, and it is intended shortly to add a siding within the works themselves. Two hundred and seventy hands are employed, and almost all classes of cable are made there—paper, vulcanised bitumen, and indiarubber being employed as insulating materials, and the two latter compounds being manufactured from the raw material at the works. It is of interest to note that the works now occupied were at one time a rubber factory, but that all the old machinery has been swept away and has given place to new, the re-equipment of the works having been effected in six months. It was commenced last summer, and by January the company had already commenced the manufacture of insulated cable. Although in operation only six months, the works, we are informed, are working nearly at their full output and many of the machines are running on day and night shift. The firm's specialities include a lead-covered impregnated paper cable, claimed to be non-hygroscopic; a vulcanised rubber cable, in which the first layer of pure indiarubber is not applied in the usual way by lapping pure rubber strip, but in a novel manner (which the firm has requested us not to divulge in the present article); and an insulating matting formed of alternate layers of vulcanised indiarubber and impregnated paper, the last product being tested to 40,000 volts.

Starting from the manager's office on the first floor, above the general offices, we first come to the large and well-arranged braiding shop, illustrated in Fig. 1. Here are 120 braiding machines of the well-known fast-speed American type, placed in three rows. This class of braiding machine although running fast and making a braiding of good texture, will take bobbins of a fairly large size, so that one girl can attend to a maximum of eight machines. In the adjoining shop on the first floor are two disused pure rubber lapping machines and a set of five vertical stranding machines for the light wires up to 7/16 which are not stranded at the St. Helens works. In the same shop are two spreading machines for spreading the

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insulating material on "proof" tape. One of these is interesting in that a steam jacketed drum replaces the register of steam pipes for drying and heating the cloth upon which

on the opposite side of the account must be set the fact that the cotton supplied in this way by the cotton manufacturer costs a fraction of a penny more per pound. All these

FIG. 1.—BRAIDING SHOP ON FIRST FLOOR.

the compound is spread. A fourth shop on this floor (Fig. 2) contains longitudinal rubber-covering machines and some taping machines for cables up to a certain size, and here also

machines are served by girls; the machines on the ground floor, on the other hand, being mostly for a heavier class of work, require as a rule male attendants.

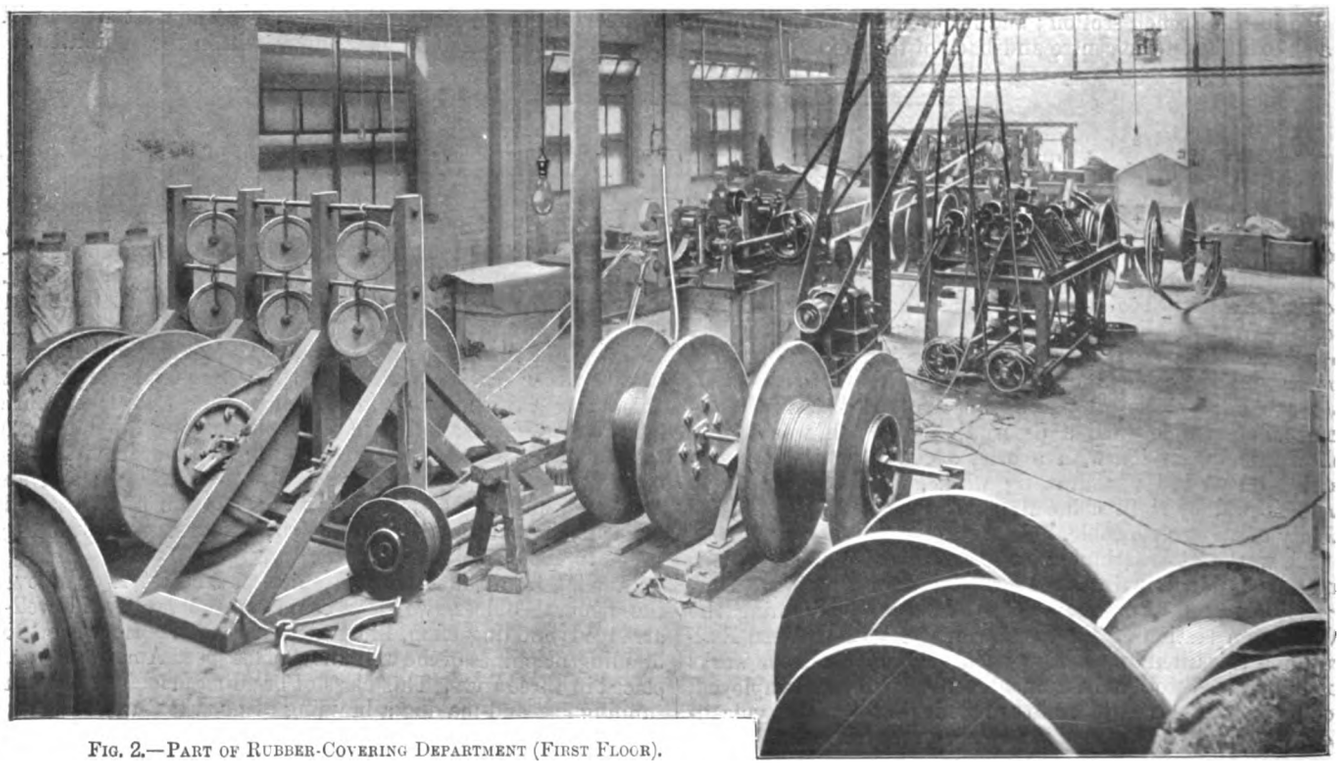

FIG. 2.—PART OF RUBBER-COVERING DEPARTMENT (FIRST FLOOR).

is the winding bench where the spools are wound for the braiding machines. The cotton is wound from larger spools not from skeins, this economising both time and space, while

On our way down we pass a well-provisioned dry store for indiarubber, in which the raw material is kept before use.

Six "washing machines" and four "mixers" first attract

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attention at the foot of the stairs. In the former the pure rubber is scrubbed and dried, and in the latter it is mixed with the so-called "pigment" to convert it into the "compound rubber" suitable for vulcanising. This mass is then rolled out into thin sheets by steam-heated callenders, after which it is ready for being cut into strips for the rubber-covering machines. The latter, some of which are on the ground floor and others above, as already mentioned, are of the so-called longitudinal pattern, in which the rubber strip is passed over ridged rollers which wrap it round the conductor and cut it sharply, the freshly-cut rubber on the two sides cohering along a longitudinal seam, which disappears on vulcanisation. Close to the rubber-making machinery is a press for making rubber-canvas "insertion," the alternate layers of rubber and canvas being formed into a solid whole under pressure.

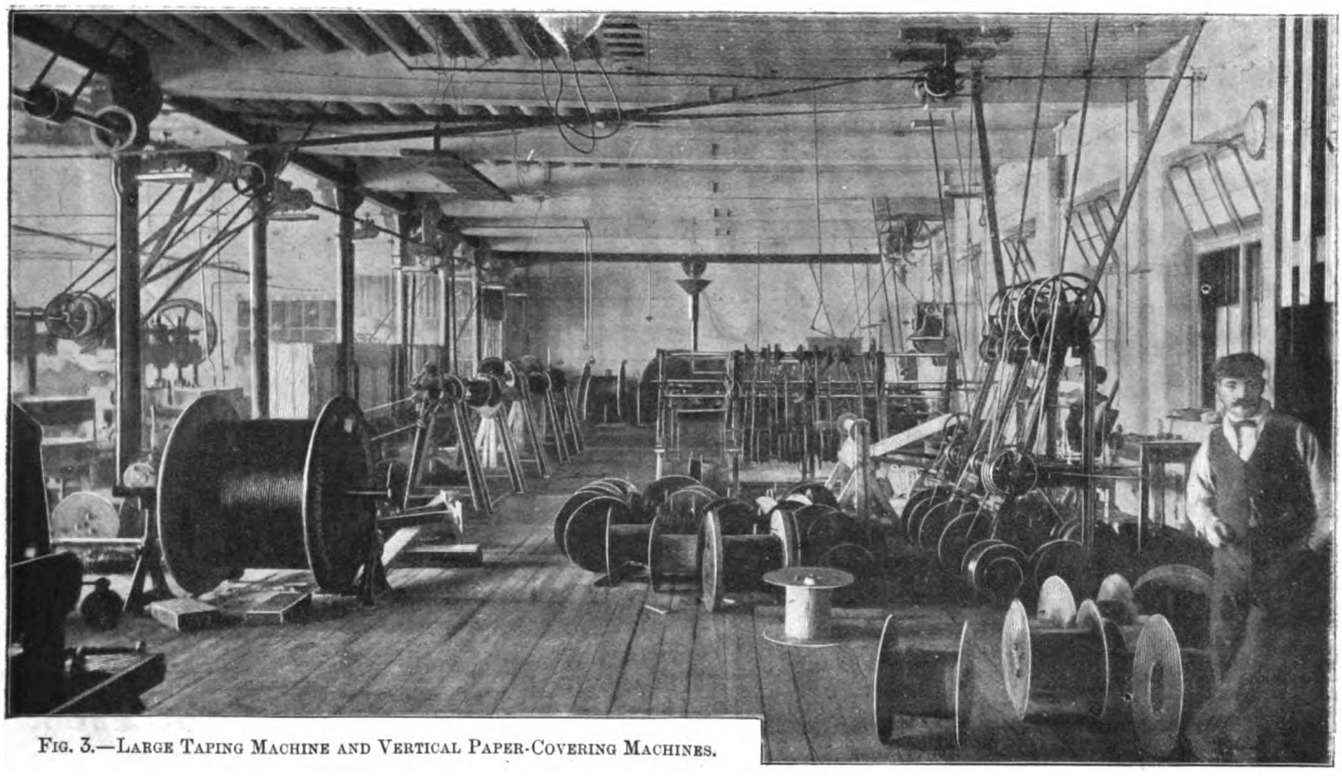

FIG. 3.—LARGE TAPING MACHINE AND VERTICAL PAPER-COVERING MACHINES.

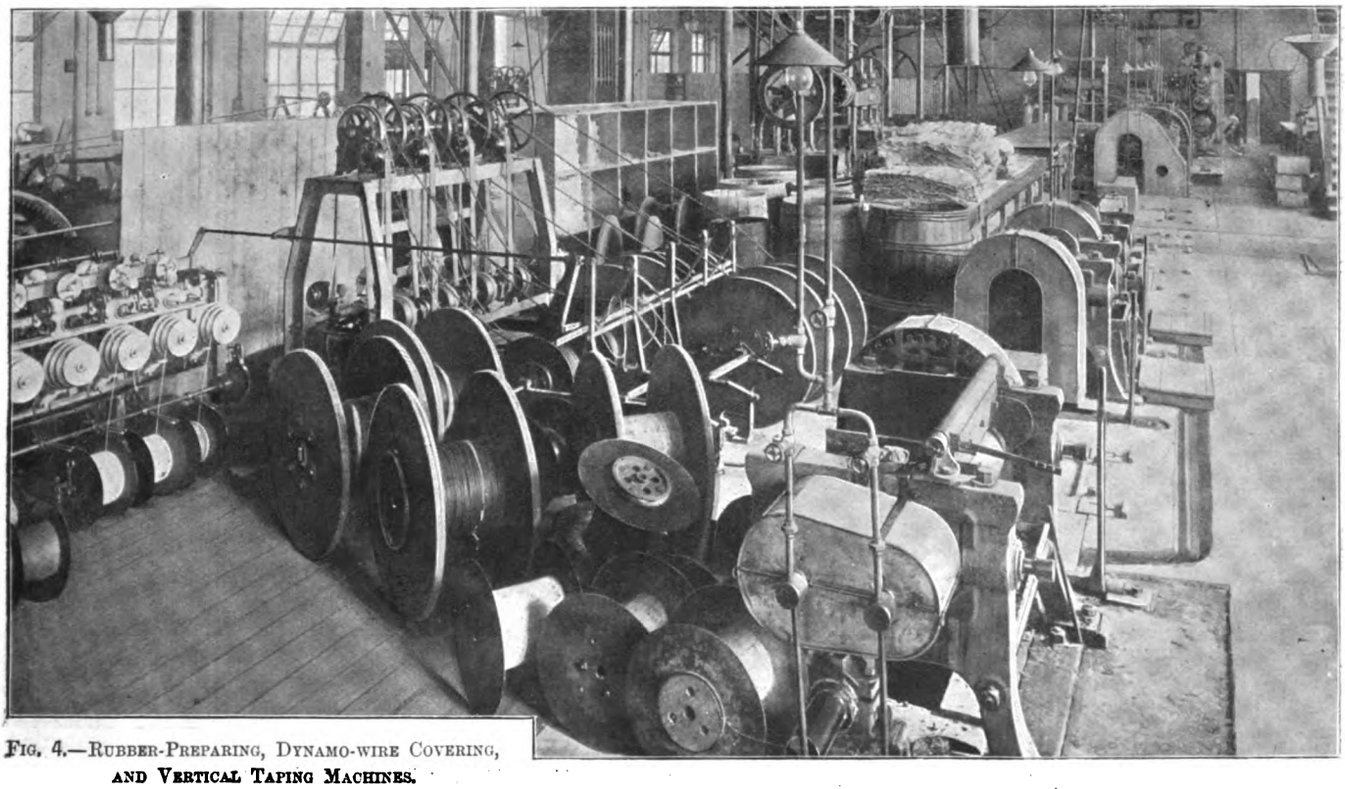

FIG. 4.—RUBBER-PREPARING, DYNAMO-WIRE COVERING, AND VERTICAL TAPING MACHINES.

The largest machine in this shop is a taping machine (seen in Fig. 3) with seven quadruple taping heads, one of which had been removed at the time of our visit. This machine will,

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therefore, lay on 28 laps of tape in one operation if required. We noted that in this machine, as well as in the large serving machine which we shall refer to presently, the cast-iron standards supporting the bearings in which the heads revolve were merely bolted to the cement floor of the shop, and had not any bed plate. In this shop are also some vertical taping machines and a cotton-covering machine for dynamo wires seen in Fig. 4. The latter, on which six wires can be attended to by one girl, will cover with two reverse laps of cotton about 6 miles of dynamo wire (one mile on each pair of dapping heads) per diem.

In the second shop on the ground floor are six large braiding machines for heavier cable, two lead presses, impregnating tanks for paper cable, a large serving machine, a large stranding machine, some vertical paper-covering machines for telephone wires, horizontal machines for laying on vulcanised bitumen, the rubber vulcanisers, and some compounding tanks. The lead presses are of the hot type.

FIG. 5.—BITUMEN, LEAD-COVERING AND VULCANISING DEPARTMENT, SHOWING ONE OF THE VULCANISERS IN THE FOREGROUND.

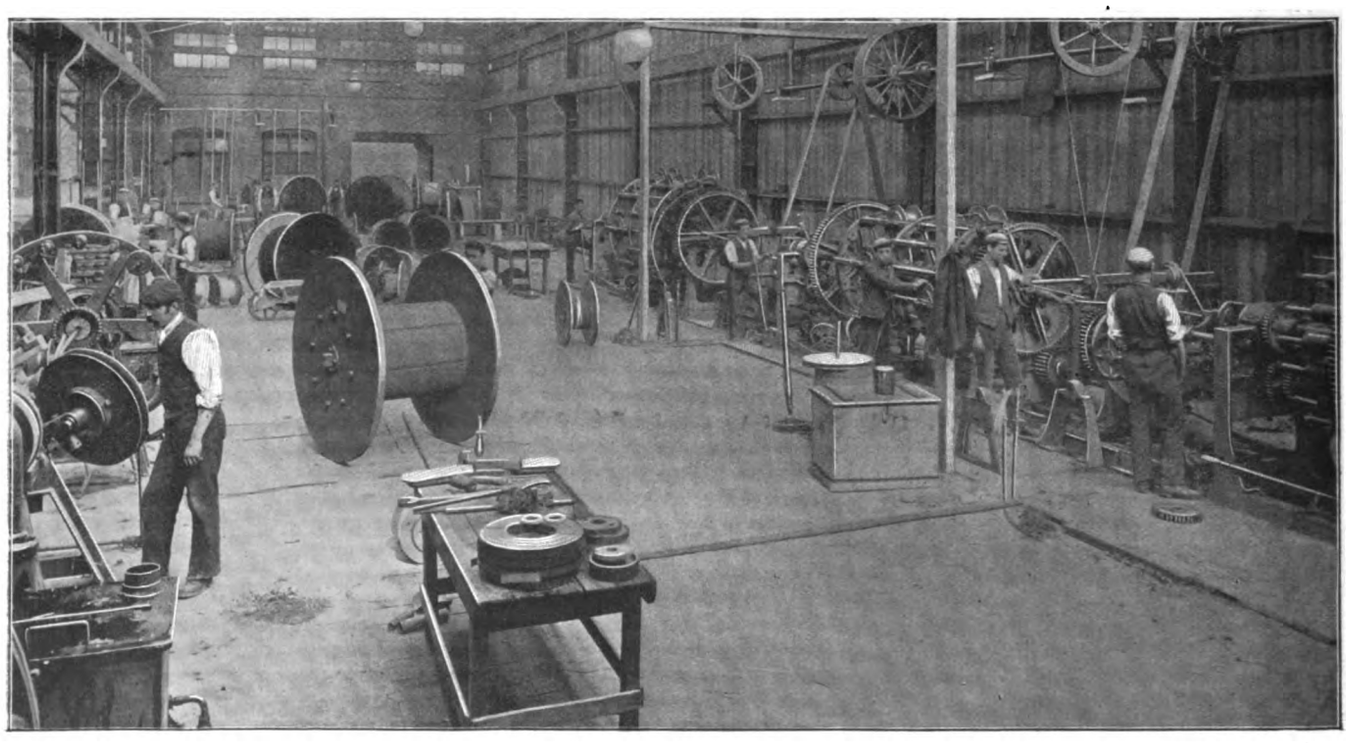

FIG. 6.—VIEW IN STRANDING AND SERVING SHOP, SHOWING TRIPLE-TANDEM STRANDING MACHINE.

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The cable is guided through a hollow steel point dipping into a die, between which a clearance is left equal to the desired thickness of lead covering. Lead in a plastic or semi-solidified state is pressed between the point and die by a vertical hydraulic ram. The hauling-off gear for the cable is driven by an electric motor, so that the attendant standing by the press can regulate the hydraulic pressure with one handle and the speed of the haul-off with another close to it. In the design of the press, made by Messrs. P. R. Jackson & Co., of Manchester, several new details are embodied, we understand, so that a point and die can be changed (to use the press for a cable of different size) in 10 minutes. The lead is melted in a small gas furnace above the container of the press, and to this furnace compressed air is supplied by a compressor driven by a motor through single-reduction spur gearing. Immediately behind each press is a horizontal cylindrical iron steam-jacketed impregnating tank for paper cables, so arranged that the cable is fed off directly from the tank to the press, as the

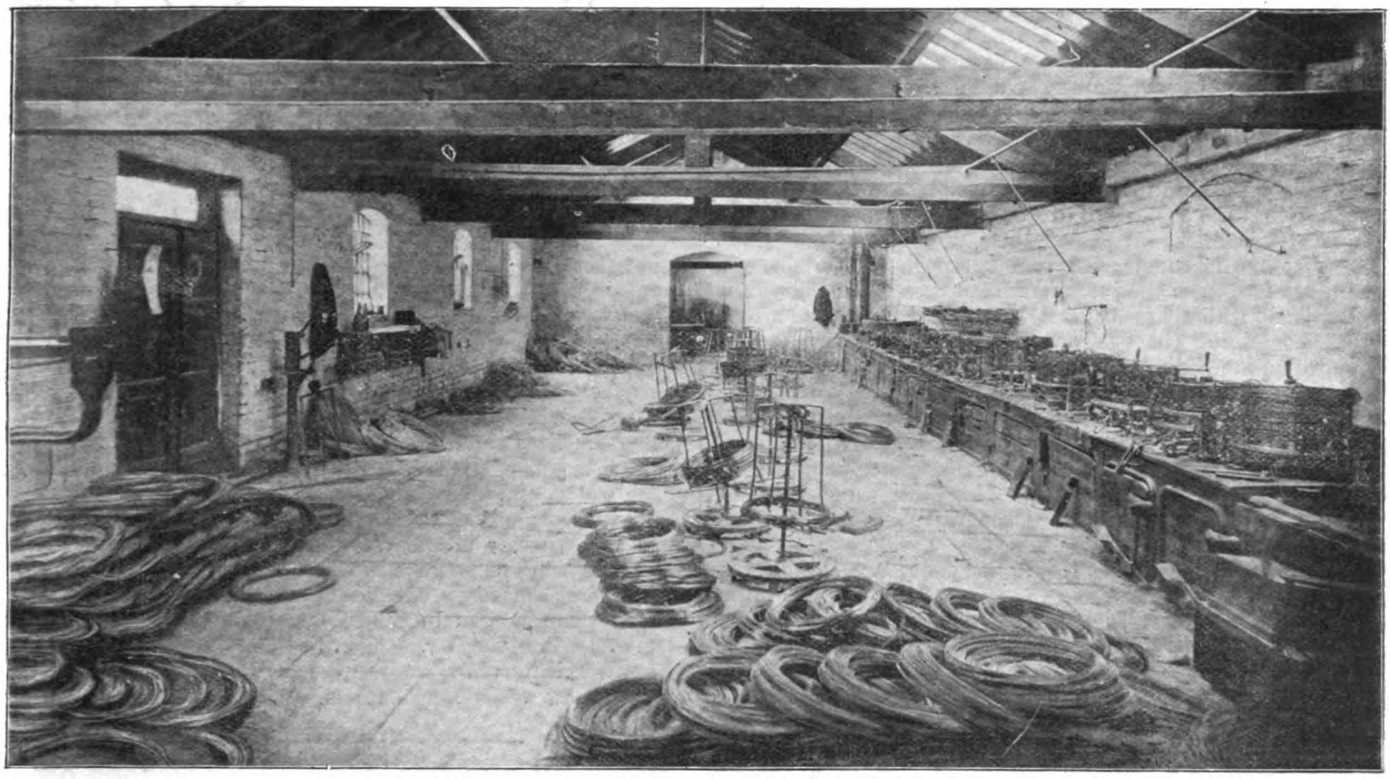

FIG. 7.—WIRE-DRAWING SHOP AT THE ST. HELENS WORKS.

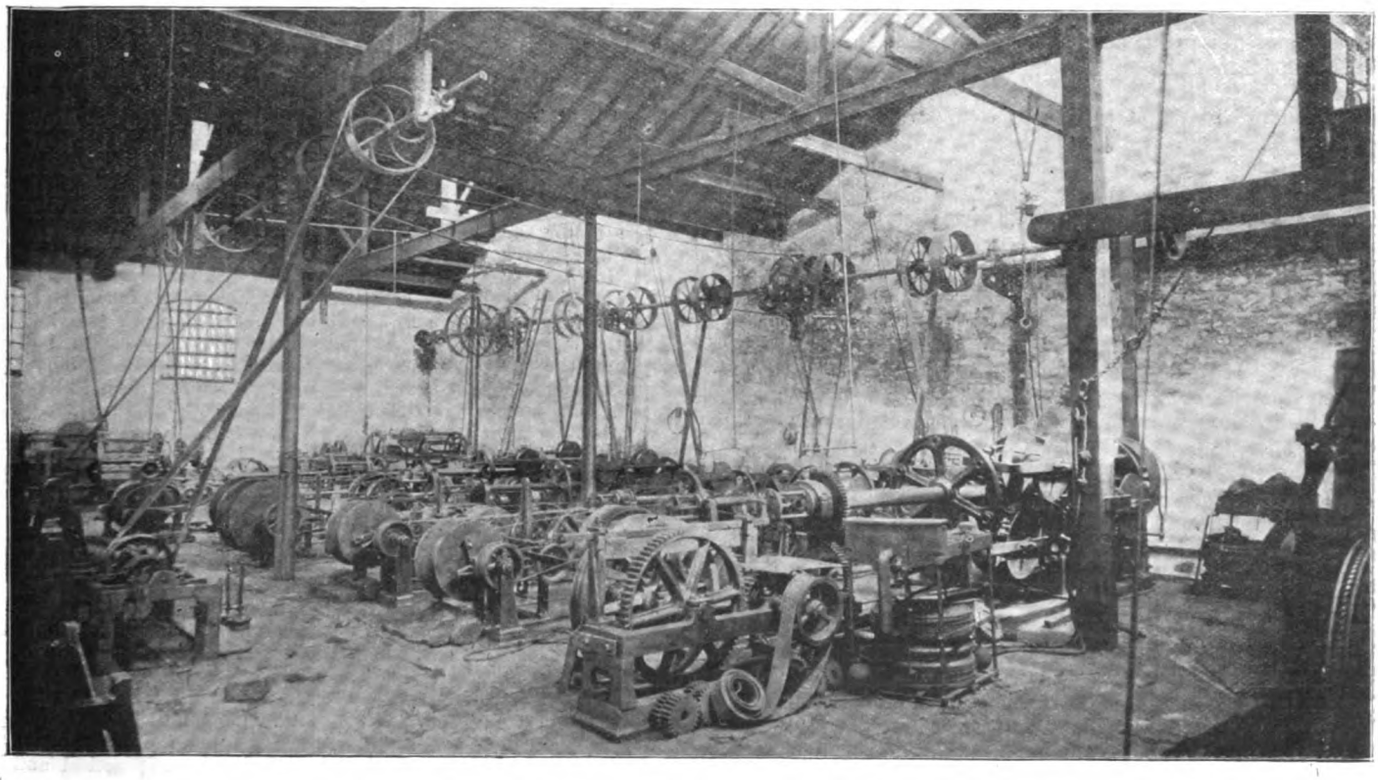

FIG. 8.—PART OF STRANDING SHOP AT THE ST. HELENS WORKS.

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drum can revolve on a horizontal spindle within the cylinder. While the cables are being impregnated in these tanks before lead covering, the drum is also kept revolving to maintain a constant circulation of the compound.

The serving machine is especially interesting. The discs on which the spools of yarn are fixed, known as the serving heads, are placed one on each side of the standard supporting the bearing, and thus the machine is of less length than those constructed for the same work according to the usual practice hitherto. It has also a new feature in a little pump which pumps the hot compound from a tank on the floor up through a pipe bent downwards over the cable, so that the cable itself drawn merely through a scraping-off die and is not itself passed through the compound tank. This machine is constructed to take spools of the size and shape received from the jute manufacturer. Fig. 5 shows the vulcanisers, which are vertical cylindrical tanks in which drums containing the rubber cable for vulcanising are put. The drums are merely barrels with annular flanges, so that two or more can be placed concentrically in the tank at the same time. The tank is then closed and dry steam is kept circulating through it until the vulcanisation is complete. Fig. 6 is a large triple-tandem stranding machine, used for concentric cables and armouring. It is arranged so that any of the three parts can be worked separately, independently of the others.

Several of the machines in all the shops are electrically-driven, usually in groups from countershafting, and the works are lighted electrically. A 200 H.P. single-cylinder engine drives the main shafting, to which the shops can be belted instead of to their motors. In addition, there is a 60kw. Lister two-pole overtype continuous-current dynamo belted to an Alley & Maclellan engine, and a 15kw. Ganz machine which can generate continuous or alternating current. From the alternating-current slip-rings the current is led to a step-up transformer in the testing room, where it can be transformed up to 40,000 volts. The transformers, made by Ganz & Co., are in four parts, each transforming up to 10,000 volts, and in each air insulation, and not oil insulation, is used between the secondary and core and between the secondary and primary.

For measuring the pressure, a Kelvin volt balance is employed, the largest which it has been our privilege to see. It is constructed on the principle usually adopted in the construction of this instrument by Messrs. James White, of Glasgow—viz., that of a disc attached to the one beam of a balance, and attracted by a fixed plate on glass supports. On the other side of the fulcrum is a counter-weight and a pointer moving over a scale. Two different constants can be obtained by changing the weights, so that a range of reading from 5,000 volts to 100,000 volts is possible. The distance between the plates is about 5in. and the lower plate has a diameter of about 8½in. The diameter of the outer case, to prevent the possibility of brush discharge, is about 4ft., and the height of the instrument over all is about 5ft.

The remaining testing room equipment calls for little comment. It was satisfactory to note that d'Arsonval galvanometers are employed instead of the four-coil moving magnet instruments which ought to have had their day in cable testing rooms at all events.

At the St Helens works of the St. Helens Cable Co., both copper and steel wire is drawn and stranded. These works cover more ground than the Warrington works—18,000 sq. yds.—although they are not so capacious, having no first floor. The copper is received from the rolling mills in the form of "copper bolts," which are coils of copper rod of about ¼in. diameter. This is submitted to a succession of drawings and annealing, being reduced about 15 to 20 per cent. in diameter each "draft." After each annealing the wire is placed in a pickling bath to clean off the oxides, the copper "bolt" also being treated in this way before drawing.

In the first shop of the main building are the copper annealing furnace and the pickling tanks already mentioned. In the next shop is a machine for flattening wire for the outer conductors of concentric cables; the wire passes between two hard steel rollers, the pressure on the wire being regulated by screwing down the upper roller. A tinning bath, next to this, consists of an iron bath containing the molten tin, and supported on a brick furnace; the wire is led through the bath, and the superfluous tin is scraped off by passing the wire through an iron die. Opposite the tinning bath is a "continuous" wire-drawing machine, of American design, the wire passing through a succession of six dies.

Next come the galvanising shop and another cleaning house, and beyond this the main wire-drawing shop (Fig. 7). The coil of wire or bolt is placed on a swift and drawn off cold through hard steel dies, the adjustment of which by means of a hammer and a set of punches to the exact diameter requires a considerable amount of skill.

There are in all 50 wire-drawing blocks, and in the stranding shop 14 stranding machines of various sizes. These are of the usual pattern, designed for quick running. Fig. 8 shows about half of the shop. The machines, as well as the wire-drawing blocks are driven from countershafting beneath the floor, and the engine (a 140 H.P. vertical compound with trip gear) is in a shed by itself. Its flywheel drives a transmission shaft through single-reduction spur gearing, the shaft passing underground to the main building.

One hundred and twenty hands are employed at the St. Helens works. Mr. W. J. Glover is the managing director of the works, and his cousin, Mr. R. B. Glover, manager. To the first-mentioned of these gentlemen and to Mr. Heyl-Dia, managing director of the Warrington works, our thanks are due for showing us over the two factories and patiently answering numerous questions. Cable is required for electrical work all over the country and in the colonies at a greater rate than ever, and there is plenty of room in the industry for energetic and enterprising works such as the St. Helens Cable Co. We wish the new works every success.

NOTES ON THE MAINTENANCE OF MOTORS ON HIRE FROM AN ELECTRICITY WORKS.*

BY C. A. L. PRUSSMAN.
(Borough Electrical Engineer, Doncaster.)

The principal factor in bringing about the steadily increasing day load of an electricity station is the electric motor, and, as a consequence, the amount of information relating to it has increased considerably during the last few years, so that much useful and interesting data is now available. A large number of Papers and articles have been written on it bearing such titles as "The Prevention of Sparking," "The Advantages or Disadvantages of using Smooth or Slotted Core Armatures," "The Use of Bi-polar or Multi-polar Machines," and "Carbon *versus* Copper Brushes." The result is that electric motors are now much more efficient and mechanical machines than they were only a short time ago. For instance, the life of the motor of to-day is considerably longer than was that of the motor of the early days, and the cost of repairs and maintenance over a given time is of course proportionately less. It has been proved beyond dispute that the electric motor is a thoroughly mechanical, efficient and reliable piece of machinery, and capable of adaptation to nearly every class of work in which motive power is required. Several of our electricity committees, acting on the advice of their electrical engineers, have commenced to purchase motors, which they are hiring out to customers at fixed rentals. The amount of the rental naturally varies in different towns, but whatever it may be fixed at, it must of course cover maintenance, inspection and depreciation, over and above the amounts included for interest, &c. The present Paper is intended to deal with the question of motors when owned in large numbers by a corporation and let out on hire to consumers. The author would not have thought of submitting to the Municipal Electrical Association a Paper on this subject had it not been for the fact that he held the position of assistant electrical engineer to the Bradford Corporation, under Mr. A. H. Gibbings, when the hiring-out system of motors was adopted in 1896. The three years during which he was connected with the Bradford undertaking and responsible for the testing, fixing, and maintaining of a large number of motors, gave him somewhat exceptional opportunities for observing the working of motors ranging from ¼ B.H.P. to 12 B.H.P., and when working under many different conditions. A few notes on the motor-hiring department therefore, when viewed entirely from practical and working conditions as regards maintenance and upkeep, may be of some little interest to members of this Association, particularly at a time when many station engineers are seriously considering the question of adopting some system of letting motors out on hire. The

* Paper read before the Municipal Electrical Association, at Huddersfield, June 21.

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anxiety as to the cost of maintenance of the motors on the part of many people would frequently seem to be groundless, the motor often being blamed when the blame might justly be placed elsewhere. As a matter of fact the motor itself seldom gives trouble of any description, provided it is chosen and fixed with due consideration to the nature of the work it is to perform, and that the starting arrangements are satisfactory. The starting switch is an item of vital importance, whose imperfections are often mistaken for the misdeeds of the motor. There are many manufacturers who turn out an excellent motor, but reliable starting switches are by no means so plenteous. Again, the few manufacturers who have a comparatively satisfactory motor-starting switch, standardise it, and make no other pattern or form, forgetting, it would seem, that if a corporation is to let out motors on hire satisfactorily, the motors must be capable of being used for all classes of work, and often it is absolutely imperative that not only the motor, but, what is as important from a maintenance point of view, the starter should be suitably designed for a given purpose. Probably there are many who will disagree with the opinion that standardisation in a department such as that now under discussion can be carried too far, but the author thinks that, of all things, starting switches are least capable of being standardised. A short reference to some of the cases with which the author has had to deal will go far to prove that a very considerable proportion of the maintenance charge is due not so much to the motor as to the apparatus and other causes external to it.

In the early days of the Bradford Corporation motor department shunt-wound machines were exclusively used, as it was then thought that this type of machine would best suit all requirements, and standardisation was considered desirable. Applications commenced to come in rapidly. At first it was found that the majority of motors were to be used for hoist and crane purposes, and hence it was frequently essential that they should be operated from any floor of the building in which they might be installed. Many of these buildings were six stories high. The motors in practically all these instances were fixed in the top flat or even in the roof. To ensure the starting of the machines from any floor a form of starter was employed, consisting essentially of two lead plates, falling by gravity into jars containing a dilute solution of sulphuric acid. The plates themselves were operated by means of a rope or chain carried to the entire height of the building. The speed of the plates when descending was regulated by means of a dash-pot, containing glycerine, the plunger having an adjustable valve. Primarily then the form of starter for all purposes was above the liquid form, and owing to the ease with which it lent itself to being operated from any floor, answered for some time admirably. One morning, however, the motor department staff was suddenly called out. A heavy frost the night before had so altered the density of the glycerine that the plates would not descend sufficiently to reach the short circuiting contacts, the speed of the motors falling considerably below what the consumers were accustomed to obtain, to say nothing of clouds of steam and acid spray, due to the rapid boiling away of the liquid. The dash-pot valves were then readjusted, and after a considerable time the whole of the complaints were remedied, and the motors were working again as merrily as ever. A few days later another similar call was made on the motor department. None of the motors would work! This time a sudden atmospheric change sent the thermometer several degrees above freezing point. The result was obvious—dash-pot valves wide open, lowered density of the glycerine, rapid short circuiting of the resistance, blowing of contractors' and Corporation main fuses, with the usual violent ringing of the telephone bell, and calls from enraged consumers. The rapid changes in temperature for some weeks caused very great trouble and expense, to say nothing of the annoyance to consumers, who promptly argued that electric motors were a failure. Experiments were next carried out with different oils in the dash-pots, and in many cases where there had been trouble with glycerine the substitution of oil cured it. Oil, however, had several drawbacks, the most troublesome of which was the unpleasant manner it had of dropping out of the dash-pot and generally causing a dirty, sticky mess on the working parts of the starters. The condition of affairs now arrived at was that in some cases the starters had glycerine dash-pots, while in other cases oil was used. The oil for some time gave little trouble. As the winter passed, the glycerine began to behave much more systematically, and curiously enough for many weeks little or no trouble was experienced from it, whilst the oil began to require greater attention. It may be incidentally mentioned before leaving liquid starters, that in no single instance was trouble experienced with the liquid in the jars freezing, and only a very small percentage of jars were broken, either in carriage, fixing or under ordinary conditions of use. Generally, however, it was decided that liquid dash-pots were not all that could be desired. The next step was the substitution of "air" dash-pots. These were not worked in conjunction with liquid for the resistance, as in deciding to abolish liquid in the dash-pots it was deemed advisable to endeavour to completely leave liquid of any kind out of the starter. This decision was come to on account of the evaporation of the water, the trouble experienced in keeping the liquid the right height and maintaining the conductivity constant. The new starters now took the form of a movable contact, falling by gravity along a series of contact studs, which in turn were connected to iron wire resistances. For some time the results obtained were most satisfactory, but a slight sparking on the contacts soon com menced to bring about worse troubles than ever, and in spite of many types of contacts being tried—among which were different forms of adjustable carbon contacts—the results were not entirely satisfactory. The author has not seen as yet a really reliable form of starting switch for working under the conditions given above, but when next he has occasion to use a starter for this class of work, he will feel much inclined to try the old liquid starter, with an air dash-pot, a combination as yet not attempted by him. With a more even temperature the starter difficulty lessened, and the next trouble to grapple with was the continual blowing o Corporation fuses, and all the attendant expenses. It will readily be seen that a very serious item of expense is introduced into the motor department if the inspectors are to spend half their time in climbing up and down the stairs of six storey buildings. The fuse trouble with crane motors for a time became very serious. The step first taken was to fix compounding coils on the existing shunt motors, the compound winding being arranged to assist the shunt coils. Four motors were first tried, and the number of visits of the motor inspector in the cases mentioned were greatly reduced. This was a most marked improvement, and the cost of maintenance of crane and hoist motors rapidly fell. In those cases where the load on the crane rarely varied and the motors were of such a size as to be well above their work, compound coils were not fixed, as no very serious trouble was experienced such as to warrant the extra expense in alterations to the motors. It is interesting to know that in spite of the somewhat severe conditions under which these motors were working in the early days, practically nothing was spent on the maintenance of the machines themselves, either in material or labour. In one or two isolated instances the commutators required attention, but nothing more than what emery cloth could put right, and such instances were distinctly attributable to the defective working of the starters. While the author has often heard the statement made that series motors give the best results for crane and hoist work, a well compounded machine, in his opinion, gives excellent results as far as a motor department is concerned, and the production of shunt motors, so arranged that compounding coils could be readily and easily attached, should they be required, might be worth consideration on the part of manufacturers. The size of motors used for hoist work was found to range generally from 4 B.H.P. to 6 B.H.P.

Leaving the question of hoist motors and starters, the next class of machines demanding attention was that in which the motors had a practically steady load throughtout the day. Cases of this kind were numerous, lines of shafting driving light machinery, such as sewing machines, small lathes, &c. Generally shunt wound motors were used except in one or two cases where compound machines were employed, the compounding opposing the shunt coils, when a particularly steady speed on a constant load was required. Many forms of starters were tried, the chief of which were the following: 1. Movement by means of worm and gear wheel, no automatic attachments of any kind being used. 2. Contact lever moving over contacts, and finally when all the resistance cut out, lever held in permanent position by small exciting coil, in series with the shunt coils of the motor. 3. Automatic overlaid attachment starters. Much has been said of late about the advantages to be gained by using overload automatic arrangements on motor starters. Taking our present example of a constant steady load, the following notes of experience obtained in Bradford with the three classes of starter named above, may not be uninteresting.

Using Starter Class 1.—It was found that only about 5 per cent. of the visits of the motor inspector were made on account of fuses having blown. Absolutely no trouble was experienced with the starter itself, as there is little doubt that a starter of this description can be made the simplest and most mechanical of all starters. The attention required was found to be less than in any other case.

Using Class 2.—It was found that 30 per cent. of the visits of the inspector were made on account of fuses having blown owing to too rapid operating of the switch, and another 20 per cent. on account of the exciting coils having either burnt out or being unable for various reasons to hold the contact lever in position. The latter defect often necessitated the complete removal of the starter and repairs to same. The commutator of the motor required considerable attention as compared with that necessary when using starter class 1, on account of the repeated heavy short circuits through the armature due to the fuses blowing.

Using Starter Class 3.—It was found that 6 per cent. of the visits of the motor inspector were made on account of fuses blowing, and another 15 per cent. owing to the automatic starters going wrong. Considerable attention was required to commutators. It will therefore be seen that where the motor has a steady constant load without repeated stops and starts being required, some form of starter which cannot be short-circuited too suddenly proves itself most efficient,

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while overload and automatic starters have introduced troubles without effecting any advantage.

The third purpose for which motors have been largely used is the driving of circular saws, planing machines, mortar mills, and comparatively heavy machine tools, &c.—in fact, all those cases where a fluctuating load of short duration is required, but where such load may for short periods amount to an overload of considerable magnitude. Further, in these cases it is only necessary to start the motor from one fixed point. That the question of the starter has an important bearing on the cost of maintaining the motor in a working condition will be seen in the following instance. In a joiners' and builders' works were installed two 6 B.H.P. motors and one 10 B.H P. motor; the two 6 B.H.P. motors were used to drive a circular saw and a planing machine respectively, and the 10 B.H.P. motor a mortar mill. These motors were started by means of starters coming under Class 1. The result was most expensive. A fuse was blown nearly every other day. Estimating this to involve five hours per week on the part of the inspector, which is well below the actual time, and assuming the wages of the inspector to be at the rate of 8d. per hour, it gives an expenditure per week of 3s. 4d, and to this must be added sundry items such as fuses. It will be seen from this that if expenses of this character are going to be incurred in many cases, an appreciable sum will soon be run up against the motor department. The starters were now removed, overload starters substituted, and the weekly expenditure fell from the above 3s. 4d. to 3d. In nearly every instance the same result was obtained, and it is surely evident that, in the face of actual results, it is not the right policy to adopt one class of starter for all purposes, but to judge each case on its merits and instal the motor and starter of such a type as to best suit the conditions under which they will have to work. By all means let manufacturers standardise so long as they standardise more than one type of starter. Again referring to the starters under class 2, in which only an underload automatic device is used—in theory this is all very well, and should prove of the utmost use, but the author's experience with them, when used on the mains of a supply station, which does not every now and then shut down, is that they are somewhat of a nuisance, and in some cases where the field circuit is accidentally broken when the motor is running, it will often be found that the fuse will blow and the release on the starter will come back to its "off" position. The automatic *overload* starter in many cases is of the utmost value, and effects a very considerable saving to the motor department. The minimum automatic starter has proved to be more troublesome than otherwise if not combined with an overload arrangement. Before leaving the question of starters it may be mentioned that a great fault to be found in starters generally, and particularly in many of the later types of the automatic ones, is the very small margin allowed in the resistance wire. In many places it was found that long before the motor was running up to speed, the starter was acting more as an electric heating appliance than a starter, which, while useful in its way, is hardly the function for which the starter was installed. The starter of to-day is too electrical and not sufficiently mechanical.

Turning from the troubles caused by the motor starters we come to some of the principal difficulties that were experienced with the motors themselves apart from those caused to the motors by defective starting apparatus. Motors from ½ B.H.P. to 3 B.H.P. were found to give more trouble by some 30 per cent. than those ranging from 4 B.H.P. to 12 B H.P. By more trouble is meant that for every 100 visits of the inspector to the larger sizes some 130 would have to be made to the smaller; assuming each visit to take 1½ hours at 8d. per hour, we get £5 for the larger motors as against £6. 10s. 8d. for the smaller, the number of motors, of course, being equal in both cases. Looked at in another way there is an expenditure in the maintenance of the small motors of much greater magnitude per £100 of capital expenditure than in the larger motors. Motors geared to their work by means of spur gearing were found to cost in maintenance practically the same as when belted, there being only a difference of 3 per cent. or 4 per cent. in favour of the belted machine. Very few armatures of motors of 4 B.H.P. and upwards burnt out under ordinary working conditions. Exceptions, however, are taken to several cases where the faults have been due to defects in the design and manufacture, but as the whole of the expenses were in all these instances borne by the manufacturers, it would not be fair to include them in the maintenance of the motors. With small motors up to 3 B.H.P. over 100 per cent. more armatures were burnt out than was the case with the large machines, and in several instances the cost of rewinding had to be borne by the Corporation, as it was quite impossible to assign any reasons for the burn-outs other than those due to ordinary wear and tear and depreciation. The most exceptional case of armature burn-outs which came under the author's notice was that of the armature belonging to a 10 B.H.P. shunt-wound enclosed motor driving a line of shafting. In this instance eight armatures burnt out or rather broke down within 14 days. The cause was ultimately found out by the manufacturers, and it is only fair to add that it was largely due to circumstances over which they had practically no control. The whole of the large expense was defrayed by the manufacturers, who did their utmost throughout to investigate and remedy this remarkable instance of armature trouble. A large number of exactly similar machines had been working for weeks in other consumers' premises without giving any trouble whatever. Breaking down of field coils was a very rare event, but here again the small motors account for 150 per cent. more failures than the large ones. When the motor department was first commenced open type machines were used, and several shunt coils had to be replaced on account of external injury which in all cases except one were caused by the consumer and replaced at his expense. In two cases armatures of 6 B.H.P. motors were completely wrecked, (1) through a consumer letting a spanner fall on the revolving armature, and (2) owing to a box catching a brass armature guard and so throwing it out of position as to cause the sharp corner of the guard to catch the armature wires with the result that nearly every connection to the commutator was cut. Needless to say in both cases the consumer had to defray the expenses of repairs.

The above remarks show what an enormous advantage the enclosed motor has over the open type in view of the great risk there is of external injury to the latter. Apart from this point and the objections raised to the open machine by the fire insurance offices, there is much to be said in its favour. This opinion will doubtless be considered antiquated and out of date, but the cost of maintenance of these open type motors was found to be less than that of the enclosed, and for cool running they certainly are superior to the enclosed motors, many of which become merely cooking stoves after a four or five hours' run on full load. While fully believing the enclosed motor is the motor of the future, there are nevertheless features about the open type machine of a very desirable character, and which are not possessed by the enclosed type.

Commutators and sparking at the bushes were the causes of considerable expense, and in a number of instances armatures had to be removed and the commutators returned. Defective and inefficient brush gear was responsible for a large amount of trouble, augmented in some cases by vibration due to poor foundations, screws, nuts, &c., becoming loose and, consequently ineffective. The greater part of the expense incurred through attention required to commutators may be avoided, if suitable and efficient starters are available, and if the foundations are of a rigid and solid nature. The passing and inspection of motor foundations will be found to play a most important part in the maintenance account. Again and again has it been shown that any sort of foundation will not do for motors, and the importance of the foundations complying with the Corporation requirements cannot be over-estimated. In those cases where the Corporations lay the necessary foundations and charge consumers with the expense, the vibration difficulty disappears to a great extent, together with many of its attendant consequences. There are instances however where it is impossible to completely obviate vibration, whatever precautions are taken in laying the foundations. There was an instance, which once came under the author's notice, where a 12 B.H.P. motor was fixed in the top room of an exceptionally high building, the peculiar shape of the structure of which made it impossible to get a really solid foundation. Work, which required very exact setting out, was proceeding in the same room, and the vibration of the motor was likely to prove absolutely fatal to the adoption of this form of driving. The particular motor installed was of a design in which the armature shaft was a considerable height from the floor. A second motor was tried in which the bearings of the armature were much lower than in the first machine. The effect on the vibration was most marked, so much so that no inconvenience was experienced from it, and the adoption of electric driving has proved a wonderful advantage to this consumer.

Bearings running hot gave much less trouble than was to be expected, and again the small motors must stand the charge of causing considerably more trouble than the larger ones. As a rule the trouble could be traced to some definite cause, such as grit getting into the bearing, or the machine not being properly lined up to the driven pulley, or damage to the oiling arrangements. Other troubles at intervals would show themselves, such as terminal screws, &c, working slack. The clamping arrangements for holding the brush rocker in position on several occasions became loose, the result generally being the blowing of the fuse or the release of the overload attachment. Insulating bushes and washers would crack or sometimes soften from the heating of the motor, particularly the bushes, &c., used on the brush rockers in some types of machines. In one case a 10in. pulley bolted on to a flywheel worked loose on the shaft, but fortunately it was discovered in time to avert what might have been a serious accident. Generally it was found that very little trouble and expense was incurred in keeping the motors in thorough working condition, but it should be noted that all motors were thoroughly examined and tested at the station on delivery from the manufacturers and before sending out to be fixed on consumers' premises, and these examinations frequently revealed defects of a nature hardly to be expected in machines sent out by manufacturers of repute. Motors without terminal screws, terminal screws that

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would not fit, sweating sockets missing, washers broken, portions of brush gear missing, &c. A practice was always made of carrying out an inspection, first for mechanical details, then electricity, and finally the motors and starters were tested for efficiency, heating, insulation, &c. It was no doubt largely due to this thorough overhauling at the supply station, that much trouble and annoyance was saved when the motors were finally fixed in consumers' premises.

It was the author's intention to include a table in these notes giving particulars as to the sizes, causes of defects when used for driving different classes of machinery, &c., of the motors he has had to deal with, but want of time has prevented him from getting this done. The foregoing remarks may, however, prove of some little use, if only in helping to show that when properly organised and worked, a Corporation motor hiring department is not a scheme which need cost excessive sums for its maintenance in thorough working order. The very great advantages of a motor load and the great success which met the Bradford Corporation's enterprise in this direction, managed by its late engineer, Mr. A. H. Gibbings, are now too well known to require any comment on the present occasion. The maintenance of the motors, it has been said, would prevent such a system ever becoming successful. If this Paper has done ever so little to dispel this idea and to show where some of the cost in maintenance is likely to be encountered, the author will feel amply rewarded.

The following is an abstract of the joint discussion on the above Paper and Mr. T. P. Wilmshurst's Paper on "Power Supply by Single-phase Motors." The latter will be found in our issue for June 6th :—

Mr. S. Z. DE FERRANTI (Hollinwood) said he thought that the subject of Mr. Wilmshurst's Paper was a matter of the very greatest importance to a large proportion of central station engineers, and a matter of vital importance to ratepayers owning alternating-current stations all over the country. It was felt that the alternating-current supplies were handicapped from the commercial point of view very much in relation to the continuous-current supplies. This was due, as Mr. Wilmshurst had pointed out, to certain defects in the system ; one of these defects was the question of motors, but he thought this would be more easily solved than that of arc lighting. The statement that alternating current was less economical in working than direct was generally believed, but, of course, it was not really so. The trouble with arc lighting was perhaps the most difficult one, but when one saw how generally enclosed arc lamps were coming into use, and when the figures of the working of these were taken, one had to go but a little bit further with the incandescent lamps in order to show that there was little in the ordinary arc lighting of shops and private premises from the commercial point of view. The efficiency of these enclosed lamps according to many tests which had been made was exceedingly low, and good incandescent lamps ran them very close. With regard to the public lighting of the streets he did not think there was any disadvantage in the alternating-current system because it could be specially dealt with, and even when one had continuous current there were disadvantages against the use of continuous current for lighting a circuit of four or eight lamps fed from different parts of the low-tension mains. Many people thought that for motive power the single-phase alternating current was played out, and that they would have to change either to continuous current (which certainly had great advantages for certain purposes) or to put down a multiphase system in place of the single phase. He had gone into the matter very carefully, and could not see any reason for putting down a multiphase system. To change the system of distribution to a two-phase system was very costly, and would not give any commensurate advantage for the expenditure involved, nor would it give a system which would be as satisfactory to work as the plain single-phase supply. There were distinct advantages in changing from single-phase to continuous current, but the advantage of multiphase over single phase did not warrant change. There was some information given in the Paper, however, which showed the good starting capacity and the very good efficiency of single-phase alternating-current motors. He had been struck with several of the installations where these motors had been employed. He had noticed a little while ago at Paisley a single-phase motor used for driving a centrifugal pump for condensing work at the station. Nothing could be better than the perfect ease of starting, the way it ran up to speed, and the way it dealt with the pumps. The motor was a beautiful piece of mechanical construction, and its operation was quite perfect. There were many motors coming on to the market which had good efficiencies, and it struck one that these were better than the continuous-current motor with its commutator, &c. There was no doubt about the advantage of distributing over a large area with the single-phase system, but it was handicapped in a few points which had yet to be solved. It remained with them to form an idea how soon these disadvantages would be got over. He had been using a condenser in connection with a single-phase motor, and when this could be put on the market at a fairly low price, then the alternating single-phase system, so far as motive power was concerned, would have accomplished the last step necessary to put in on an equality with continuous current, and the single-phase motor will really then be able to accomplish with high efficiency and good power factor all that one could wish. The advantages of a plain single-phase supply are so great and so undisputed that he was sure it was worth everyone's while to remove the objections rather than say the system is bad and should be replaced by something else.

Mr. S. E. FEDDEN (Sheffield) said the problem before them in Sheffield was, how they should supply their consumers with power, and he hoped this was solved by Mr. Wilmshurst's Paper, as he stated that with single-phase motors they could run lifts and do almost anything they required. He did not agree with Mr. Wilmshurst, however, that enclosed alternating lamps were as good as continuous-current lamps. He thought single-phase current should be run through rectifiers for arc lamps. In Sheffield they had one consumer who had a very large number of lights and motors, and he had requested them to supply him with continuous current, so they had fixed a motor generator for this purpose. This motor ran very well after it had got into synchronism ; but it took some time to do this. He was anxious to learn all he possibly could respecting the single-phase motor, as if he had to instal continuous current plant it would mean an enormous amount of capital expenditure.

Mr. W. A. CHAMEN (Glasgow) said he was very pleased to hear of the prospects which the alternating single-phase works had before them, but he was glad he had not the problems connected with this system to deal with himself just now. He thought Mr. Prussman's Paper was a most valuable one to those who were considering the question of hiring out motors. He believed that the liquid switches referred to had been superseded by resistance coils and more economical kinds of apparatus.

Mr. W. LANGDON DAVIES (London) said he could thoroughly endorse the difficulties which have had to be endured by those who had tried to instal single-phase motors on their circuits. The trouble, however, in many cases arose through the circuits not being sufficiently large, as they had been laid simply for lighting, and no allowance had been made for motive power. Unless the motor could be provided with some kind of storage it was impossible to get the power factor above a certain point, and therefore they were bound to have a certain amount of wattless current. There were in England some 15 different periodicities, varying from 40 to 100 ∽ per second, and a motor to be designed to its very best should be designed for the periodicity of the mains upon which it is to be run. It was impossible to keep stocks of motors for all the different periodicities, and it sometimes happened that the motor supplied was not at all suitable for the periodicity of the particular mains.

Mr. R. C. QUIN (Blackpool) had had experience with both single phase and continuous current. In comparing the two systems he thought the palm for elasticity and general purposes, apart from power, must be given to single-phase alternating current. New life had been given to continuous systems by the increase of voltage. Mr. Ferranti had told them of a two-phase motor to be applied to the single-phase motor, which he (Mr. Quin) had no doubt would be accomplished before long. In Blackpool they ran their machines in parallel, but the result was that the wave form of their curve varied minute by minute, and consequently single-phase motors were not a success with them.

Mr. W. B. ESSON (Johnson & Phillips) said the difficulties encountered in using the single-phase motors in the past were largely due to the engineer not specifying that the generating plant was required for power. Some of the generators at many stations had a drop of 20 to 30 per cent., and under these circumstances it would be difficult to suppose that with these alternating motors would run satisfactory. What was required, of course, was to raise the power factor. From the engineer's point of view the motor with a power factor of 90 per cent. and an efficiency of 80 per cent. is a better machine than with a power factor of 80 per cent. and an efficiency of 90 per cent. With reference to multiphase supply he disagreed entirely with Mr. Ferranti. To convert a single-phase machine into a two-phase machine was a very simple matter, and the extra cost would only be about 5 per cent. The advantages he considered were great as the system was absolutely flexible. With the two-phase system he considered it was a very simple matter to supply either alternating or continuous current. It was a great consolation to him to know that some kind of a condenser was commercially possible. He was sure, however, that the single-phase motor plus the condenser was no comparison whatever with the multiphase motor with regard to the risk of breakdown.

Mr. H. FARADAY PROCTOR (Bristol) asked Mr. Ferranti what would be the relative advantages of high and low periodicities in conjunction with condensers ?

Mr. S. Z. DE FERRANTI said that he did not see any chance for high periodicities so long as it was left high periodicity. He thought they should have the high periodicity reduced to low, and he was glad to say that he did not think it would be as expensive a matter as at first thought.

Mr. A. S. BARNARD (Hull) asked Mr. Quin if he took the 500-volt current straight from his trolley wire into a private house ?

Mr. R. C. QUIN replied that there was no law by which they were not allowed to take high pressure into a house.

Ald. WOODHEAD (Halifax), Councillor J. P. SMITH (Barrow-in-Furness) and Mr. C. S. VESEY BROWN (Lincoln) also spoke.

Mr. T. P. WILMSHURST (Derby), replying, said that Mr. Esson overlooked the point of view of the station engineer, who may possibly have to scrap £50,000 worth of plant. The single-phase motor may not be the best motor on the market, but it was not sufficiently inferior to the continuous or two-phase to warrant any change. He would rather have the alternating single-phase or two-phase motor than the continuous. He thought, on reading Mr. Prussman's Paper, it was a confession of failure all the way through for continuous motors, and he felt he was glad that he was not a continuous-current engineer. With reference to arc lighting he had both alternating and continuous lamps at Derby, and he preferred the alternating lamp from the point of view of trouble and the light which the lamp gives.

Mr. C. A. L. PRUSSMAN (Doncaster), in reply, said that, regarding starting switches, he considered it was better to make a variety of switches, more particularly than to trouble about the question of cost. In some cases an overload switch was necessary. He thought there was a danger in the manufacturers quoting their motors and switches in one price as there would be a danger of having to take one particular type of starter always. He thought if Mr. Wilmshurst compared the number of motors on alternating-current mains with those on continuous mains then the percentage amount of trouble would be in favour of the continuous current.

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

All Editorial letters to be addressed to The Editor.

All letters for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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RIVAL SYSTEMS OF ELECTRIC POWER.

The impetus which has been given of late to the development of electricity for motive power purposes in this country has apparently divided the electrical profession into no less than four rival camps, each prepared to defend its chosen motor system against the onslaughts of the other three. The battle of the motor systems has been called a duel, because of the rivalry between continuous and alternate-current systems; and it has also been called a triangular duel, because alternate-current men are divided into single-phase and polyphase advocates. But, as a matter of fact, it is a four-sided duel, if duel it be at all, for the polyphase men dispute among themselves the relative merits of two-phase and three-phase systems, a dispute which involves not merely a matter of detail but essential differences in the design. We are speaking now of motors, and motors only; it is on the question of the type of motor to be recommended to consumers that this four-cornered fight is taking place. Were we to consider, not merely the motor, but the entire system of generation, transmission, distribution, and motor working, we should discover curious compacts and tacit understandings between the various foemen. For instance, some are on the polyphase side when it is a question of generation and transmission, but transfer their allegiance to the continuous-current camp when the motor question arises. Others are consistently and staunchly polyphase right through; while others are equally consistent in their allegiance to other simple systems. The permutations and combinations of the four ordinary arrangements promise, therefore, to provide an almost endless variety of practice in the immediate future, and to afford ample opportunity to consulting engineers to display ever varying ingenuity before their distracted clients. What the best interests of the profession call for, however, is not such a condition of things as this, but rather that engineers should ascertain with as little delay as possible what is really the best system for any given set of conditions. Simplicity, uniformity and standardisation in practice are *desiderata* to be aimed at by consulting engineers who may design electricity works in future, rather than an ambitious display of originality—troublesome to the contractors, costly to the clients, and exasperatingly disappointing to posterity.

Returning to the question of motors, it is worthy of note that certain prominent engineers are the undoubted believers in the universal applicability of the system each one may champion; whereas others are only the advocates of a given system because it seems best to suit an already existing condition of things. Mr. Ferranti, for example, is the

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undoubted champion of the single phase motor; Mr. Esson is not less valorously the champion of the two-phase motor; Mr. Chamen is the staunch advocate of continuous currents; whereas, on the other hand, Mr. Wilmshurst, the municipal electrical engineer at Derby, is an advocate of the single-phase motor only, because to introduce it into Derby is less costly than to convert the existing single-phase system of distribution into a polyphase or continuous-current system. This aspect of the matter is presented in his Paper on "Power Supply by Single-phase Motors," read by Mr. Wilmshurst at the recent convention of the Municipal Electrical Association. The conditions of supply at Derby, however, are specially favourable to the use of single-phase motors, as compared with other alternate-current works in this country; for there is a lower frequency there than in any other system, the frequency being only 40~. Even Mr. Ferranti had to admit, in the discussion which took place on this Paper, that single-phase motor working is hopeless where the frequency is high. Mr. Faraday Proctor, who extracted this confession, probably had his own system at Bristol in his mind, and must have felt justified in laying down continuous-current plant for the power supply of that city. Everyone will agree that a satisfactory electrostatic condenser would place the single-phase motor in a much more advantageous position than it is at present. But the admission does not do the single-phase motor much good, since no satisfactory condenser is to be found on the market. Mr. Ferranti's assurance that he possesses—indeed, has owned and worked for over four years—a condenser possessing all the requirements of durability, &c., is encouraging to engineers who, as controllers of existing single phase plants, can see no way of converting to a system better adapted to power supply; but we question whether it will cause one moment's hesitation to those who contemplate laying down polyphase plant. To the single-phase motor a condenser is almost a necessity of existence; but the condenser, even when perfected, will fall far short of raising the single-phase motor to the rank of the ordinary polyphase motor. The single-phase motor is doing good work, in a restricted way; factories are being driven by it, and it has shown itself useful in a variety of cases where other electric power could not be obtained. But it has not the elasticity and ease of the polyphase system. In fact, where motor power work alone is to be carried out, or wherever the load is chiefly due to motors, experience, we think, has already abundantly shown that the polyphase systems are superior to any other; but where the load is largely due to electric lighting, practice, we believe, will for some time to come be divided between polyphase and continuous-current systems, or will consist in a combination of the two.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Æther and Matter. By Joseph Larmor. (Cambridge University Press, 1900.)

All Nature, so far as physical investigation extends, consists of æther (why need one be bothered with that inconvenient diphthong? ether is much easier to write) and matter, and consequently Mr. Larmor's treatise naturally touches on an immense variety of fields. The basis of our theories of light, electricity and magnetism, chemical action, electrolysis, aberration, the Zeeman effect, are all touched on, together with a discussion on the Scope of Mechanical Explanation, and on the Idea of Force. It will thus be seen that it deals with questions which lie at the basis of our whole conception of the physical universe, and of our methods of explaining its phenomena. It would require more space than could reasonably be accorded to a review, and more time than the readers of *The Electrician* would mostly care to devote to the subject, to discuss in a way that could be followed the questions raised by Helmholtz, Hertz, and Larmor as to the sufficiency of the principle of least action as a basis of our mathematical analysis of physical phenomena, but the readers of *The Electrician* may naturally feel an interest in many of the questions dealt with in this important work.

In dealing with the phenomena of electromagnetism we may consider ether and matter as all one medium with different properties in its different parts, some parts being insulating and some conducting, some having one permeability and some another. In such a treatment it is not necessary to look for an explanation of these properties, and such a treatment covers a large number, indeed a *very* large number, of the phenomena. It is the method employed in our ordinary treatise on electromagnetism, and is quite sufficient for most purposes. But just as dealing with light as propagated in rays is a most useful method in optics, but breaks down when we study the subject more profoundly, so we are driven by many electro-chemical phenomena, by the electric discharges in vacuum tubes, and by a number of other phenomena in which the relation of molecules and atoms of matter to the ether is involved, to form some more definite hypothesis as to the connection of ether and matter than the simple one that we are dealing with—a single continuous medium with different properties in different parts. Ever since Faraday discovered the law of electrolysis, that to the rupture of each chemical bond there corresponded the transference of the same quantity of electricity, no matter what the kind of bond might be, it has been in the scientific air that electricity as well as matter may be atomic. Maxwell, in this connection, was driven to use the term atom of electricity, although he deprecated it as quite contrary to the whole spirit of his treatise, but it is now recognised largely, thanks to Mr. Larmor and to Prof. Lorentz, of Leyden, that so far from this idea being contrary to the spirit of Maxwell's treatise it is in reality quite compatible with it, and from some points of view even essential. Mr. Larmor's book is mostly concerned with an elaboration of this view of the nature of electricity. He supposes that these atoms of electricity, or electrons, as Mr. Stoney called them, produce the phenomena of electric currents by their motion, and either move from molecule to molecule of matter, as in ordinary metallic conduction, or along with the atoms of matter, as in electrolytic conduction. To suppose that an electric current consists of opposite streams of positive and negative separate electrons instead of a continuous process taking place at all parts of a conducting wire necessitates a rather complicated study of the equations that are ordinarily used; and this is one of the matters that Mr. Larmor devotes attention to, with the result that he finds that all the ordinary equations are applicable to the theory he is investigating, to the degree of accuracy attainable by our existing methods of studying the phenomena. It seems, however, pretty certain that if an electric current consists in the motion of separate electrons it cannot be *exactly* equivalent to a current uniformly distributed over the conductor. The self-induction of a current that runs in a set of separate wires is somewhat greater than that of a current uniformly distributed over the same area as that occupied by the wires, and one would consequently expect a small difference between the calculated and observed self-inductions of a coil, if this electron hypothesis be true. Hertz looked for but failed to detect anything of this kind. The effect to be expected is so very small that even he may very well have been unable to find it with the appliances at his disposal.

Mr. Larmor's fundamental treatment of the subject enables him to discuss effectively the changes in electric and magnetic phenomena that may be expected to arise owing to the motion of matter through the ether. In one of the appendices he enters into a discussion as to how this is possible when the ether is a medium that transmits transverse vibrations. The only other media we are familiar with that transmit transverse vibrations are solids, through which we cannot in general move without resistance. He shows conclusively that the suggested expla-

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nation of Sir George Stokes that the ether is like a very soft solid is untenable on account of the existence of aberration, and the absence of any evidence of slipping of the earth through the ether with the consequent irregular distribution of relative velocity over its surface. His theory practically assumes that matter can move through the ether much in the way that a drop of liquid water can move through a lump of ice, namely, by melting in front and freezing up again behind. Upon this class of theory matter and electrons are centres of some peculiar strain in the ether, and when they move it is this strain that moves like a wave through the ether, whether with a central core like the core of a vortex ring, or without one is not finally decided. The general conclusion at which Mr. Larmor arrives is that no terrestrial experiments yet devised can decide whether the ether is or is not stagnant near the earth, because the phenomena would be exactly the same so far as our existing means of observation are concerned, whether the observer and all his surroundings were standing still relatively to the ether, or were moving with such velocities as 20 miles a second, which is comparable with that of the earth in its orbit, and is the greatest at our disposal. In order to reconcile this with the result of Michelson and Morley's classical experiment he has to assume that the length of a body depends on whether it is moving lengthwise or sideways through the ether. To justify this he shows that, if the laws connecting the forces between material atoms vary with motion through the ether in the same sort of way as those between electric charges do, then just the required change of length that experiment demands would occur. This seems to make it practically certain that Michelson and Morley's experiment is really a very accurate measurement of the change of length of a body as it moves in different directions through the ether. As this theory would require that a diameter of the earth should only change by about 10cm. as it moves in different directions through the ether, the extraordinary delicacy of Michelson and Morley's experiment is made evident. It is to be regretted that no effect other than aberration and the change of frequency of light waves, due to the relative motion of the earth and the ether, can be detected; for, if any considerable change in electromagnetic forces due to this cause existed, there might be some hope of our being able to utilise this relative motion to drive engines, and thus obtain a source of power practically unlimited in amount, and confined to no one part of the earth.

The book consists of 15 chapters and six appendices. The 15 chapters are substantially the same as the work to which an Adams prize was awarded to Mr. Larmor in 1898, and contain, in addition to the subjects already referred to, discussions as to the effect of the motion of the medium on the transmission of light through it, as to the nature of Röntgen radiations, and as to the pressure that light exerts on bodies that reflect or absorb it. The appendices contain an admirable summary of the relation of electrolytic conductivity to ionic theory and electric osmosis, and a short account of the theory that explains thermo-electricity by the motion of electrons. In Appendix E. Mr. Larmor develops a theory as to the intrinsic nature of an electron that is most interesting and suggestive, even if not in every respect unassailable. Advance, however, would be impossible if every hypothesis were relegated to the lumber heap that appeared open to serious objections. The wave theory of light was long discarded on account of the difficulty felt in reconciling it with the rectilinear propagation and the polarisation of light, and even yet some difficulty attaches to it on account of the free motion of matter through a medium that transmits transverse waves. Yet the difficulty does not, fortunately, prevent our accepting the wave theory of light as even more than a working hypothesis. Mr. Larmor does not claim more than this for his suggestion as to the nature of an electron.

The last appendix contains an account of most of what is known as to the theory of the Zeeman effect and its connection with Faraday's discovery of the effect of the magnetisation of a medium in rotating the plane of polarisation of light.

In all its parts the work is most interesting and suggestive, though in many places so condensed and general in its language as to be very difficult to follow. It marks a distinct advance in the scientific treatment of electromagnetic phenomena and important developments of our knowledge of the connection between matter and ether.

GEO. FRAS. FITZGERALD.

Die Einrichtungen zur Erzeugung der Röntgenstrahlen, und ihr Gebrauch. By Dr. B. DONATH. (Berlin: Reuther and Reichard, 1899.) 4.50M.

There is a large amount of information to be found in this book: sound information of a practical sort, and—mostly German. Indeed, if the work had for its object alone the advertisement of German apparatus, it might be said to have fulfilled its purpose exactly, for, in discussing the merits of the various coils, vacuum bulbs, and so forth, there appears to have been a deliberate effort to avoid adequate reference to the work of other nationalities.

The first few pages deal mainly with elementary ideas relating to the action and function of primary batteries and their connections, while at the end of this first chaper we are introduced to a summary of the matters referred to therein. The plan appears to be useful: it is certainly thorough, and being adopted throughout the book, forms, with the table of contents and index, a ready means of rapidly co-ordinating a reference. The practical aspect of the work begins to appear in Chapter II., where the details of both primary and secondary battery design are discussed and illustrated. On page 28 the first word is spoken as to electrical induction, and descriptions of various induction coils follow naturally. But one might not expect to find, outside an instrument maker's catalogue, such a profusion of illustrations and references to contact-breakers or current interrupters as is given in the fourth chapter of this book. We found there descriptions of between 20 and 30 slightly different interrupters, accompanied by as many well-executed drawings of the instruments. The majority of these devices make use of mercury in some manner or other, and many of them are ingenious. The electrolytic interrupter is given considerable prominence. We do not know of any other work on this subject that gives such a complete account of methods of interrupting the primary current of induction coils.

The more subtle properties of the vacuum bulb are next described, and a rapid survey taken of the progress of researches relating to the matter, but the illustration on p. 77 of a Röntgen lamp in action is unsatisfactory. It is well known now that at low pressures the cathode stream emanates almost entirely from the central part of the hollow negative electrode. The question of regulating devices for varying the gas pressure within exhausted bulbs is briefly discussed, and in Chapter VI. we again find numerous illustrations and references to apparatus for use with the induction coil and Röntgen lamp. Resistances, ammeters, and stands for holding the exhausted bulbs are there fully described. The actual process of taking a radiograph is not omitted, while considerable space is devoted to purely photographic details. It is surprising, however, to find no reference to Mr. Mackenzie Davidson's work in connection with the localisation of foreign bodies embedded in the tissues, for he has done more than anyone else to place this matter upon a practical basis.

In the last 20 pages of the book Dr. Donath gives an account of researches undertaken by numerous physicists to ascertain the "nature of Röntgen rays," and this concluding chapter has been excellently done. The various well-known theories are there set out with clearness, and their merits discussed without allowing this portion of the work to overshadow the rest of the book. There is a good sense of proportion evident throughout the whole compilation, and we commend it to all who have an interest in the fascinating study of this branch of electrical physics.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Reports to the Malarial Committee of the Royal Society, 1899-1900." (London: Harrison & Sons). 2s. 6d.

"The Official Gazette of the United States Patent Office." Nos. 12 and 13, Vol. XCI. Published by authority of Congress. (Washington: Government Printing Office.)

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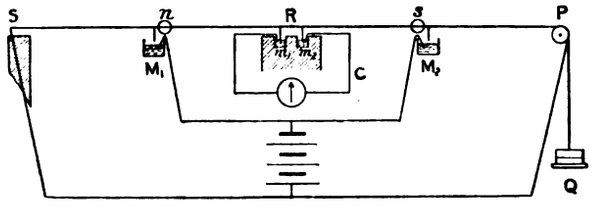
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Anomalous Electromagnetic Dispersion.—As in optics, so in the domain of electromagnetic radiation, the angle of refraction varies with the incident wave-length. In some chemical substances the dispersion does not vary continuously with the wave-length, but changes abruptly at certain points, and then we have anomalous dispersion, as in the solutions of certain copper and chromium salts, and, according to Kundt, in iron, nickel and cobalt. Recent researches have shown that these anomalies are invariably found in the neighbourhood of absorption bands, and the experiment of Macaluso and Corbino, first supposed to indicate an inverse Zeeman effect, has since been connected with the anomalous dispersion of sodium vapour in the neighbourhoud of the D lines. A. Schmauss has made some measurements of the electromagnetic rotatory dispersion in the fuchsine solutions and in didymium glass which justify the general conclusion that optical anomaly in dispersion is invariably associated with electromagnetic anomaly. In strongly absorbing media the anomaly extends for a considerable distance on both sides of the absorption band, and it increases with the concentration and with the narrowness and sharpness of the absorption band.

[A. Schmauss, *Ann. der Physik*, No. 6, 1900.]

A String Alternator.—K. Honda and S. Shimizu have invented a simple contrivance for converting a continuous into an alternating current whose frequency may be readily varied within wide limits. It is a modifiation of Pupin's interrupter, and its construction is evident from the diagram. A copper or aluminium wire is stretched horizontally, one of



the ends being fixed to a stout support S, while the other, passing over a small metallic pulley, P, is attached to a weight, Q. The wire is electrically discontinuous at the middle point R, so that the current is diverted into the circuit C, with which contact is established through the mercury cups $m_1 m_2$. Two further mercury cups at $M_1 M_2$ serve as alternative terminals for the battery current. The vibration of the string, once established, is maintained by the magnets n and s, which may be electromagnets or permanent ones. The wire has a single node in the centre, and the circuit c is the circuit in which the desired alternating current is produced. The Japanese physicists add that they have produced rates varying from 30 to 1,000 per sec. The inductance of the circuit must be kept small.

[Honda and Shimizu, *Am. J. Science*, July, 1900.]

Magnetic Rotatory Polarisation in Liquefied Gases.—The continuity of the optical properties of substances under different circumstances as to pressure and temperature, especially during changes in the state of aggregation, is an important point of investigation on which light can be thrown by measurements of the Faraday effect. The molecular rotatory constant will generally depend on pressure and temperature and will vary considerably with the state of aggregation. Becquerel made some measurements in which he found that during the transition from the liquid to the gaseous state the magnetic rotation of carbon bisulphide decreases much more rapidly than the density. This would indicate that the Faraday effect is practically confined to liquids. L. H. Siertsema has begun a series of experiments with a number of liquefied gases which promise some interesting results. Many difficulties have to be surmounted, such as the formation of bubbles owing to a slight conduction of heat. This necessitates additional protecting glasses, and consequently larger rotations to compensate the increased inaccuracy. The author uses the Aron's mercury arc lamp, and begins with methyl chloride at −28deg. Preliminary measurements show that the dispersion, at all events, is of the same order as that found in the gaseous state.

[L. H. Siertsema, *Proc. Roy. Acad., Amsterdam*, May 26, 1900.]

Spark-Length of an Induction Coil.—R. Beattie has studied the effect on the secondary spark-length of using different materials for the primary poles, and of varying the rate of break and the E.M.F. in the primary circuit. In place of the usual vibrating interrupter a special contact-breaker was employed, by means of which the primary poles could be separated either slowly or quickly, as desired. As regards the material of the poles, platinum gives a much longer spark than either lead or carbon. This is no doubt due to the fact that carbon is more easily disintegrated, and sets up an arc which bridges the gap. A quick break gives a long spark, and a slow break a short spark. As a rule, a high E.M.F., by prolonging the arc, gives a shorter spark in the secondary. But this is not the case with carbon, zinc and lead poles and a slow break. The "best capacity" for increasing the length of spark also depends upon the rate of break, decreasing as the break is quickened. In the case of zinc, however, it increases, and for certain capacities a quick break may actually give a shorter spark than a slow break. This peculiar behaviour of zinc when used as a break-pole is probably connected in some way with its non-arcing properties.

[R. Beattie, *Phil. Mag.*, July, 1900.]

Thermo-Electricity of Nickel Steel.—The announcement of the high thermo-electric force of nickel steel containing 28 per cent. of nickel having given rise to some doubts, C. E. Guillaume forwarded an authentic sample of such steel to E. Steinmann for re-determination. The latter announces now that the phenomenally high value of −2,461 microvolts with reference to lead is not shown by the authentic specimen, which only shows 385 microvolts. The old specimen turns out to have been wrongly labelled. It should have been marked as containing 36·1 per cent. of nickel.

[E. Steinmann, *Comptes Rendus*, July 2, 1900.]

ELECTRICITY WORKS ACCOUNTS.

Croydon Municipal Electric Supply Works.

The accounts of this undertaking present once again most satisfactory figures. In our remarks on the 1898-9 accounts we were able to note the excellent position which the concern had attained even then only in the second year of working. Last year's results, summarised in our table this week, indicate a material advance in all essential respects. Examining the figures representing the generating costs it will be noticed that with the exception of the fuel item all the charges, though some have increased, are much below the normal even under the improved conditions of output and load-factor. The fuel item is true to the prevailing tendency to high costs in this department. We learn from the Corporation's electrical engineer that the consumption of coal during the year was no more than 5·87lb. per unit generated. In view of this, the figure of 0·97d. per unit points to an exceedingly high price of coal at Croydon. The wages at the station have fallen very materially from what was already a very low figure. The slight increase in the works costs has been more than compensated by a diminution in the management charges, with the result that the aggregate costs have been reduced.

Following upon the reduced prices for current, the average total revenue has diminished by nearly 0·9d. While this reduction in the revenue has caused a falling off in the percentage working profit, yet to it is no doubt largely due the splendid advance not only in the output but in the lamp connections. As compared with the output of 451,664 units in 1898-9 last year's record of 781,291 units sold marks an advance of 73 per cent., while the lamp connections show an increase of nearly 44 per cent. The load factor has risen from 10·9 per cent. to 12·5 per cent. To the favourable load factor

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	CROYDON.	KINGSTON-UPON-THAMES.
Undertaking Worked by	Croydon Corporation.	Corporation of Kingston-upon-Thames.
Date of Commencement of Supply	November, 1896.[a]	November, 1893.
System of Supply	Alternate-current sub-stations, two-wire.	Alt.-curr. trans. sub-stations, also house trans.
Chief Engineer	T. Herbert Minshall.	J. E. Edgcome.

YEAR ENDED	MAR. 25, 1899.	MAR. 25, 1900.	DEC. 31, 1898.	MAR. 31, 1900.[b]
QUANTITIES—				
Units generated	619,849	1,026,679	—	—
,, SOLD (TOTAL)	451,664	781,291	232,370	364,000
,, sold to consumers	340,717	557,947	164,413	264,155
,, sold for public lighting, &c.	110,947	223,344	67,957	99,845
,, used on works	102,193	108,523	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	16·2	18·4	14·9	23·3
Maximum supply demanded	472·5 kilowatts	714 kilowatts	245	—
Number of public lamps	75 arc, 4 (32 c.p.) glow	130 arc	36	41 arc, 23 incand.[c]
Number of consumers	415	595	211	311
Connections to mains in 8-c.p. lamps	31,432	45,122	11,856	16,130
CAPACITY OF PLANT IN 8-C.P. LAMPS	27,800	42,500	15,600	15,600
CAPACITY OF PLANT IN KILOWATTS	890	1,360	500	500

CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£84,984	£95·4	£131,984	£97·0	£43,426	£86·8	£58,426	£117
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	84,984	95·4	131,984	97·0	43,426	86·8	58,426	117
RECEIVED (TOTAL)	37,400	42·0	37,400[f]	27·5	41,000	82	49,426	89·9
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	37,400	42·0	37,400	27·5	41,000	82	49,426	89·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	47,584	53·5	94,584	69·6	—	—	9,000	18·0
Share (unissued)	—	—	—	—	—	—	—	—
Share (uncalled)	—	—	—	—	—	—	—	—
Loan (including Debentures)	47,584	53·5	94,584	69·6	—	—	9,000	18·0
REPAID (TOTAL)	—	—	—	—	—	—	—	—
RESERVE OR SINKING FUND	—	—	—	—	—	—	—	—
DEPRECIATION FUND	—	—	—	—	—	—	—	—
EXPENDED (TOTAL)	88,561	99·6	117,385	86·3	44,813	89·7	50,674	101
Lands and buildings	15,511	17·4	17,210	12·7	7,394	14·8	8,476	17·0
Plant	36,089[b]	40·6	48,403	35·6	22,789	45·6	24,939	45·4
Mains	34,825	39·1	49,633	36·5	13,004	26·0	15,546	28·3
Miscellaneous	2,136[c]	2·40	2,139	1·57	1,626	3·25	1,714	3·12
BALANCE OF CAPITAL ACCOUNT	−51,161[d]	−57·5	−79,985[d]	−58·8	—	—	−1,248[d]	−2·27

REVENUE—	Total.	Per unit sold.	Total.	Per unit sold	Total.	Per unit sold	Total.	Per unit sold.
TOTAL	£9,394	4·993d.	£13,427	4·124d.	£4,701	4·852d.	£7,486	4·234d.
Revenue from supply	7,980	4·240d.	10,814	3·321d.	3,827	3·950d.	6,231	4·106d.
,, meters, &c.	203	0·108d.	341	0·105d.	133	0·137d.	179	0·118d.
,, public lighting	1,212	0·644d.	2,029	0·624d.	720	0·743d.	1,049	0·692d.
,, sale of lamps, &c.	—	—	10	0·003d.	21	0·022d.	27	0·018d.
,, miscellaneous sources	—	—	233[g]	0·072d.				
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£4,053	2·153d.	£6,751	2·073d.	£3,480	3·594d.	£4,750	3·133d.
WORKS COSTS	2,895	1·538d.	5,172	1·588d.	2,942	3·037d.	3,957	2·609d.
Generation of electricity	*2,532*	*1·346d.*	*4,474*	*1·375d.*	*2,714*	*2·803d.*	*3,603*	*2·377d.*
Fuel (including cartage, &c.)	1,721	0·915d.	3,145	0·967d.	1,751	1·806d.	2,408	1·589d.
Oil, waste, water, stores	170	0·090d.	322	0·099d.	175	0·181d.	220	0·145d.
Wages at station	544	0·289d.	654	0·204d.	508	0·524d.	613	0·404d.
Repairs and maintenance at station	97	0·052d.	342	0·105d.	280	0·289d.	361	0·238d.
Distribution of electricity	*114*	*0·061d.*	*267*	*0·082d.*			*147*	*0·097d.*
Wages, &c.	69	0·037d.	158	0·049d.				
Repairs, renewals of mains, &c.	45	0·024d.	109	0·033d.	228	0·235d.	147	0·097d.
Public lighting	*249*	*0·133d.*	*431*	*0·132d.*			*208*	*0·137d.*
Attendance	116	0·062d.	431	0·132d.			208	0·137d.
Renewals	133	0·071d.						
MANAGEMENT AND PROPERTY CHARGES	1,158	0·616d.	1,579	0·485d.	538	0·555d.	793	0·523d.
Royalties	—	—	—	—	—	—	—	—
Rent, rates, taxes	*160*	*0·085d.*	*205*	*0·063d.*	*134*	*0·138d.*	*160*	*0·106d.*
Management	*998*	*0·531d.*	*1,375*	*0·422d.*	*404*	*0·417d.*	*633*	*0·417d.*
Salaries	688	0·366d.	967	0·297d.	276	0·285d.	405	0·267d.
Stationery, &c.	112	0·060d.	97	0·030d.	33	0·034d.	60	0·040d.
Establishment charges	106	0·056d.	168	0·052d.	80	0·083d.	54	0·036d.
Law charges, &c.	92[e]	0·049d.	141[e]	0·043d.	15	0·015d.	114[e]	0·075d.

FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£5,340	8·11%	£6,676	6·49%	£1,221	3·04%	£2,736	5·73%
Sum carried to Depreciation Fund	—	—	—	—	—	—	—	—
Sum carried to Reserve or Sinking Fund	1,985	3·01%	2,762	2·68%	1,231	3·07%	1,347	2·82%
Net interest on loans (incl. Debenture charges)	2,108	3·20%	3,014	2·93%	1,102	2·75%	1,439	3·02%
BALANCE FROM LAST ACCOUNT	—	—	248	0·241%	—	—	—	—
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,248	1·89%	1,148	1·12%	—	—	—	—
Deficit	—	—	—	—	*1,112*	*2·77%*	*48*	*0·101%*
ORDINARY DIVIDEND PAID	—	—	—	—	—	—	—	—
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	43·2%		50·2%		74%		63·5%	
Expenditure per kilowatt capacity	£4. 11s. 1d.		£4. 19s. 2d.		£6. 19s. 2d.		£9. 10s. 0d.	
REVENUE PER KILOWATT CAPACITY	£10. 11s. 2d.		£9. 17s. 6d.		£9. 8s. 2d.		£14. 19s. 5d.	
Expenditure per 8-c. lamp capacity	2s. 11d.		3s. 2d.		4s. 5½d.		6s. 1d.	
REVENUE PER 8-C.P. LAMP CAPACITY	6s. 9d.		6s. 4d.		6s. 0¼d.		9s. 7½d.	
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 11¾d.		5s. 10¼d.		7s. 11d.		9s. 3½d.	
Price charged for lighting, per unit	6d.		7d. to 2d.[h]		6d. to 4d.[a]		6d. to 4d.[c]	
Price charged for power, per unit	3d.						3d. [glow per ann.	
Price charged for public lighting	2d. per unit		2·18d. per unit		£20 per lamp per ann.		£20 per arc & £3. 10s. per	

CROYDON.—REMARKS—*a* Station taken over from contractors on March 25, 1899. *b* Includes £1,518 on arc lamps. *c* Being amount paid in purchase of goodwill and undertaking of the Crystal Palace District Electric Supply Co., including their mains and services. *d* Over-expended. *e* Being to insurance. *f* Exclusive of £75,842 overdraft on bank. *g* From British Thomson-Houston Co. (Ltd.) being excess of coal used owing to non-delivery of alternator. *h* On maximum demand system.

KINGSTON-UPON-THAMES.—REMARKS—*a* On maximum demand system (two-hour scale). *b* For the *period of 15 months*. *c* There are 36 continuous current open and five alternating current open arc lamps. The glow lamps are of 25 c.p. *d* Over-expended. *e* Includes £78 to insurance and £37 to law.

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and also to the particularly high efficiency of distribution brought about by the practice of switching out transformers during the day time is due no doubt in large degree the excellent results exhibited by the Croydon undertaking so comparatively early in its career, and when the traction plant now on order is in operation, the costs are likely to show still better figures.

Kingston-upon-Thames Municipal Electric Supply Works.

We are glad to be able to record a decided improvement in the position of this undertaking. The accounts summarised in our table cover the period of 15 months ended on March 31 last, so that in any comparison of the figures it must be borne in mind that the winter proportion of the period was unduly large, and therefore favourable to lower costs.

Thanks to a very advantageous contract for the supply of coal having been made in 1899, prior to the rapid rise in the price, the fuel item has actually shared in the general reduction which has been effected in the costs. Notwithstanding this, however, the fuel item is more than double the average 1898 figures in stations of about the same size.

The other items, both of works and management costs, stand at satisfactory figures, with the result that, with the steady average revenue of about 5·9d. per unit sold, the working profit for the 15 months has increased more than pro rata in comparison with the previous year's result.

A new 200kw. steam alternator will soon be—if it is not already—at work, and by the completion of the low-pressure network of mains throughout the chief streets work on any high-pressure feeder is facilitated through the possibility of isolating it without interfering with the supply.

The following table indicates the progress made:—

Year.	No. of consumers.	Equiv. 8 c.p. lamp con.	Output units sold. Total.	Units sold to consumers.	Total rev.	Total expenditure.	Working profit.
1893–4	77	4,000	128,267	44,642	£1,985	£2,573	–£587
1895	99	4,800	134,084	67,445	2,442	2,704	– 262
1896	129	6,825	155,681	88,620	3,013	2,712	+ 301
1897	163	9,200	194,268	126,835	3,929	3,062	+ 863
1898	211	11,856	232,370	164,413	4,701	3,480	+1,221
15 months 1899–1900	311	16,130	364,000	264,155	7,485	4,750	+2,736

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	July 6, 1900	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 16, 1899	Liverpool (Municipal)	June 22, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	July 14, 1899	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, 1900	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, 1900	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	July 13, ,,
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, 1899
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 18, 1900
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	July 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, 1899	Woolwich (Company)	Jan. 13, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 8, 1899
Kingston-upon-Hull (Mun.)	July 13, ,,		

CORRESPONDENCE.

TRANSPARENCY OF LIQUIDS TO ELECTRIC WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in this week's *Electrician*, under the heading "Contemporary Electrical Science," an abstract by Mr. E. E. Fournier d'Albe of a Paper by Mr. A. de Heen on "Electrical Transparency of Liquids." Reference is made therein to experiments identical in nature with some which I described in *The Electrician* in a letter about six weeks ago, carried out with an apparatus arranged by me several months previously for investigating the electro-optical qualities of bodies. I there stated I had examined a large series of liquids and compared them in respect of their powers of absorbing or stopping electric waves of about 8in. in wave-length. In Mr. E. E. Fournier d'Albe's abstract it is said that the liquids examined by M. A. de Heen could be divided pretty sharply into two classes, the transparent and opaque, also that carbon bisulphide is classified as one of the opaque liquids. The abstractor or author suggests that these differences between the liquids correspond with no other physical difference. As regards the above statements I should like to point out that my experiments showed carbon bisulphide to be a liquid particularly transparent to electric waves, and since reading the abstract I have repeated these experiments to confirm the fact. So far from being opaque like water, it is almost as transparent as turpentine or paraffin oil, and more so than olive oil or acetone. I pointed out, in my letter to *The Electrician*, that the opacity or transparency to electric radiation was determined by the magnitude of the dielectric constant of the liquid. If the dielectric constant is large and abnormal the liquid is opaque, if small it is transparent. Now bisulphide of carbon has a dielectric constant 2·67, and this value is normal, in that it is equal nearly to the square of the optical refractive index. I also drew attention to the fact that all liquids containing in their chemical molecule radicles such as HO, NO_2, and other easily-replaced atomic groups, have large or abnormal dielectric constants and considerable absorptive power for electric waves. Hence the remark in the abstract of Mr. E. E. Fournier d'Albe that the electro-optic absorption power runs parallel to no other physical difference is not quite correct, and bisulphide of carbon, being transparent, is no exception to the above-mentioned criterion. I may add, however, a mention of an experiment which was shown by me, with others, at the recent Royal Society soirée, which indicates that large dielectric constant *per se* is not the determining cause of opacity, but that opacity is really due to a sort of consequent good conductivity for high frequency oscillations. I prepared a number of thin glass tubes like small test tubes, and filled them with water. These were packed side by side in a wooden frame. It is clear that by thus laminating the water the conductivity of the mass in directions along and across the tubes was made very different, whereas owing to the thinness of the glass and its high dielectric constant the resultant dielectric constant of the mass was not so much altered in the two directions. When tested for electro optic opacity this system of water tubes was found to be opaque when the length of the tubes was held parallel to the electric force, but transparent when so held that the tubes were placed perpendicular to the electric force. This experiment seems to me to indicate that all liquids of high dielectric constant may be looked upon as good conductors for exceedingly rapid electric oscillations, but that this conductivity cannot be inferred merely from experiments with steady or low frequency alternating currents. It is however possible to distinguish between the qualities, and to make a liquid appear as if it were electro-optically transparent, even if it has a high dielectric constant, by, so to speak, laminating it like a dynamo armature. I find the same to be the case with a metal wire grating. If the wires are long and close enough, the screen is opaque to radiation with electric force parallel to the wires. If, how-

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ever, the wires are cut up into very short lengths like a series of midget pins placed end to end, a grating formed of rows of these series is transparent to electric radiation, however close the rows may be placed, provided the pins do not quite touch each other. I must not encroach more upon your space at present, but shall hope later on to describe in detail numerous experiments on this subject I have made in the last half year.

—Yours, &c., J. A. FLEMING.

Pender Electrical Laboratory, University College,
London, July 14.

WIRELESS TELEGRAPHY.

In a Parliamentary Paper issued last Saturday as a Statement with regard to the additional Navy Estimates for 1900–1901, we notice an item, "Wireless Telegraphy Apparatus, £9,500."

The *Pall Mall Gazette* says the interest shown by the Kaiser in the development of the German navy has recently manifested itself in an order that every warship is to be fitted with apparatus for wireless telegraphy. The system to be adopted is not Marconi's, but that of Prof. Slaby and Count Arco, who have made daily experiments with it over long distances for many months past. They are said to abandon entirely the use of self-induction or choking coils and of "mixed metallic powders" in the coherer. A daily service of wireless telegraphy has (continues the *Pall Mall*) already been established with their instruments between Schiffbauerdam and Oberspree.

The *Engineer* states that of the 55 ships mobilised for the naval manœuvres this year, the "Adrienne," "Camperdown," "Jaseur," besides some others, are specially fitted for wireless telegraphy. The "Majestic" and the "Diadem" have also been fitted. The system is said to be not Marconi's, "which the Admiralty have found too expensive." Torpedo officers have charge of the installation in each case. The manœuvres this year will be entirely of a wireless telegraphy order.

On the general subject of the adoption of the Marconi wireless telegraph system by the Board of Trade, and in particular in reference to the answer given by Mr. Ritchie in the House of Commons on Friday last (elsewhere reported) to a question on the subject, Major S. Flood Page, managing director of the Marconi Company, in a long letter to *The Times*, says :—

I have recently returned from Borkum, where we have an installation worked half of the time by an ordinary German Government telegraphist, which is earning revenue daily. We have an assistant in the lighthouse at Borkum and another on the lightship 20 miles away. They take their tour of duty with the German telegraphists in receiving and transmitting shipping news, and communicating with the North Germrn Lloyd steamship "Kaiser Wilhelm dor Grosse" on her voyage into and out of Bremerhaven. This installation has been working for more than two months, and is interesting as being the first and only wireless telegraph receiving and transmitting ordinary intelligence worked by ordinary Government telegraphists, the messages being paid for on a commercial footing. A wire telegraph is fitted in the lighthouse which is in communication with the Continent, and messages received by wireless are repeated by wire telegraph in the ordinary way. Dr. J. A. Fleming, F.R.S., and I met recently, at Borkum, commissioners from Berlin to witness the working of the system, and they expressed themselves completely satisfied with the excellent demonstration which they received. The paying messages average about six a day, 10 being the greatest number received in any one day. Communication between lighthouse and lightship is thus used for the secondary object of sending commercial intelligence. This might have been done in England more than a year ago, as is well known to Mr. Ritchie, for he has himself seen the practical working on more than one occasion. The attitude of our Government towards this latest application of science to industry and commerce has been much the same as that exhibited towards every branch of electrical enterprise.

Mr. Hanbury, on behalf of the Post Office, said in the House of Commons that the Post Office would grant a licence to my company. I have before me a letter from the Post Office, dated May 1, 1899, stating that "the question of a licence to the company in respect of telegraphic communication between ship and shore by means of the Marconi system is receiving due consideration"; and in another letter, dated August 17, 1899, it is stated that the department is now in a position to discuss the terms of the licence, &c. Unfortunately the question of a licence got mixed up with the question of the use of the patents generally by the Crown, and we have not got the licence.

Some months ago we arranged with the South-Eastern and Chatham Railways to install our apparatus on their boats running between Dover and Calais. They are anxious to carry out the arrangement, as safety and security for passengers and economy in the cost of telegraphing, amongst other advantages, would have accrued; but their steamers are not fitted, some power prevents it. One rumour says that it is the French Government that prevents it; another that the English Post Office regard this purely commercial application to the needs of a purely commercial company like the South-Eastern as an infringement of the Post Office monopoly. The installation would only be used for the business purposes of the railway company; the public would not be able to use it. Anyway an obstruction exists; this hidden power, whatever it is, prevents the railway company availing itself of the advantages of wireless telegraphy, and hinders our earning the revenue which would accrue from this mutually advantageous and ordinary commercial transaction.

Perhaps we do come under the Post Office monopoly; perhaps we are exempt; perhaps we might be able to substantiate some claim to come under the exceptions of the Telegraph Acts. Certainly it is not our intention to be drawn into a dispute with the Post Office, whose monopoly extends only, as far as marine work is concerned, three miles from the coast. I presume there is no doubt that a steamer fitted with our apparatus may steam up and down the coast three miles and one yard from the shore and speak as much as they like to any station we may have on the coast without infringing the Post Office monopoly, and the burden of proof of that additional yard would hardly fall on the steamship. However, Mr. Hanbury's answer to Sir J. Leng in the House of Commons leads us to hope that ere long we shall not only have a free licence from the Post Office, but that they may give us a percentage of the additional business we shall bring to them.

I am glad to say the Admiralty is fully alive to the value of the system in its application to ships of war, and has arranged with this company to install the Marconi system on board more than 30 ships and torpedo stations.

Mr. Bullocke and four of our assistants landed on Saturday last from South Africa, and have reported that the Marconi apparatus fitted for about three months on four ships of Her Majesty's Navy in Delagoa Bay has worked day and night with complete success.

Mr. Ritchie, in Parliament the other day, said a departmental committee was sitting to deal with the question of communication by means of wireless telegraphy between lighthouses and lightships. As no one from this company has yet been called to give evidence I presume that our 12 months' successful working at the South Foreland has been taken as demonstrating the practicability of such communication.

PARLIAMENTARY INTELLIGENCE.

ELECTRIC LIGHTING IN THE EAST END OF LONDON.

On Wednesday the Select Committee of the House of Lords, of which the Earl of Camperdown is chairman, considered the act to confirm provisional orders made by the Board of Trade relating to Battersea, Limehouse, Mile End Old Town, and St. George's-in-the-East.

Mr. WORSLEY TAYLOR, Q.C., said there was no opposition to the Battersea order. He appeared on the Limehouse order, which was identical with the others. Mr. Shiress Will, Q.C., appeared on the St. George's order, and Mr. Baggallay on the Mile End order, and probably one opening would suffice, there being also only one petition, that of the County of London, which was directed against all three districts. In the session of 1897 this company got a provisional order confirmed for supplying electricity in Limehouse, Mile End Old Town, and St. George's-in-the-East. The point which all three local authorities made was that up to the present the company had done absolutely nothing to supply electric light in any one of the districts. The authorities thought the time would come when they ought to have electric light, and that they were the best people to supply it, and the result was that they all obtained provisional orders. If the case stopped there it would be a strong one; but a material change had been effected since 1897 by the County of London Local Government Act, 1899, under which the three districts in question, with Whitechapel, would form the new borough of Stepney. Whitechapel had an order, and a site on which were works which they could expand up to about 15,000 H.P., and this would carry them on for years. The average price per unit charged by the company was 4½d., whereas that of the Whitechapel District Board of Works was only 3d., and therefore on the mere ground of cheapness the local authorities were justified in their action. In section 3 of the order it was provided that as from the date of the announcement of the Order in Council establishing the new metropolitan borough of Stepney the undertakings and areas of supply under the three orders should be deemed to be one undertaking and one area of supply; so that the Board of Trade had not merely given the authorities the right to supply themselves but had rolled the whole thing up into one. It was for the company to show why these authorities should not be allowed to supply themselves rather than for the authorities to show why the bill in the public interest ought to pass. The company had tried, by bills, to get power to connect their St. Luke's works with the East-end districts, but failed. Then they turned to the Regent's Canal, and he believed had bargained for a wayleave along the towing path there.

Major P. CARDEW said the generating station at present existing in Whitechapel was on a good site. The existing plant was not very large, the supply not having been started very long. It would be possible to place plant of 15,000 H.P., or equal to 10,000kw. on the site, which was about 2½ acres in extent. The system of supply was the low-pressure direct; that from the St. Luke's station high-pressure alternating, though he believed they had a certain amount of low-pressure plant there, too. Comparing the positions of the two stations—one in Whitechapel and one in St. Luke's—he thought the advantage, from a commercial point of view, rested with the Whitechapel station. He thought the present action of the local authorities justified. With regard to competition, his view would be very different if the company had already expended a large sum of money in the district; but as they had spent nothing they had no right to complain. If a company was doing its duty and carrying out a thoroughly efficient supply there was an element of unfairness in the local authority (having consented to the coming in of the company) wanting to compete.

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Cross-examined: Supposing our failure to supply in this district and to do our duty is entirely owing to the action of the local authority and the County Council, do you not think it unfair that they should come in?—No. I think the difficulty you are in is the result of your deliberate policy. You deliberately decided that you would supply from a station which had no access to the district. I think you must stand or fall by that policy.

Mr. W. JAMESON, surveyor to the Whitechapel district, said the electrical works were created under his supervision. The boiler capacity at present was about 600 H.P. or 700 H.P. The works were started just before last Christmas, and were now supplying very nearly to their full capacity—about 15,000 lamps. There was a quantity of machinery on order, which would be delivered probably within the next three months, and would quadruple the power of the station. The average charge in Whitechapel for electric current was about 3d. per unit. The authority supplied a considerable number of small motors for sewing machines in connection with the East-end clothing trade, &c. For shops taking the light for a considerable period the Whitechapel charge worked out to less than the cost of gas. A new building at the site of the works was in course of construction.

Mr. PARKER, assistant engineer of the Whitechapel district, said he believed that 3d. would be a remunerative charge in the district. The demand for electric current was increasing. It would take about two years to make the necessary arrangements to supply the new district.

Mr. RATCLIFF, clerk to the Limehouse District Board, said the company's act received the Royal Assent in 1897. They were bound to carry out the works by September, 1899, but they only gave notice at that date of their intention to lay the mains. No notice was taken of this intimation, and after the expiration of a month there would be no statutory powers to object to the laying of the mains. The company, however, had not even yet commenced to lay mains.

That was the case for Limehouse.

Mr. KNIGHT, engineer and surveyor of the Mile End Old Town District gave details as to the steps taken by the three districts to join with White chapel in securing the revocation of the County of London Company's powers and the promotion of their own order. It was not true that the company had been delayed by the districts in the carrying out of their order of 1897. His district had an acre of land on the canal on which there was a destructor, and that they could use for the building of an electricity generating station. The County of London Company had never done an inch of work in the Mile End Old Town district.

Mr. BAGGALLAY, Q.C., submitted that at the present moment the County of London Company's powers were capable of being revoked by the Board of Trade. The company would not be injured, save that they had had to pay the costs of getting the order of 1897, which they had not carried into effect.

Mr. THOMPSON, vestry clerk of St. George's-in-the-East, said his Vestry had not received a communication from the Board of Trade stating that they declined to revoke the company's 1897 order. His Vestry had made suggestions to the Board of Trade for the amendment of the company's supply, but without success.

Mr. SHIRESS WILL pointed out that when the company obtained their powers in 1897 they were bound to supply electricity to the districts from a generating station within the districts. They had delayed through endeavouring to get the supply from the generating station in another district authorised by their act of 1892. The Board of Trade had sanctioned the present order, and the bill confirming it had passed the House of Commons.

Mr. BRAITHWAITE, jun., deputy-chairman of the County of London Company, said his company, having obtained their order had endeavoured to obtain wayleaves through intervening districts in order to supply electricity from St. Lukes, the company, seeing that the economical way to supply would be from that district. A bill for the wayleaves was rejected in 1899. They had now succeeded, at considerable expense, in getting wayleaves from the Canal Company, and the company were prepared at once to commence laying down plant, having all the necessary capital available. The company had already gone to considerable expense in making provision for special plant. They had plant for 500kw. at their City-road Station in view of the supply of these eastern districts, and a deal of this plant would be idle if not so used. Besides, the company now proposed to supply motive power as well as lighting, and to do that had made arrangements for new and special plant. The districts were power districts, and the supply must be economical. It would not be economical to generate the electricity in the districts themselves.

Yesterddy Mr. CHARLES P. SPARKS, chief engineer to the County of London Company, said his company had endeavoured for some time to obtain wayleaves from their generating station to Mile End Old Town, Limehouse, and St. George's. They had at length been successful in obtaining wayleaves along the Regent's Canal for a distance of 3¼ miles. They proposed to lay down four conduits. They would begin to supply under their present two-phase system till they got the permission of the Board of Trade to supply continuous current. The capacity of the City-road station was 2,200kw. The maximum load last winter was 1,260kw. with 450kw. reserve, which would have been available for the east-end district. This year they would have a reserve of 500kw., in addition to the supply from the original plant. He pointed out that difficulties had been put in the way of the company in the matter of wayleaves and the laying of mains in the east-end districts. The company supplied electricity in its northern district at the rate of about 4d. per unit for lighting and 2½d. for power. The capital expenditure in making use of the wayleaves which had been acquired would be £11,000 to carry 1,500kw. over a distance of 3½ miles. The cost of pipes would be 17 per cent. of the total, the cost of the cables would be 66 per cent., and the cost of labour, supervision, &c., 17 per cent. The amount to be paid for wayeaves was £300 a year for three years and £500 a year after that.

Cross-examined by Mr. Worsley Taylor, Q.C.: Within about 15 months every shilling of the company's existing capital would be utilised.

Mr. WORSLEY TAYLOR: Very well; that brings us to the bottom of the hardship to you of the passing of this bill.

WITNESS said that the total capacity of the company was 3,400kw., which, if the normal rate of increase was maintained, would be utilised in 15 or 16 months.

By the CHAIRMAN: The company supplied St. Luke's, Clerkenwell, and other places in the north, and between that district and the district they proposed to serve lay the districts of Bethnal Green and Shoreditch, and part of the City. To supply the district in dispute wayleaves through a district which they did not supply were necessary.

In re-examination, WITNESS said that the two-phase system had been adopted in order to give a supply to the east-end districts. They were studying economy in this matter, and in order to give an effectual supply they had spent a great deal of money. At Christmas, 1901, the existing plant at the City-road works would be fully occupied, but they had further plant for the accommodation of the east-end on order. His company were supplying the City of London Company with electricity in bulk, that company having had some difficulty to encounter. Their supply would end in a few months, and would relieve machinery for supplying 450kw., or, with reserve, 600kw.

The CHAIRMAN: I gather that you do not think it would be remunerative for any one to supply the new Stepney borough alone?—I do not include Whitechapel. We do not supply or propose to supply that.

The CHAIRMAN: You mean that St. George's-in-the-East, Mile End Old Town and Limehouse could not supply themselves economically?—Yes.

But they could be supplied economically from Whitechapel?—Yes. These gentlemen have taken our case, and applied it to themselves.

Mr. S. MORSE, solicitor to the petitioners, gave a history of the electric supply orders affecting not only St. George's, Mile End Old Town, and Limehouse, but also Whitechapel. His company had promoted a bill to enable them to reach Mile End and the other parishes through Whitechapel and Shoreditch. The Committee who considered the bill decided not to give the powers asked for, which were of a wide character. They then asked for permission to communicate from their existing station to the districts they had power to supply, but it was said that the bill was so altered that it would be necessary to drop it at that period, and come again to Parliament for fresh powers. In 1899 the company submitted to the Board of Trade the system of supply they proposed to use. Witness then quoted from correspondence and resolutions of the local authorities to show that the east-end districts had held a conference, and had decided to get the London County Council to assist them in obstructing the carrying out of the company's works. The London County Council accordingly adopted obstructive tactics, and effectually prevented the company from carrying out their works from Sept. 30, 1899, to March 3, 1900, when the Board of Trade ruled that they were out of court. On Sept. 23 the local authorities through certain members of Parliament, waited upon the Board of Trade, and endeavoured by an *ex parte* statement to get that department to revoke the order granted to the County of London Company for the supply of the east-end district. The Board of Trade, without hearing the company, but knowing what they were doing, decided that they should not be interfered with. Witness detailed the arrangements entered into between the North Metropolitan Railway and the Canal Company and the County of London Company for wayleaves from the City-road station to Mile End Old Town, and said if this bill were to pass the company would be bound for three years to pay £300 a year. He did not think Mile End Old Town had power to stop their laying mains in the district. When the agreement was entered into the company knew the present orders were pending. He did not know, however, what the bill had to do with the agreement. The bargain was made deliberately with their eyes open. In 1897, when the company got their order, it could only have been carried out by getting a generating station in the district itself or obtaining wayleaves, for Parliament had rejected that part of the bill which would have enabled the company to get a connected supply distinct from the City-road to Mile End Old Town.

By the CHAIRMAN: His company had power to lay mains in Mile End Old Town, that district not having objected within the statutory period.

Mr. MOON, for the company, first dealt with the two legal points, first as to their legal right to carry their mains along the Regent's Canal.

The CHAIRMAN: That right is not disputed.

Mr. SHIRESS WILL: I contend that the agreement with the Canal Company is not binding, not having been sealed.

The CHAIRMAN: But it could be completed to-day. All you say is that it is incohate. There is no question as to power to enter into the agreement to grant the wayleave.

Mr. SHIRESS WILL: No doubt.

Mr. MOON said that according to the decision of the Committee, the agreement might be made conclusive. It had been partly fulfilled as already two payments of £75 each had been made by the company. As to the contention that the company had no power to break up roads through a district other than their area of supply, in order to give communication between the generating station and the area of supply, he quoted from the decision of the Committee presided over by Lord Cross, which sat to consider that amongst other questions, to the effect that compulsory power for works might be given under such circumstances. It was held that to come under that decision the bill giving the power for breaking up streets must also have contained the power to set up the generating station, but this he contested, the decision of Lord Cross's Committee having made no reference as to the time at which power to break up streets should have been given. He went on to point out that the company had power to supply this east-end district and had already gone to great expense to put that power into operation, and that to pass this bill would be to render

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the local authorities competitors. And the Committee must bear in mind that the only ground on which Parliament had allowed a local authority to compete with existing undertakers in the supply of electricity had been that of failure on the part of the private company to carry out their statutory obligations. And no doubt the main argument of the promoters was that the County of London Company had not carried out their powers. Against this he reminded the Committee that the company had been obstructed in their endeavour to obtain wayleaves, as their attempt to secure a continuous district of supply had been defeated. Moreover, the Committee must recollect that the Board of Trade had been applied to to revoke the company's provisional order, and had declined to do so, and declined without calling on the company to reply to the arguments of the applicants. So far from having done nothing to fulfil the order, the company had done a great deal though they had not at that moment expended any money in the districts of the particular local authorities promoting the present bill. Besides the cost of obtaining the provisional order, they had put down two-phase plant with the object of supplying these districts. They had adopted a special type of plant to enable them economically to transmit the current to Mile End, and they had provided at St. Luke's station an excess quantity of power amounting, with reserve, to 600 kw., which they would utilise for the new district at once. Finally, the company had used their best endeavours to carry out the order they had obtained in 1897, and had now obtained the necessary wayleaves and were in a position to commence supplying the three eastern districts in from four to six months, and under the circumstances there was nothing to justify the passing of the bill, and, as a consequence, the revocation of the company's order.

Mr. SHIRESS WILL summed up for Mile End Old Town. He said that so far as the district was concerned it would be better for the new borough of Stepney (which would one day be the purchasing authority) to have a complete undertaking within its own boundary than to have an electric light installation perfect in everything but the generating station.

The CHAIRMAN said that no doubt if they were beginning *de novo* the interests of the inhabitants of the district would be consulted in that matter, but as things were it was impossible to ignore the existence of the Brush Company and of their order.

A dispute arose as to what had been said in evidence on the two-phase system, and the chairman recalled Mr. Sparks, who stated that the two-phase system was used over a large part of their area of supply north of the Thames, and in the whole of a separate area of supply south of the Thames. The two-phase system was the most modern system for distributing electricity at a distance.

Mr. W. M. ACWORTH replied for Limehouse.

Mr. BALFOUR BROWNE, Q.C. waived the right of reply.

The CHAIRMAN then announced that the Committee had decided that the bill might proceed.

Discussion arose on the question of the payment by the promoters of the costs incurred by the company in connection with their provisional order and in relation to the supply of the east-end districts.

Mr. BALFOUR BROWNE said that if these costs were paid the company would agree to the cancellation of their order.

The answer of the local authorities could not then be given, and the matter stands over till to-day (Friday).

METROPOLITAN DISTRICT RAILWAY CO.'S BILL.

This bill was considered on Friday by a Select Committee of the House of Lords, presided over by Viscount Portman.

Mr. POPE, Q.C., for the promoting company, said that for many years the question of electric traction had engaged the serious and constant attention of the promoters. Electric traction had hitherto only been applicable to lighter railways than those usually employed in this country, and the main difficulty had been found to be the extreme draught and weight of a train capable of carrying passengers in such numbers as were carried on the District Railway. For two years Sir John Wolfe Barry and Sir William Preece had been engaged in experimenting as to the best mode of applying electric traction to the purposes of that railway, and a certain measure of success had attended their efforts. At present an experimental train was running between Earl's Court and High-street, Kensington, to test the applicability of the scheme. The bill was to enable the company to carry out the system of electric traction which the two engineers had proposed. They sought to acquire a site at Chelsea Creek for a generating station; they had been able to arrange with the local authorities to lay mains below the streets to carry the energy from the station to the railway. It had, however, been found necessary to lay an alternative cable. This they proposed to lay on the extreme margin of the lands of the West London and West London Extension Railways. This would involve no real interference or injury to those railways, and he (the learned counsel) considered it at least a selfish policy for the Great Western and the London and North Western Companies, who were the owners of the line, to deny the District Railway the right to lay this electric main.

Sir JOHN WOLFE BARRY said the advisability of employing electric traction had been for a considerable time before both the Metropolitan District and the Metropolitan Railway Companies. A year or two ago the District Company obtained leave from Parliament to work their line electrically, but they did not obtain powers to purchase land for a generating station, nor facilities for laying electric mains and conducting the power to the railway. They conveyed about 50,000,000 passengers a year, and the new system would be an enormous benefit to the public. Last year the Metropolitan and District Railways placed at his disposal a sum of £20,000 for the purpose of conducting experiments on the working of their full-sized trains. Up to that time in this country no full-sized train had been worked electrically on steep gradients, and it was thought desirable to have a full-sized experiment. This was made on the line between Earl's Court and High-street, Kensington, on which there is a gradient of 1 in 42, and had been entirely successful. They were able to travel more quickly, to start the train more rapidly, and to convey heavier loads than with steam locomotives. The site for the generating station at Chelsea Creek was very suitable. No residential injury would be caused, and, being on the Thames, coals could be economically conveyed, and water obtained for condensing purposes. The electrical conductors would be placed in cast-iron boxes, about 9in. by 15in., laid 2ft. below the surface of the street. The object of the alternative route was to duplicate their cable, as they would have to duplicate all the plant. He did not think the laying of the main would interfere with the petitioning railway companies' property. The estimates for land were £58,000 and for buildings £55,000, and the total cost to fit the District Railway for working electrically would be about half a million.

Sir WILLIAM PREECE said, in conjunction with the previous witness, he had conducted experiments between Earl's Court and High-street, Kensington, with a passenger traffic heavier and greater than anything that had been done anywhere, even in America. The results had been highly satisfactory. The introduction of electricity as a motive power on the underground railways would be of great benefit to the public. It would clear the atmosphere of the underground railways; it would secure a beautiful light in the carriages, and it would enable the speed of the trains to be increased. As to the site for the generating station, they had never been able to find a site so advantageous as that at Chelsea. He felt strongly the necessity of an alternative route. Though he had had 47 years' experience of electricity, they were every day being met with something new and unexpected. They must have, in electrical enterprises, two strings to their bow, and he objected to a great railway traffic like theirs being dependent upon a line of pipes going through the streets. In his opinion the placing of the conduits on the extreme verge of the railway would in no sense interfere with the traffic or with the convenience of the railway. He could form no estimate of how long the cable would last. The only experience of a similar main was that from Deptford to Trafalgar-square. The distance was 7 miles or 8 miles. The cables had been down five years. They were worked at very high pressure—10,000 volts—such as they also proposed to use, and during that period of five years there had been only one fault—only one occasion to open the street. His impression was that the interests of the Chelsea Electric Supply Co. would be fully protected by the clauses of the Board of Trade and of the Consolidated Electric Lighting Act of 1899. They had no intention of competing with the Chelsea Co. in the supply of electricity.

On Monday Sir JOHN WOLFE BARRY, recalled, said Sir Wm. Preece and himself had carefully considered this site for the generating station at Putney before deciding on the Chelsea site. There were many objections to the Putney site. It was in an important residential district. The site would not be large enough for the work they contemplated, and it was not central, being at the extreme end of one of the District Railway's lines. He knew many cases in which companies had asked to put up power stations in residential districts, but Parliament had declined to allow them to do so. In the case of the Chelsea site, Parliament had already authorised the erection of a generating station there, and their company had met with no objections.

Mr. WEDDERBURN, Q.C., for the owners of the West London Railway, said for the first time in his experience a trading company was seeking to carry its lines along the property of a railway company. The promoters had entirely failed to prove that public necessity which alone could justify such an interference with private property.

Mr. SHIRESS WILL, Q.C., for the West London Extension Railway, took the same line of argument.

The CHAIRMAN said the Committee found the preamble of the bill proved, but they would not sanction the laying of the alternative line of pipes on the property of the railway companies.

Clauses having been adjusted, the bill was ordered to be reported, as amended, to the House.

WALSALL CORPORATION BILL.

On Tuesday the Select Committee of the House of Commons, of which Col. Gunter is chairman, considered this bill, which included a proposal to re-equip the existing tramway system and to make extensions both inside and outside the borough, including extensions to Bloxwich, Willenhall, Walsall Wood, and through Great Barr to the boundary of the adjoining district of Perry Barr, whence a line will be made by the local authority of Perry Barr through their area and connecting with the existing tram system to Birmingham. The overhead trolley system is proposed. A petition by residents asked that if the Committee sanctioned any part of the scheme the Corporation should not be allowed to go outside their own boundaries.

Mr. W. J. SMITH, mayor of Walsall, said the inhabitants of Birmingham's road were practically unanimously favourable to the tramway scheme, which he explained was much needed to bring in the outside population on market days. At present these people entered the borough in carriers' carts and other similar conveyances. The line would be much used to convey people to the pleasant country district of Great Barr, and as giving a direct route to Birmingham. It was not anticipated that the tramway would be profitable for the first year or two, and the deficiency, if any, under the bill would be thrown on the borough rate, and would not fall on the outside district served by the line. He believed, however, that the tramway system as a whole would pay.

Several witnesses were then called, who gave evidence as to the local need for and advantage of the tramways.

Mr. R. GREEN, C.E., who prepared the plans and sections and the estimates of expense in connection with the bill, said: From an engineering point of view this was one of the easiest systems of tramway he had been connected with. There was an existing tramway system in the town which the Corporation proposed to acquire, and which would require to be re-laid and be re-equipped. The total expenditure contemplated was £160,050,

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which included £25,000 for the extensions of the generating station and cars. The suggestions made by the opponents that Birmingham-road should be re-laid with wood would be impracticable. In the first cost of granite as compared with wood there was not much difference; but in a case like this granite would have three times the life of wood, besides which the annual cost of maintaining wood was much greater than that of maintaining granite. From a sanitary point of view also he much preferred granite. The steeper the incline of a road the more difficult wood became for horses; and there were some considerable gradients in this scheme. Nor would wood pavement lessen the noise of a tram. He considered that in very narrow streets two lines were better than one, and it was provided that in all cases where there was less than 7ft. 6in. between the outer rail and the kerb, there should be a double line. Without any special expense for widening or other things the cost of the overhead trolley system was estimated at about £12,000 per mile. The overhead trolley system was very much cheaper than other electrical systems of traction.

After hearing the evidence of the petitioners against the bill and counsel on their behalf,

The Committee passed the preamble of the bill, which, after clauses had been considered, was ordered for report.

LONDON UNITED TRAMWAYS BILL.

The Select Committee of the House of Lords, presided over by Lord Rosse, on Friday last resumed consideration of this bill. Strenuous opposition was offered by frontagers along the route of the proposed branch line along the Richmond-road, Twickenham, to a point near to Richmond Bridge.

A number of local witnesses in support of the scheme closed the promoters' case.

Mr. EARLE, for the Middlesex County Council, said the desire of the Council was to protect their roads from aggression. The effect of these tramways would be to increase the population of the districts through which they would run, and therefore it was desirable that the ordinary requirements as to width of road should be insisted on. He submitted that the payments to be made by the company to the District Councils should be taken into account in the settling between the Middlesex County Council and the District Councils in regard to the upkeep of the roads.

Mr. FITZGERALD, Q.C, explained that a portion of the tramways in the Acton district would have been purchasable by the Acton Council in 11 years, but in consideration of their agreeing to grant a uniform term of 24 years the company had agreed to make a payment of £400 a year to the Council.

Evidence in support of the frontagers' petition was then taken.

Mr. C. A. BRERETON, C.E., said he resided at East Twickenham. He did not think Richmond-road a suitable one in which to lay down a tramway, owing to the abruptness of its curves and to its circuitous route.

Further similar evidence having been given,

Mr. WHEELER, Q.C., for the frontagers, condemned the trolley system as wholly objectionable, urging that there was nothing final about electric traction which, in the same way as steam, had supplanted horse-power, and might itself be supplanted before very long—and he referred in this connection to the progress being made in motor cars—in which case it would be impossible to restore Richmond-road to its present attractive condition. He entirely declined to assent to the view that, because enormous sums of money had been spent on local authorities, and because these local authorities had given their consent to the scheme, therefore they represented local feeling. These assents he held had been given because of action on the part of the company which would render outlay on their part unnecessary when that outlay had to be faced.

Without calling on counsel for the promoters to reply, the CHAIRMAN said the Committee found the preamble proved.

A clause giving the Middlesex County Council certain protection in regard to the roads having been agreed to, the bill was ordered to be reported for third reading.

GLASGOW DISTRICT TRAMWAYS BILL.

Questions of *locus standi* in regard to this bill were considered by the Court of Referees of the House of Commons on Thursday last. The bill is being promoted by Mr. W. M. Murphy and others and seeks authority to construct two groups of electric tramways, one in and around Paisley and the other in and around Renfrew. When the bill was before the House of Lords the proposed line between Govan and Renfrew was struck out, Glasgow Corporation undertaking to promote next session a similar line as part of the Glasgow tramways system. The petitioners against the bill to whose *locus standi* the promoters objected were the Glasgow and Renfrew District Railway Co., the Corporation of Glasgow, Paisley and Barrhead District Railway Co., Glasgow and South Western Railway Co., and Glasgow and Paisley Joint Line Committee. When the Court of Referees met it was found that the petitions of the Corporation of Glasgow, Glasgow and South Western Railway Co., and Glasgow and Paisley Joint Line Committee had been withdrawn.

Representatives of the Glasgow and Renfrew and the Barrhead District Railways having declared that the electric tramways would seriously compete with their lines,

Mr. PEMBROKE STEPHENS, Q.C., for the promoters, admitted there would be a certain measure of competition, but contended that such competition was not sufficient to justify a *locus standi* being granted. With a view to meeting objection from the railway companies, the promoters had reduced their parcels-carrying limit from 500lb. to 56lb. They thought that that concession would end the difficulty.

The Paisley and Barrhead Co. and the Glasgow and Renfrew District Co. were granted a restricted *locus*.

ELECTRIC POWER BILLS.

In the House of Commons on Monday, on the consideration of the Durham (County of) Electric Power Bill, Mr. CALDWELL moved that the Standing Orders be suspended, and that the bill be read a third time.

Mr. GALLOWAY objected to special facilities being given to the promoters of this bill. The motion was, however, agreed to, but on the motion that the Standing Orders be suspended in order that the bill be read a third time, Mr. Galloway repeated his objection to the bills being rushed through the House under special facilities.

A division was challenged, but not persisted in, and the bill was ultimately read a third time, as were also the Lancashire Electric Power Bill and the South Wales Electrical Power Distribution Bill.

The North Metropolitan Electric Power Supply Bill was read a third time in the House of Commons on Tuesday.

LIVERPOOL OVERHEAD RAILWAY BILL.

This bill, which authorises the construction of new electric railways at Seaforth and Liverpool, the widening of a short portion of the system in Liverpool, and increases the capital powers of the company, was passed by the Unopposed Bill Committee of the House of Commons on Friday last, after passing the committee stage of the House of Lords.

Royal assent has been given to the Southport Extensions and Tramways, Stockport Corporation Tramways, Lincoln Corporation (Tramways, &c.), and the City of London Electric Lighting bills.

WIRELESS TELEGRAPHY IN LIGHTHOUSES.

In the House of Commons on Friday, in answer to Sir J. Colomb, Mr. RITCHIE said he understood the experiment of establishing electrical communication with the East Goodwin light vessel was regarded as successful. The experiment having been completed, the apparatus was removed, and whole question of electrical communication with light stations had, as he had previously stated, been referred to an inter-departmental committee, on which the Post Office, the Treasury, the Admiralty, and the Board of Trade were all represented. He was not aware of the name of the receiving office in Germany with which the Borkum light vessel was in communication, and was, therefore, unable to state the distance between the office and the vessel. The distance between the East Goodwin light vessel and the receiving office in England was about 10 miles. The mere practicability of establishing communication was not the only question to be considered. Very difficult questions of patent rights were involved, and the question how to deal with those rights needed careful handling.

Mr. J. LOWTHER: Are steps being taken to expedite the settlement?

Mr. RITCHIE: I have expressed to the Committee a hope that they may speedily make their report.

CABLE COMMUNICATION BETWEEN BRITISH COLONIES.

In the House of Commons last night, Mr. TOMLINSON asked the Secretary of State for the Colonies whether he was aware that, although the island of Jamaica is now in direct telegraphic communication with the British Empire through British cables by Turks Island, Bermuda, and Halifax (Nova Scotia), no steps have yet been taken to establish direct communication between Jamaica and the other West Indian islands, and that the cables connecting Jamaica with the fortified coaling station of St. Lucia and the islands of Barbados, St. Vincent, and Trinidad, and the other West Indian islands, as well as the mainland of British Guiana, all touch foreign soil at one or more points. Also whether British Honduras is also dependent upon foreign cables, and that if a colonist in British Honduras wishes to telegraph to the United States or England he has to take a journey into the neighbouring Republics of Guatemala or Spanish Honduras in order to do so.

Mr. J. CHAMBERLAIN: The facts are as stated. The points raised in the question have been carefully considered, and will not be lost sight of. Considerable expenditure would be involved, and I cannot promise any immediate action in the matter.

PROPOSED CABLE TO WEI-HAI-WEI.

In the House of Commons, on Tuesday, the CHANCELLOR OF THE EXCHEQUER stated, in reply to Sir C. Dilke, that the proposed cable to Wei-hai-wei was not to be laid from Gutzlaff, but from the Saddle Islands, which were some 30 miles further seawards. The Great Northern Telegraph Co. had no station on those islands. Arrangements would be made for the working of the new cable by a British staff. Negotiations were in progress with the Eastern Extension Telegraph Co. as to the ownership of the cable. Pending the result the company are to lay and work the cable.

TELEPHONIC COMPETITION.

In the House of Commons, on Friday, Mr. HENNIKER HEATON asked the Secretary to the Treasury the amount paid by the National Telephone Co. as royalty on their gross receipts last year, and where this sum was to be found set out in the public accounts.

Mr. HANBURY: The amount paid by the National Telephone Co. to the Post Office as royalty for the year ended March 31, 1900, was £134,115, and this amount will be found included in the finance accounts (p. 23), described as "Telegraph Service, Gross Receipts."

Mr. G. BOWLES: Does the Government propose to enter into competition with the company with a view to extinguishing this receipt?

Mr. HANBURY: The Government are, in this matter, carrying out the wishes of Parliament, which has decided that there shall be competition.

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LEGAL INTELLIGENCE.

Attorney-General v. National Telephone Co. (Ltd.).

This case came before Lords Justices Smith and Vaughan Williams in the Court of Appeal yesterday on the appeal of plaintiff from an order of Mr. Justice Bucknill dated June 12, 1900.

Mr. H. F. DICKENS, Q.C., said Mr. Justice Bucknill ordered that the case should be tried with a jury. The plaintiff appealed from that order on the ground that the causes of action and the defences set out in the pleadings disclosed no questions in which the jury could render any assistance, and that if any question of fact arose at all they would depend upon an enormous amount of correspondence and negotiations which could not conveniently be set before a jury. Counsel said the action was brought by the Attorney-General on the relation of the London County Council and by the London County Council against the defendants to restrain them from committing a nuisance by opening the streets in the metropolis for the purpose of laying their telephone wires, and also for a declaration that the defendants were not entitled to do that except under certain consents by certain of the Telegraph Acts. Plaintiff also claimed a declaration that defendants were not entitled to break up the streets whenever they liked for the purpose of repairing their wires when so laid. The telephone company were, he contended, practically claiming to have the right to lay their telephone wires not under the powers of the Telegraph Acts at all, but because they had the consents of local authorities. Of course that raised a point of law—viz., whether the company could have the right against the Attorney-General to create a nuisance. The points of law raised were no doubt important ones, but his submission was that it was not a case in which a jury could render any assistance.

Lord Justice SMITH said that on looking at the pleadings he thought there was a question of fact raised as to whether the telephone company had caused any obstruction in the streets which would rightly be decided by a jury.

Mr. DALDY, on the same side, argued that this was a proper case to be tried by a common law judge sitting without a jury. The action was for an injunction and for a declaration, and could have been brought in the Chancery Division.

Their LORDSHIPS, without calling upon Sir Edward Clarke for the company, dismissed the appeal, with costs.

Othen v. Electrical Undertakings (Ltd.).

In the Chancery Division on Saturday Mr. Justice Cozens-Hardy heard a debenture stockholder's action against the company and the trustees of the deed. All the parties consented to take the judgment in the settled form, with the appointment of a receiver and manager. The court appointed Mr. C. E. Hare receiver and manager, to act for four months, but would not give him liberty to borrow £500 to carry on the business, stating that the parties would have to take out a summons in chambers for that purpose.

Workmen's Compensation Act.

Recently at the Bury County Court an application was made for an order for the payment of 12s. per week as compensation under section 8 of the Workmen's Compensation Act to E. Clegg, formerly in the employ of Mr. A. Greenhalgh, Radcliffe. It appeared that it had been agreed between the parties that Clegg should receive 12s. per week as compensation for injuries received. Difference arose, however, as to whether or not Clegg should attend each week at the works to receive the money, and he had been distinctly told that unless he did so the money would not be paid. There was nothing in the act which stated that a man must attend at the works in order to receive compensation, nor did it state that the money should be sent to him, but it was contended that the general law which applied to other debts and the general practice of the county court must be taken to cover the clause in the act.

After hearing arguments,

Judge J. K. BRADBURY pointed out that the clause meant that the person who paid was to get a discharge from the person who received the money, and did not say where the money was to be paid. He did not think it was the duty of the creditor to go for payment, and he made an order that the respondent should pay the weekly compensation at the residence of the applicant. The judge refused to grant an order in stay of execution in view of an appeal by the insurance company, the chief party affected by the decision.

Ellis *v.* Knott was an appeal action tried in the High Court recently It was desired to set aside the award of Judge Smyly, Q.C., at the Derby County Court. Appellant Ellis was a joiner, and respondent Knott was employed by him as a machinist. Part of respondent's duty was to work at a circular saw. While so working in August, 1899, he met with an accident, one of his fingers being cut off by the saw and two other fingers being injured. His average weekly earnings were 36s. An agreement was arrived at by which appellant agreed to pay respondent 18s. a week. A memorandum of this agreement was registered in the County Court, stating that appellant was to pay respondent a weekly payment of 18s. as compensation, "such payment to continue during the incapacity of the respondent, or until such time as the same should have been ended, diminished, or increased according to the provisions of the Act." In November, 1899, appellant offered to take respondent back into his employment at the same wages as before, but respondent refused the offer. Appellant thereupon filed a request for arbitration to review the weekly payment. The respondent at this time was earning about 10s. a week at other employment. At the hearing medical evidence was given as to whether respondent was fit to work at the same employment as before the accident, and the evidence of appellant was to the effect that the offer which he made was to employ the respondent at the same work at which he was working before the accident, and at the same wages. The County Court Judge said that, in his view, respondent could not work at the same employment at which he worked before the accident, or earn at that employment the wages he then earned; and that, therefore, he ought not to compel a man to go back to the employment to which he objected to go, even though the employer offered to make things easy and pay him his full wages. He further held that the sums respondent was then earning were no justification for reducing his allowance. He made an award refusing to reduce the weekly allowance.

Lord Justice COLLINS held that the appeal failed. The finding of the County Court Judge was that the man was no longer capable of earning the same wages at the same work at which he was employed before the accident. That work was, upon the evidence, the only work at which he could, as a mechanic, earn wages of that amount. Having lost one of his fingers and two other fingers being injured, the man was not fit to work at the circular saw. That was the only work offered to him by the appellant. The finding of the judge was, therefore, a finding that the man's earning capacity had been diminished. Having arrived at that fact, everything else followed, and the amount of the weekly payment was for the judge to determine, after giving due effect to all proper considerations.

Lord Justice Vaughan Williams and Lord Justice Romer concurred, and the appeal was dismissed, with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—The question of authorising the National Telephone Co. to put their wires underground is at present under consideration by the Finance committee. Last week a representative of the directors of the company attended before the committee to explain the company's proposals. He said the expenditure necessary to put the wires underground would be from £35,000 to £40,000, and the company would undertake not to increase the present charge for telephone service provided the necessary sanction to lay their wires underground were given. The company would also make other concessions. No decision has yet been come to.

Bermondsey (London).—The Vestry have received notice from the London County Council of intention to seek Parliamentary powers to construct an electric tramway on the conduit system along the new Tower Bridge southern approach.

Bradford.—A special meeting of the Council was held on Wednesday when the estimates for the current year were submitted and approved. The recommendation of the Electricity committee to apply for sanction to borrow £140,000 for electric lighting extensions was adopted.

Brechin.—Plans of the proposed electricity station building to be erected by the Angus Electric Light & Power Co. have been approved by the Police Commissioners.

Bristol.—At the meeting of the Electrical committee, held on Friday, Sir William Preece's report on the scheme for the extension of the electricity undertaking prepared by the borough electrical engineer (Mr. H. Faraday Proctor) was discussed. The report approves the scheme, and it was resolved to instruct the architect (Mr. H. Williams) to prepare the necessary drawing, specifications, and quantities, and when this preliminary work is completed to advertise for tenders. Extensions of the mains were also authorised.

British Chamber of Commerce, Paris.—The report presented at the twenty-sixth annual general meeting of this Chamber, dealing with the statistics of Anglo-French trade of 1899, and containing also comparative statistics with the previous year and a compendium of French legislation in 1899, is just issued by the British Chamber of Commerce, 25, Boulevard des Italiens, Paris.

Cardiff.—The Electric Lighting committee have authorised the engineer (Mr. N. Appelbee) to obtain quotations for an additional 500 H.P. steam alternator. The existing plant at the station is sufficient only to meet next winter's demand. The committee have also decided on Mr. Appelbee's recommendation to obtain a coal conveyor at £560.

Chartered Institute of Patent Agents.—The qualifying examination of persons desirous of being registered as patent agents will be held in November. A copy of the notice giving full particulars can be obtained on application to the secretary of the Institute, 19, Southampton-buildings, London, W.C.

Cork.—The Council have sanctioned the use by the Cork Electric Tramways & Lighting Co. of overhead wires for the supply of electric current in the suburbs.

Chatham.—The Council have decided to consult an electrical expert as to the purchase of so much of the undertaking of the Chatham, Rochester and District Electric Light Co. as is within the borough.

Dublin.—The electric tramway from Clontarf to Howth is practically completed, and the Board of Trade inspection will take

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place this week. The cars will run to and from the Nelson Pillar and the Hill of Howth, arrangements having been made with the Dublin United Tramways Co. to use that portion of the system.

Dunstable.—An increase of 5d. a thousand in the price of gas, coupled with the receipt of two notices of intention to apply for provisional orders, have induced the Council to take up the proposal to establish municipal electricity works. In the course of a discussion last week the deputy-mayor (Ald. F. T. Garrett) said he was in a peculiar position by reason of the notice given by his firm, Messrs. F. T. & A. Garrett & Co., electrical engineers. They had served a similar notice upon the Upper Houghton authorities. He had not wanted to force the hands of the Council at this juncture, though he had held the opinion for a long time that it was a question which the corporation should take into consideration. In case the corporation should not take the matter up, he thought electric lighting powers should not go into the hands of a company of which they knew nothing. It would be better for the undertaking to go into the hands of a local company or firm rather than those of outsiders. There was nothing to prevent the corporation obtaining an order and transferring it to a company; but his opinion was that the Corporation should undertake the work themselves. If the Corporation decided to take the matter up themselves he should be pleased to arrange to hand over his interests in regard to the neighbouring authorities to the Council. He should support the proposition to appoint a small committee to make inquiries as to cost, &c. He thought an electric lighting undertaking properly installed and properly equipped was bound to be a remunerative one. Ultimately it was unanimously decided to appoint a committee of four to make the suggested enquiries. This committee consists of the mayor (Mr. Ald. Perkins), the deputy-mayor (Mr. Ald. Garrett), and Messrs. Bosketh and Nash. There are several private electric plants in the district, including that at the big printing works of Messrs. Waterlow & Sons (Ltd.).

Electric Cycle Cleaners.—Mr. H. J. S. B. Cunliffe, M.A., writes:—

"Can I have my cycle house (which is already illuminated by electricity) fitted up with any sort of appliance for brushing my cycles and polishing them? Surely, if dentists can have an appliance of the sort that I have now in my mind fitted up in their consulting rooms for drilling teeth, it ought not to be a very hard matter to have a light contrivance fitted up in a cycle house for cleaning a machine, seeing that the 'bits' used would never be larger than a lamp chimney brush. Also, is there any means whereby electricity can be adapted to rotate the cylinders of an ice-cream making machine?"

Mr. Cunliffe's address is the New Club, Brighton, and perhaps makers of this class of apparatus will communicate direct with him.

Electric Railways and Tramways in Saxony.—On Dec. 31, 1899, the total length of the electric railways and tramways in Saxony was 142 miles, compared with 101¼ in 1898. The lines employed 131 motor cars and 289 trailers, compared with 591 and 238 respectively in 1898. On the accumulator cars a device has been introduced to overcome objectionable smells from the acid of the batteries. Upon several lines electric heating has been adopted.

Electric Traction in West London.—Mr. J. Clifton Robinson, managing director and engineer of the London United Tramways, writes to say that the preamble of the company's bill was passed by a House of Lords committee on Tuesday. A report of the proceedings before the committee appears on p. 491 of the current issue, and particulars of the committee stage in the Lower House appeared in our issue of May 11. Mr. Robinson states that the whole of their extensive scheme in West London, embracing extensions to Heston, Isleworth, Twickenham, Teddington, Hampton, and Hampton Wick, will at once be proceeded with. The present lines are already equipped, and will shortly be opened for traffic.

Electrical Enterprise in Italy.—The municipal authorities of Montorio al Vomano are applying for a concession to utilise the water power of the River Vomano for the generation of electric current for the lighting of the town.

Some experiments with electric accumulator traction have just been carried out on the Bologna-San Felice branch of the Rete Adriatica Railway. The test was made with a special car, similar to a Pullman, and it is stated that a speed of 70 kilometres per hour was attained. Similar experiments are shortly to be made on the Modena-Parma line.

Electricity in Mining.—At the meeting of the Burma Ruby Mines (Ltd.) on Tuesday the chairman (Sir Lepel H. Griffin) said their agent telegraphed on 6th inst. that both the electric plants were working satisfactorily. He thought they might look upon those electrical installations as the axis on which their future prosperity was to turn. If they had chosen to work in the old-fashioned way, with an enormous expenditure on fuel, fuel growing dearer each year, he was perfectly certain that the company would never have been a success. They had the intelligence, directly working by electricity was proved in other parts of the world to be a success, to adopt it in Mogok, and with the very best possible results.

Gloucester.—The electricity works were formally opened yesterday (Thursday).

Greece.—According to a report just published the Athens and Piræus Railway Co. must, according to the conditions of its franchise, adopt electricity as the motive power on its lines within the next three years. The length of the railway is 5 miles, extending from the quay at Piræus to the business centre of Athens. Along the route there is a tunnel three-quarters of a mile in length. It is stated further that a Belgian company, which owns and works a steam tramway in the same district, proposes to adopt electric traction.

Grimsby.—The Corporation have received the sanction of the Local Government Board for the issue of £57,538 Corporation stock for electric lighting and other purposes. Tenders are to be invited for the stock.

Hornsea.—The Council had a conference with Messrs. Bennett and Ward Thomas, on Monday, as to the proposed electric lighting and tramway scheme for the district. The chairman (Mr. T. B. Holmes, J.P.) said they were prepared to entertain a light railway scheme to Bridlington, but it would be of no benefit to Hornsea at present to have a tramway. However, if the company for which Messrs. Bennett and Ward Thomas were acting obtained an order for the light railway to Driffield, the Council would then discuss the scheme for Hornsea.

Hospital Lighting.—The Governors of Lincoln Hospital have decided to adopt electric lighting.

Kidderminster.—The town hall and municipal buildings are to be wired for the electric light.

Lancaster-Morecambe Electric Tramway.—A scheme for the construction of an electric tramway between Lancaster and the west end of Morecambe is being promoted by Mr. John Gardner, of Morecambe, and it is probable that parliamentary powers will be applied for next session.

Leigh.—Application has been made by the Council for sanction to borrow £5,000 for electricity works.

Light Railways.—The following dates have been provisionally proposed for the holding of inquiries by the Light Railway Commissioners:—

July 23. Kingston, Surbiton, & Dist. (1899) and Extens. (1900).	Sept. 26. Wigan.
„ 24. Hayling Island.	„ 27. Hyde and Dukinfield.
„ 26. Norwich and Dereham.	Oct. 10. Durham & District & West Hartlepool Extens. (1899).
„ 30. Bath and District.	„ 11. Jarrow and South Shields.
Aug. 3. Mid-Anglian (1899) and amending (1900).	„ 12. Wales & Laughton & Barnsley & District (Exten. No. 2).
Sept. 20. Rhyl & Prestatyn (Exten.).	„ 17. Kidderminster and Bewdley (Extension No. 2).
„ 21. Pwllheli and Nevin.	„ 25. Swansea and District.
„ 22. Warrington and Runcorn.	„ 26. Llanelly and District, and
„ 24. Windermere and District.	„ 27. Rhondda Valley.
„ 25. Blackburn—Burnley.	

Limerick.—An inquiry was held here last week into the application of the Council to borrow £20,000 for electric lighting. Mr. Baker, of the Gas committee, said he would advise the Corporation to undertake electric lighting even if it involved some loss. Plans and technical details of the scheme were submitted by the consulting engineer (Mr. J. Enright).

London County Council.—At Tuesday's meeting, £30,500 was loaned to Whitechapel for electric lighting. On the recommendation of the Asylums committee a capital expenditure of £39,000 was authorised for the construction and equipment of a generating station for the supply of electricity and water to the Horton Asylum. Of this sum £18,000 was for electric lighting plant. On the application of Shoreditch Vestry the Council consented to the erection of a new generating station at Bath-place, Haggerston.

Manchester.—An inquiry was held on Thursday last into the application of the Corporation for sanction to borrow £188,890 for electric lighting extensions. Mr. Hudson, deputy town clerk, explained that the sum formed part of £500,000 which it was decided to borrow in March, 1899. Particulars of the remainder of the proposed expenditure were not yet in a sufficiently advanced state to lay before the inspector. The city electrical engineer (Mr. C. H. Wordingham) gave technical details. He stated that there had been a great increase in the demand for electric current. The increased output in 1898 was at the rate of 31 per cent, in 1899 it was 43 per cent., and in the present year the percentage, so far, was 24. With regard to the supply of electricity for tramways he expected that three sections of the tramways would be in operation by the end of the year.

Melton Mowbray.—The local electric light company are about to start laying electric lighting cables. The Council will reinstate the roads at the company's expense.

Moss Side.—Sanction to a loan of £12,000 for re-laying the tramlines for electric traction has been applied for by the Council.

Municipal Telephony.—At the meeting of the Huddersfield Corporation on Wednesday Ald. Calvert moved the adoption of the recommendations of the Electricity committee to apply to the Postmaster-General for a licence to establish and work a telephone

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exchange in the Huddersfield area for 25 years. Mr. Riley thought that before the Council committed themselves to any expenditure they should have information as to the probability of the scheme being remunerative. Ald. Calvert said the estimates of expenditure and revenue had been gone into. The cost would be £30,000 for the whole scheme. He did not think there could be any doubt that they or any other municipality would be able to use the National Telephone Co.'s wires in other towns if their messages went over the trunk lines. Ald. J. L. Walker was not opposed to municipal telephones, but they ought to be sure before taking an important step of that kind that there would be an interchange of messages between the National and the Corporation systems. The town clerk (Mr. F. C. Lloyd) supported the statement of Ald. Calvert with regard to inter-town communication. The company was under obligation by agreement with the Postmaster-General to distribute in other towns the messages they received over the trunk wires from the Corporation exchange. He pointed out, however, that the case was somewhat different in regard to the urban districts outside Huddersfield, and as to the position these places would be in there was certainly a difference of opinion. Ultimately the Council confirmed the committee's recommendations by a substantial majority.

At the meeting of the Manchester Telephone committee on Tuesday a letter was read from the manager of the National Telephone Co. (Mr. W. E. L. Gaine) in reply to the suggestion made by representatives of the committee, that the company should sell their plant in the Manchester telephone area to the Council. The reply was, we believe, in the negative, but a counter proposal, made by Mr. Gaine, is, we understand, to form the subject of an interview between the parties.

Obituary.—The death is announced of Mr. Hamilton Smith, mining engineer, which took place at Durham, New Hampshire (U.S.A.), on 4th inst. In addition to his connection with many mining enterprises, Mr. Smith was also associated with the Electric Traction Co., the Central London Railway Co., and the Anaconda Copper Co.

The death is announced of Mr. Alexander Bruce, manager of Dumbell's Bank and chairman of the Isle of Man Tramways & Electric Power Co. (Ltd.), which took place at Douglas on the 15th inst.

Parsons' Turbo-Alternators.—The Corporation of Frankfort-on-Main (Germany) has placed an order with the newly-formed Brown Boveri-Parsons Syndicate for a 4,000 H.P. single-phase turbo-alternator for the extensions to the Frankfort electricity station. The plant installed at this station consists of four 500kw. and two 1,000kw. units, and two further 1,000kw. units are being erected. Throughout the plant at Frankfort is single-phase, yet the total capacity of the motors connected to the mains exceeds 5,000 H.P. The turbo-alternator now on order will run at 1,360 revs. per min., giving current at 3,000 volts. It will be capable of giving its full output of 4,000 H.P. when working on an inductive load having a power factor of 80 per cent., and will be provided with a special winding by means of which it can be made to generate three-phase current with an output of 5,000 H.P. This set will be much the largest turbo-alternator ever made, and is designed to rival in power the largest reciprocating steam engine ever built for direct connection to electrical machinery.

Roumania.—A company, entitled La Société des Tramways et Eclairage Electrique de Braila, has been formed, with a capital of £160,000, for erecting electricity supply works, and constructing an electric tramway in Braila, Roumania. The Helios Co. is interested in the venture.

Sao Paulo (Brazil).—In May last the Sao Paulo Railway, Light & Power Co. commenced the supply of current for lighting this city of 300,000 inhabitants. The station and works generally were designed by Mr. F. S. Pearson, the works have been carried out under the supervision of the engineer-in-chief, Mr. Greaves, and Mr. R. C. Brown is manager of the company. The alternating-current system with four-wire distribution at 400 volts is used. Current is supplied for lighting, power and traction. The company is itself the owner of a railway which commenced working in April with 10 single-decked cars on the overhead trolley system. The company leases the water power owned by the State, which will equal 10,000 H.P. upon the completion of their works. The Sao Paulo Company has recently acquired the concession granted by the municipality of Santos to Drs. Santos da Silva and Joao da Silva Martins for the introduction of electric traction into that city. The company has petitioned for an extension of the concession to enable it to run electric cars to different points not already served by the local tramways company. The district possesses a private telephone service at a subscription of $15 per annum or 10s. per month.

Scholarships.—As a result of the recent Scholarship Examinations at the Electrical Standardising, Testing and Training Institution, the following awards have been made by the Board of Control: To Mr. F. E. Berry, Wellingborough School, Maxwell Scholarship value £52. 10s., tenable for two years, and to Mr. A. W. Scrooby, of Dunheved College, a prize value £21.

Southport.—A Board of Trade inquiry was held on Tuesday into the Corporation's application to borrow £40,000 for reconstructing and electrically equipping the Birkdale and Southport tramways, with which the Southport and Ormskirk light (electric) railway will ultimately connect. The present loan will bring the Corporation's expenditure on electric tramways to £135,500, and this sum will be further increased by £50,000 or £60,000 when the reconstruction of the Churchtown tramways is taken in hand. £66,000 has been expended on new lines to the Blowick and High Park district, which Mr. A. P. Trotter officially inspected on behalf of the Board of Trade on Tuesday. The lines were opened for traffic on Wednesday.

South Shields.—An inquiry was held here last week into the application of the Council to borrow £36,750 for electric lighting extensions. The application was supported by the town clerk (Mr. J. Moore Hayton), and technical details were given by the borough electrical engineer (Mr. J. A. Jeckell).

Tunbridge Wells.—An interesting review of the progress of the electricity works at Tunbridge Wells appears in the Tunbridge Wells *Advertiser* for July 13 accompanied by an interview with the borough electrical engineer, Mr. Horace Boot, whose exhaustive project for dealing with the large demand for current in Tunbridge Wells has now been adopted in its entirety. Under this scheme, as our readers are aware, £25,000 is to be expended. This extension is the fourth that have taken place since the works were first established.

Valencia (Spain).—A French company has recently taken over the tramways of this city, 25 miles in extent, and is substituting electric for steam and horse traction. Already electric cars are running between Valencia and the park. The trolley system is used. The cars are of Spanish construction, and the electrical equipment is Belgian.

Vladivostock.—A concession for the construction and working of electric tramways and of public and private electric lighting in Vladivostock has recently been granted. The tramway is to be about 12 miles in length.

Water Power in Canada.—The Shawinigan Water & Power Co., lessees of the Shawinigan Falls, are completing the equipment of their extensive works for the transmission of power to Montreal, a distance of 80 miles. The capacity of the works when these arrangements are completed will be almost unlimited, and the scheme will place Montreal in the front rank for cheap power for manufacturing purposes. The works will be completed during the summer, and will at first provide power for 30,000 H.P., to be subsequently increased to 75,000 H.P. This power will be available in the spring of 1901. The main cables will traverse the line of the Great Northern of Canada Railway, which runs in a direct line west from Shawinigan Falls to Joliette, from thence overhead to the island of Montreal, being taken into the city by underground route. So far little has been done in Montreal to put electric power into general use for industrial purposes. Owing to the low cost of development at Shawinigan, competition between steam and electricity will be very keen at Montreal, where the average price of steam coal is 12s. 6d. per ton.

West Bromwich.—The foundation stone of the electricity station buildings at Black Lake was laid by the Mayor (Ald. S. Pitt) on Monday.

Workhouse Lighting.—The Holborn (London) Guardians recently decided to put down independent plant for the electric lighting of the City-road workhouse, but at the next meeting of the Guardians Mr. Putterill will move that current be taken from either the Shoreditch Guardians or the County of London Company, on the ground that this course would be more economical than the guardians generating their own current.

The House committee has been requested to reconsider the question of adopting electric lighting at the Kidderminster workhouse, and to submit particulars of cost of wiring, with relative cost of electric and gas lighting, &c.

Worksop.—An inquiry was held here on Tuesday into the application of the Council to borrow £15,579 for electric lighting. Plans and technical details of the scheme were submitted by the consulting engineer (Mr. A. B. Mountain). The chairman of the Lighting and Paving committee (Mr. Ilett) said the Council were unanimous in regard to this loan. It was most desirable to adopt some improved method of public lighting as there had been considerable complaint for some years past as to the gas lighting.

Wurtemberg.—Telephone rates in this city have been recently reduced to £4 per subscription per annum, with an additional charge of ½d. for communicating over the local circuit, over distances of 9 miles 1d., 31 miles 2d., and beyond this distance 6d.

Outing.—The employés of the Robertson Lamp Works held their annual excursion on Saturday when a party of over 200 spent the day at Hastings.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

As announced in an advertisement the *Pacific Cable* committee invite tenders on behalf of Her Majesty's Government, the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland for the manufacture and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cable between Vancouver and Queensland. The whole undertaking will be divided into three contracts, and a fourth contract is also proposed for surveying and sounding the whole route before the cables are laid. Forms of contract, specification, and particulars may be obtained from Messrs. Clark, Forde & Taylor, 4, Great Winchester-street, London, E.C., where tenders must be lodged by noon of Tuesday, 14th prox.

The Electric Lighting committee of the Vestry of *St. Mary, Islington* (London) require tenders for relaying York and other stone, and providing new York and other stone where necessary, over the electric conduits and mains which may be required during the ensuing three years. Further particulars are set out in an advertisement, and specifications may be obtained at the electricity department, 50, Eden-grove, Holloway, N. Tenders to the vestry clerk (Mr. Wm. F. Dewey), Vestry Hall, Upper-street, N., by noon of 25th inst.

Halifax Corporation invite tenders for combined steam engine and alternator, alternators, static transformers, induction motors, rotary converters, and three-phase extra high-tension switchboards. Specification may be obtained from the borough electrical engineer (Mr. H. F. Street), Foundry-street, Halifax, and tenders must reach the town clerk (Mr. Keighley Walton) by noon of Tuesday, 31st inst. An advertisement contains further particulars.

Barnes Urban District Council is prepared to receive offers of terms from "free" wiring firms for wiring premises in the Barnes district. Applications to Mr. John Eustace Anderson, clerk to the Council, High-street, Mortlake, S W., before 6th prox. An advertisement gives some further particulars.

Glasgow Corporation require tenders for concentric and single main cables, particulars of which are set out in an advertisement. Specifications may be obtained from the engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow, and tenders must be lodged with the town clerk (Sir J. D. Marwick) on or before 26th inst.

Grimsby Corporation invite tenders for wiring their electricity works. Specifications may be obtained from the town clerk (Mr. W. Grange), St. Mary's-gate, Grimsby, and tenders must be in by Aug. 8. An advertisement gives further information.

Dorking District Council invite offers for leasing their provisional order. Tenders to clerk (Mr. Geo. Scales), 65, High-street, Dorking, by Aug. 30. See advertisement.

Salford Electric Light committee invite tenders for nine transformers and 4½ miles of low-tension concentric cable. Tenders to chairman of committee by 10 a.m., 27th inst.

Salford Corporation invite tenders for laying cables, tramway feeders, and street lighting. Tenders to town clerk by Aug. 13.

Hull Corporation invite tenders for an electric lighting installation at the Springhead pumping station. Tenders to chairman Water and Gas committee, Town Hall, Hull, by 10 a.m., 23rd inst.

Hull Corporation also require tenders for five high-tension continuous-current rotary transformers, with switch gear and accessories. Tenders to chairman of Electric Lighting committee, by noon of July 26.

Sunderland Corporation invite tenders for coal-conveying plant for their electricity station. Tenders (addressed chairman Lighting committee) to town clerk by noon of 27th inst.

Aston Manor District Council require tenders for the supply and erection of electricity generating plant. Tenders to chairman Health committee by noon 24th inst.

Darlington Corporation require tenders for arc lamp posts and brackets. Tenders to town clerk by 28th inst.

Rugby District Council invite tenders for leasing their provisional electric lighting order (1898). Applications to clerk by Aug. 1.

Bradford Corporation invite tenders for steel girder and steel trough rails and fishplates. Tenders to town clerk by 28th inst.

Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment. Tenders to clerk by Aug. 31.

Torquay Council require tenders for additional generating plant. Tenders by Aug. 6.

Cardiff Corporation require tenders for ten 30kw. transformers. Tenders to clerk by July 24.

Barcelona Harbour committee invite tenders until Oct. 2, for elevators, lifts, &c., for the new commercial depository building of the port.

TENDERS RECEIVED AND ACCEPTED.

Shoreditch (London) Vestry have accepted the tender of Messrs Babcock & Wilcox for four boilers for the electricity works at £5,600, and for four economisers at £880. The following is a list of the tenders submitted:—

Dry Back Boilers.

	4 boilers.		8 boilers.
Fleming & Fergusson	£9,300	...	£17,500
D. Stewart & Co.	7,705	...	15,245
Davey, Paxman & Co. (10 boilers)	14,169		
Hodge & Son	6,250	...	12,300
Fraser & Co.	5,889	...	11,579
E. Danks & Co.	5,500	...	11,005

In Fraser & Co.'s tender the amount of £250 was added for work not included in the specification for the four boilers, and £600 for the eight boilers. In Davey, Paxman & Co.'s tender £700 was added for a stoker. Danks and Co.'s quotation for an economiser of 960 tubes was £1,776, and that of D. Stewart & Co. £1,943. 6s.

Water Tube Boilers.

	4 boilers.		8 boilers.
Babcock & Wilcox marine type (*accepted*)	£5,600	...	£11,200
Ditto land type, Green's make	5,500	...	11,000
D. Stewart & Co.	7,097	...	14,027
W. R. Renshaw & Co.	6,248	...	11,996
B. R. Rowland & Co.	5,655	...	11,145
E. Danks & Co.	...	...	11,005
Stirling Boiler Co.	4,283	...	8,490

In Babcock & Wilcox Co.'s accepted tender for economiser, a B. & W. 350 sq. ft. economiser is specified. The same firm's alternative tender for land-type boilers specifies the price for economiser (Green's make) £1,650. Danks & Co. and D. Stewart & Co. tender for economisers at the same figures as in the dry back boiler tender.

The following tenders have been received for the electric lighting of Thorp Perrow, Yorkshire, for Mr. N. C. Allfrey. Mr. Morgan Williams, C.E., 39, Victoria-street, Westminster, S.W., is consulting engineer:—

Mavor & Coulson...(*accepted*)	£1,995	Cox-Walkers	2,400
Ditto (alternative)	2,051	Ditto (alternative)	2,280
Ditto (alternative)	2,030	Bland Bros.	2,380
J. H. Holmes & Co.	2,575	Walker & Hutton	2,250
Ernest Scott & Mountain	£2,504		

Glasgow Corporation have accepted the tender of Messrs. Mechan. & Sons for the switchboard for the Port Dundas station at £1,122. The contract for the supply of carbons for 12 months has been divided between the International Electric Co. and the General Electric Co.

London County Council has accepted the tender of Messrs. J. T. Mayfield & Co. for the installation of telephones, tell-tale clocks, fire alarms, and call-bells at the Horton Asylum for £1,655.

Grimsby Town Council have accepted the tender of Messrs. Chamberlain & Hookham for electricity meters, and that of Messrs. Mackenzie Bros. for arc lamp posts.

The tender of Messrs. Bardell Bros. has been accepted by the Lynn Council for extensions of the electricity station buildings at £1,178.

APPOINTMENTS VACANT AND FILLED.

Bolton Corporation invite applications for the post of electrical engineer to take charge of their electric lighting and tramway undertakings. Further particulars are set out in an advertisement, and applications must be delivered to the town clerk (Mr. R. G. Hinnell) not later than 30th inst. The Corporation are offering a salary of £500 per annum, with annual increments of £50 to a maximum of £700.

An electrician-in-charge is required for the Huddersfield Corporation electricity station. An advertisement contains further particulars, and applications must be sent to the borough electrical engineer (Mr. A. B. Mountain), St. Andrew's-road, Huddersfield, by 26th inst.

Manchester Tramways committee require an experienced traffic superintendent. Particulars from the general manager (Mr. J. M. McElroy), and applications (addressed to chairman of committee, Town Hall, Manchester) must be sent to the town clerk (Mr. Wm. Henry Talbot) before Saturday, 28th inst. See advertisement.

The Hoylake and West Kirby District Council require a clerk of works, to act under their consulting engineer, for their electricity supply undertaking. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. Roderick Williams), Town Hall, Hoylake, by 26th inst.

British Electric Traction Co. (Ltd.), Donington House, Norfolk-street, Strand, London, W.C., have a vacancy for a first-class draughtsman. See advertisement.

An assistant is required in the engineering department of the Merchant Venturers' Technical College, Bristol. Applications to registrar by Aug. 13. See advertisement.

The Governors of the Birkbeck Institution invite applications for the position of head of the physics department. Applications to the principal, Bream's-buildings, Chancery-lane, E.C.

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A demonstrator and assistant lecturer in physics is required for the University College of South Wales and Monmouthshire, Cardiff. Applications to secretary, by Sept. 9.

Mr. Arthur Wigram, with Messrs. Willans & Robinson, Rugby, has been appointed junior assistant engineer at the Sunderland Corporation electricity works.

The British Electric Works Co. have appointed Messrs. Gent & Co. agents for Newcastle and district. Mr. S. Haynes has been appointed Nottingham agent to the company.

Mr. R. A. D. Macalister, of Hanley, has been appointed assistant electrical engineer at Greenock at £120 per annum.

BUSINESS NOTICES.

B.E.T. Staff Changes.—Mr. James Devonshire having been appointed a member of the committee for Associated Undertakings, has vacated the position of district superintendent for London and South Eastern district; Mr. Daniel F. Sugrue has vacated the position of district superintendent for the Eastern Counties district, and will undertake certain supervisory duties for the management. Mr. George Stevens has resigned the position of secretary, and has been appointed chief district superintendent, with charge of the London and South Eastern and Eastern Counties districts. Mr. Charles H. Dade has been appointed secretary; and Mr. Ernest Hopwood has been appointed districts secretary.

Mr. W. G. Rhodes, M.Sc., M.I.E.E., has resigned his position as chief lecturer in electrical engineering at the Royal Technical Institute, Salford, to join Mr. T. M. Hewitt, formerly manager of Messrs. Mather & Platt (Ltd), and now carrying on business as consulting mechanical and electrical engineer, Tower Chambers, Brown-street, Manchester. In future the business will be carried on at the same address under the style of Hewitt & Rhodes.

The General Electric Co. of New York notify the opening of a London office at 110, Cannon-street, E.C. It is stated that the business of the company will be conducted in close accord with that of the British Thomson-Houston Co. (Ltd.) and the companies owning general electric patents in various countries, or who are licensed thereunder. The office will be open for the sale of general electric apparatus and supplies to the colonial and ex-territorial trade.

Messrs. J. A. Aiton and J. L. Clark (trading as Clark & Aiton), consulting engineers, 102, Fenchurch-street, and 25, Laurence Pountney-lane, London, E.C., 25, Water-street, Liverpool, and 75, Buchanan-street, Glasgow, have dissolved partnership.

Messrs. Welch, Fry & Skelton, electrical engineers, are removing to Salisbury House, London-wall, London, E.C.

Messrs. Babcock & Wilcox (Ltd.) are removing to Oriel House, Farringdon-street, London, E.C., after 23rd inst.

BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee in bankruptcy of Thos. Ford (trading as Thos. Ford & Co.), electric fittings manufacturer, Victoria Works, Emily-street, Highgate, Birmingham, has been released.

The trustee in the bankruptcy of H. J. Wimshurst, electrical and motor car engineer, 4, Foleshill-terrace, Coventry, has been released.

A receiving order has been made against Leonard Francis, electrical engineer, 13, Corporation-road, Southwold, Suffolk. The first meeting of creditors will take place on 21st inst., at 8, King-street, Norwich, and the public examination on 24th inst., at the Town Hall, Great Yarmouth.

The discharge of F. G. W. J. Adams, electrical engineer, lately trading in partnership as Downie & Adams at 24, Newman-street, Oxford-street, W., has been suspended for two years.

A meeting of creditors of W. J. S. Green, electrician, &c., of Aston, was held last week at Birmingham. The statement of affairs showed liabilities £279. 5s. 4d., deficiency £266. 17s. 7d. Bankrupt, who assigned heavy expenses and bad trade as causes of his failure, executed a deed of assignment in 1894, with liabilities of £182. 18s. 10d., of which £20 was still owing, and the adverse balance gradually accumulated from that time. The Official Receiver was appointed trustee.

L. Francis, electrical engineer, 13, Corporation-road, Southwold, has been adjudicated bankrupt.

The Brockie-Pell Arc Lamp (Ltd.) is to be wound up voluntarily for purpose of reconstruction. Mr. D. F. Basden, 33, St. Swithin's-lane, E.C., is liquidator. Particulars of the registration of the new company are given in another column.

Claims against the Dawson Gas Engines Syndicate (Ltd.) must be sent to the liquidator (Mr. A. S. Chapman), 7 and 8, Ironmonger-lane, E.C., by Aug. 28.

Patent Amendment.—Notice is given in an advertisement that the Société Anonyme Pile Bloc, 27, Rue de l'Hotel de Ville, Lyons, France, has applied for leave to amend specification of Letters Patent No. 16,597 of 1896, granted to MM. R. M. J. Heurtey and P. Germain for "Improvements in and relating to primary batteries." Particulars of the amendment are given in the *Illustrated Official Journal* (Patents) of the 11th inst., and notice of opposition must be given within one calendar month from that date.

Insulating Fibre.—Messrs. Cort & Co., 277, Camberwell New-road, London, have issued a new wholesale price list of insulating fibres, hard and flexible, and of balata, gutta-percha and cotton belting.

Radiography Apparatus.—Messrs. Isenthal & Co., of 85, Mortimer-street, London, W., have issued the third edition of their radiographic list, which can be obtained on request.

Westinghouse Plant.—The British Westinghouse Electric Co.'s circular No. 1,028, just issued, is devoted to a description of Westinghouse rotary converters, several important installations of this plant being illustrated.

Burglary.—Mr. A. P. Lundberg has again been the victim of the housebreaker (the third time in six months). Unfortunately, on this occasion the loss has been considerable, some valuable tools having been removed. Correspondents are invited to communicate with Mr. Lundberg in the event of their letters having remained unanswered or remittances unacknowledged.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 11 to July 17, with the ports of destination:—

Africa—Alexandria, £104; Cape Town, £212; Durban, £289 (including £151 telegraph material); East London, £442; Port Elizabeth, £760. *Argentina*—Buenos Ayres, £1,083 (including £914 (telegraph material). *Australasia*—Brisbane, £26; Melbourne, £38; Perth, £16; Sydney, £226; Wellington, £120 (telegraph cable). *Austria*—Fiume, £21. *Azores*, £166,000 (telegraph cable). *Belgium*—Ghent, £15. *Ceylon*—Colombo, £75. *Chili*—Boca, £1,141. *China*—Shanghai, £86. *Germany*—Hamburg, £374 (including £350 telegraph material). *Gibraltar*, £78. *Holland*—Rotterdam, £150 (telegraph material). *Hong Kong*, £230. *India*—Bombay, £446; Calcutta, £800 (including £260 telegraph wire). *Mauritius*, £165. *Straits Settlements*—Singapore, £12,357 (telegraph material). *Turkey*—Constantinople, £10. Total £185,264, against £6,912 in the corresponding week last year (July 12 to 18).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 30, 1900.

7,983. J. N. Maskelyne, jun. London. Improvements in electrical signalling.

7,989. W. F. Jones. London. Improvements in electric switches.

7,997. O. Kammerer. London. A new and improved electric gear for cranes.

May 1, 1900.

8,013. H. O. Farrell. Manchester. Improvements in and connected with electric switches.

8,015. A. Ballance and S. A. Jefferson. Hull. A new or improved method and apparatus for electric railways and traction purposes.

8,019. J. Dewar. Glasgow. Improvements in and relating to winches for raising and lowering arc lamps.

8,022. A. H. Midgley. Bradford. Improvements in dynamos and electro motors.

8,028. G. W. Holt and A. J. Hallam. Birmingham. Improvements in and relating to electric bells or instruments requiring vibrating motions.

8,061. J. A. Poché. London. Overhead electric protector for conductors.

8,067. A. T. M. Johnson and G. Guyott. London. A new or improved method of tuning electric currents and producing musical sounds by electrical agency.

May 2, 1900.

8,103. A. G. New. Woking. Improvements in electric igniters for internal combustion engines and the like.

8,107. The British Electric Works Co. (Ltd.) and B. Brander. Birmingham. Improvements in or connected with telephone instruments.

8,111. The British Electric Works Co. (Ltd.) and B. Brander. Birmingham. Improvements in parts of telephone instruments.

8,116. F. A. Williams. Manchester. Improvements in the construction of casing and capping, and in the means of attaching same together for use in connection with electrical installations.

8,122. B. C. Bouquet. London. The improved electrical fusible cutout.

8,123. H. Oppenheimer. London. Improvements in and connected with electric light wall plugs. (Actien-gesellschaft Mix & Genest, Germany.)

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8,153. W. L. Wise. London. Improvements in transformers. (The Actien-Gesellschaft Elektricitäts-werke vorm. O. L. Kummer & Co., Germany.)*
8,160. W. Ely. Liverpool. Improvements in electric switches.*

May 3, 1900.

8,179. W. F. Jones. London. Improvements in electric switch apparatus.
8,181. C. J. Wightman and A. Hudson. Bradford. Improvements in junction boxes for the conduits or casings of electric wires.
8,201. G. H. Barnes. Birmingham. Globe or shade holder for gas, oil, or electric light fittings.
8,207. The British Thomson-Houston Co. (Ltd.). London. Improvements in insulated electric conductors, and process of and apparatus for making the same. (W. S. Clark and G. H. Rupley, United States.)*
8,208. The British Thomson-Houston Co. (Ltd.) London. Improvements in high-potential electric switches or circuit-breakers. (E. M. Hewlett, United States.)*
8,211. B. A. Brooks. London. Electro-mechanical printing apparatus.
8,225. S. Gelder. Liverpool. A new or improved article of manufacture for use in connection with telephone or telegraph instruments.
8,226. P. Schmitt. London. Improvements in plates for secondary batteries.*
8,227. V. A. Fynn. London. Improvements in or connected with windings for dynamo-electric generators motors and converters.*
8,234. The British Westinghouse Electric & Manufacturing Co. (Ltd.). London. Improvements in electric rail bonds. (C. F. de Redon, United States.)
8,239. Siemens Bros. & Co. (Ltd.) London. An improvement in electricity meters constructed on the Ferraris principle. (Siemens & Halske Aktien Gesellschaft, Germany.)*
8,241. M. Kallmann. London. Improvements in electricity meters.

May 4, 1900.

8,257. T. H. Gardner and L. Gardner. Manchester. Improvements in electric ignition devices for gas and oil engines.
8,271. P. C. Middleton and W. S. H. Smith. London. A new or improved electrical switch.
8,289. G. E. Heyl-Dia. Liverpool. Improvements in or in connection with insulated electric cables or conductors and the manufacture thereof.
8,290. G. E. Heyl-Dia. Liverpool. Improvements in or relating to insulated electric cables or conductors and the manufacture thereof.
8,293. J. F. Smith. Birmingham. Improvements relating to electrical installation and distribution.
8,299. J. Y. Johnson. London. Improvements relating to two-liquid primary batteries and regenerating the same. (H. J. Dercum. United States.)*
8,300. J. Y. Johnson. London. Improvements relating to two-liquid primary batteries and regenerating the same. (H. J. Dercum. United States.)*

May 5, 1900.

8,315. W. F. Jones. Hammersmith. Improvements in electric switches.
8,347. J. Taylor and A. Hudson. London. Improvements in or relating to the "trolley-head" employed in connection with electrically propelled cars or vehicles.
8,351. L. Petich. London. Improvements in electro-medical batteries.
8,357. G. Hookham. London. Improvements in electricity meters.
8,361. F. Gill, R. Gilmour and P. H. Claxton. London. Improvements in apparatus for switching electric currents on and off, especially suitable for lighting telephone switchboards.

May 7, 1900.

8,382. T. W. Madsen and F. M. Madsen. London. Improvements in electric switches.
8,384. J. Higson and J. Hargreaves. Keighley. Improvements in means for supporting overhead conductors for electrically-propelled tramcars.
8,427. O. Kammerer. London. Improvements in and connected with electrical presses.
8,433. F. Dannert. London. Process for the production of electrically conductive illuminating bodies.*
8,434. F. Dannert. London. Process for the production of electric incandescence bodies.*

May 8, 1900.

8,439. S. W. Richardson and R. P. Elliott. London. Improvements relating to intercommunication by means of electro-mechanical typewriting or printing instruments.*
8,449. R. Kennedy. Leeds. Improvements in transmitting power and in electric motors and generators therefor.
8,465. A. J. Boult. London. Improvements in or relating to electric motors. (P. J. Collins, United States.)*
8,471. L. Renaud. London. Improvements in electrical accumulators. (Date applied for under Patents, &c., Act, 1883, sec. 103, Dec. 6, 1899, being date of application in France.)*
8,475. The British Thomson-Houston Co. (Ltd.). London. Improvements in alternating electric current motive apparatus. (C. P. Steinmetz, United States.)*
8,476. The British Thomson-Houston Co. (Ltd.) and H. M. Hobart. London. Improvements in induction electric motors.*
8,479. E. J. S. Wheatcroft and E. B. Gray. London. Improved electrical starting switch.
8,524. S. Simpson. London. Improvements in coin-freed mechanism applicable to gas, electricity, and like meters.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

13,276. Rosling and Appleby. Enclosed motors or dynamos.
13,424. Aldridge. Electric cranes and similar revolving appliances.
15,525. Hopstede-Crull. Electric switches.
13,593. Tommasi. Secondary batteries. (Date applied for under International Convention, January 23, 1899.)
13,656. Leitner. Brakes for electric motor vehicles.
16,352. Bedell. System of telegraphy.
16,739. Grunow. Road contact and like systems for electric railways. electric train control.
16,922. Hardingham (Schulz). Electric spark-fuse.
25,072. De Mare. Electrolytic interrupter.

1900.

420. Bremer. Electric arc lamps.
2,621. Ruhstrat and Ruhstrat. Safety and indicating device for electric circuits.
2,857. Lambert. Phonograps and like instruments for reproducing sound.
2,862. Richter and Eschler. Electric traction motors.
3,196. Wojniewicz. Telegraphic apparatus.
3,274. Buck. Process of and apparatus for the electro-deposition of metals.
3,315. Brookes (Boston Electric Heating & Power Co.). Electric heating apparatus.
3,441. Byng and Bell. Systems of telephonic communication and signalling.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.).

The fifty-sixth half-yearly ordinary general meeting was held yesterday (Thursday) under the presidency of the Marquis of Tweeddale, K.T.

The SECRETARY (Mr. George Draper) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, I have to invite your approval of the report and accounts, but before putting the resolution, I will refer to some of the more important events during the past half-year. The gross revenue for the half-year amounted to £543,684, an increase of £50,160. Analysing the receipts from various sources we find there is an increase generally from the most important traffic centres, more especially from South Africa. India, however, again shows a decrease, as compared with the corresponding period of last year, of £3,500. The total ordinary expenses for the half-year amounted to £128,072, an increase of £5,511. When I had the pleasure of addressing you last January, you will no doubt remember that this increase in the expenses was fully entered into and anticipated, and you must be prepared for a gradual increase in the working expenses in future for reasons I shall refer to presently. The expenses attending repairs and renewals of cables amounted to £27,939, against £34,520, a decrease of £6,581. This is to a large extent due to the extra credit received on account of the hire of our ships by other companies and foreign governments. You will notice from the report that a further reduction from 4s. 9d. to 4s. per word in the tariff between Europe and the colonies of South and Western Australia and Tasmania came into operation on May 1 last, and that the agreement with these colonies provides for further reductions under certain conditions to a minimum of 2s. 6d. per word. Substantial reductions in the tariff between the contracting colonies and South Africa will also come into operation when the new cables between Durban and Perth are completed. It is also anticipated that further reductions in the tariff between Europe and the Cape will take place in accordance with an arrangement between this Company, Her Majesty's Government, and the Governments of Cape Colony, Natal, and others interested. Negotiations are also in progress for a reduction in the tariff between Europe and India. The delay is caused by the fact that various administrations interested in this tariff have, under the regulations of the International Telegraph Convention, to be first consulted. Application has been duly made in the proper quarter, but up to the present replies have not been received. This Company has, as far as its own line is concerned, given its consent to the reduction from 4s. to 2s. 6d. per word with a further reduction to 2s. under certain conditions. This Company is, therefore, in no way responsible for the delay in the reduction of the tariff between this country and India. The effect of these important reductions will doubtless be to increase the volume of traffic, but it must be remembered that we can only earn the same amount of revenue in the future as we have done in the past by performing a much greater amount of work. This, in its turn, necessitates a larger staff, and consequently an increase in the various expenses incidental thereto. Another and more important factor which these reductions in tariff bring in their train is the necessary additional outlay for new cables and the extra annual revenue charges attending such large items of expenditure as we have already made, and which we have still to make. The reduction of rates and increased cable capacity are so closely connected that, considering the enormous outlay involved in laying new cables, a reduction of rates must of necessity be done gradually and with the utmost discretion, as a considerable time must elapse before the traffic develops sufficiently to give a fair return on the additional expenditure. Whenever traffic has shown evident signs of expansion warranting a reduction being made, your Directors have always

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been willing to consider the question, notwithstanding all that has been said to the contrary by those who criticise our actions, but who are not sufficiently acquainted with the complicated question of cable rates. Your Directors are consistently following a policy of sharing our prosperity with the telegraphing public, after providing a fair and reasonable return to our stockholders. We have now arrived at a position of which, I think, we may be justly proud, and I think it must be admitted by those who have watched the progress of this Company that its prosperity is the result of careful and judicious management; and it is only of late years that a financial position has been arrived at which makes it possible for us to undertake the heavy responsibility of expending large sums on new cables in view of further and more important reductions of rates. The charge has been frequently made against this Company that the amount distributed by way of dividend and the accumulation of our reserves are excessive, but considering the peculiar nature of our property, the amount distributed by way of dividend cannot fairly be held to be unreasonable. To properly appreciate the financial position of these companies the net return on the total capital should be taken into consideration. The amount distributed on the capital of this Company and the Eastern & South African Co., of which this company holds the whole of the share capital, is only a little under 5½ per cent.; it is exactly 5·43 per cent. With regard to the amount of our reserve funds, it is held by those responsible for the management that the business of submarine telegraphy can only be successfully conducted by adequate provision being made for depreciation, so that cables can be renewed as they wear out, and additional cables can be laid as required without creating heavy additions to the capital account. Your Directors are of opinion that it is only by consistently adhering to this policy that further and more important tariff reductions can be made. When we successfully established submarine telegraphic communication with Gibraltar, Malta, Egypt, India, and later on with South Africa, we had to rely on a single line of cables, but the appreciation of submarine telegraphy entirely altered the method of conducting the trade of the world. Governments, merchants, and the Press found it indispensable and relied upon it for rapid communication. In consequence, traffic developed, and this Company, in conjunction with the other associated companies, recognising the necessity for greater security against interruptions, immediately commenced to duplicate their cable system throughout, and, as traffic increased, triplicate and even quadruplicate cables were laid over certain sections. Since the early part of last year this Company alone has incurred the following liability for new cables: The Porthcurnow-Gibraltar-Malta and Alexandria sections, already laid, costing £442,000, and the Cape Town-St. Helena-Ascension and St. Vincent sections, already laid, costing about £840,000, or a total of £1,282,000. The St. Vincent-Madeira-Porthcurnow and the Durban-Mauritius sections, together with the Sierra Leone-Ascension cable, duplex apparatus, and the extra cost of replacing the old s.s. "John Pender" by a vessel of greater speed and carrying capacity, and other items, will bring the total expenditure lately incurred and to be incurred by this Company alone to over £2,500,000. In addition to what this Company has agreed to expend on new cables, the Eastern Extension Company has undertaken an expenditure of about £1,250,000, so that, exclusive of the Porthcurnow-Gibraltar-Malta-Alexandria cables already dealt with by this Company, the cost of the new route from Great Britain to the Cape and on to Australia, together with the Sierra Leone-Ascension cable, will involve an expenditure between the two companies of over £3,300,000. Since the beginning of last year up to the date of the present accounts we have been able to pay towards these new cables about £1,175,000. Of this amount we have charged to capital account for the Porthcurnow-Gibraltar and Malta sections £306,000, and to reserve fund on account of the Malta-Alexandria and the Cape St. Vincent sections £435,000. To enable us to meet the expenditure in connection with the new lines to South Africa and beyond, without large issues of fresh capital, we have borrowed from the reserve fund of the Eastern and South African Company considerable amounts from time to time. You are already aware that the whole of the share capital of the South African Company is held by this Company, and, by paying a moderate return on its ordinary shares, that company has been able to invest in high-class securities on account of its general and other reserve funds the sum of £567,000, in addition to the amount of £560,000 loaned to us. It is, of course, very necessary for the South African Company to provide substantial reserve funds against the depreciation of their cables and other contingencies. The total length of the South African Company's system at the present date is 9,072 miles. I think you may rest assured that your interest in the South African Company is a valuable one, and the manner in which the resources have been husbanded has proved of very considerable strength to this Company, and has been of great assistance towards carrying out the important projects we have in view. Your directors do not propose to issue any additional capital at the present time, as they are of opinion that it is more judicious to wait until the important extensions to Australia are further advanced before finally deciding how to deal with the cost of these new cables. The accounts presented to-day are for the twenty-eighth complete year of the existence of this Company, during which time wonderful developments have taken place in submarine telegraphy, and I think we hold a better position, both financially and from the point of view of efficiency, than we have done in any previous year.

I am glad to see so many familiar faces here to-day. Stockholders, however, must, in the ordinary course of things, alter from time to time, and it may interest those who have not heard it before if I give a short history of the progress we have made during the last 28 years. This Company was formed in 1872 by the amalgamation of the four original companies owning the cable between Great Britain and our Indian Empire. The most important places connected at that time by the main line were Gibraltar, Malta, Egypt, Aden and India. The length of our cables at that date was 8,376 miles; to-day it is 34,662 miles, an increase of 26,286 miles. The length of land lines owned and rented in 1872 was 937 miles; it is now 3,139 miles, an increase of 2,202 miles. Our capital in 1872 was £3,397,000; at the date of the accounts presented to-day, it stands at £7,262,098, an increase of £3,865,098. Our gross revenue was £376,922 in 1872; for last year it amounted to £1,018,634, an increase of £641,712. The percentage of total expenses to revenue, however, has increased from 25 per cent. in 1872 to about 33 per cent. for the present year—fully accounted for, I think, by the increase in our income. After making suitable provision for the general and other reserves, the amount distributed amongst the ordinary stockholders is at the same rate as it was in 1872, whereas the average rate during the whole period is exactly 6 per cent., and the average rate per cent. paid on the whole of the capital of this Company is only 5½ per cent. I mention this more particularly to show that, although we are paying a fair return to our stockholders, we are employing our surplus funds to give our customers the benefit of improved communication and reduction in tariff whenever it is practicable to do so. When this Company was formed in 1872 we owned two cable-repairing ships, but we can now find enough work for five in this Company and two in the South African Company. The number of stations and agencies in 1872 was about 15. At the present time we have 72 in various parts of the world, and the Eastern and South African Company have 13; a total of 85. Offshoots from our original main line have been made connecting Spain, Italy, Austria, Russia, Crete, Greece, Turkey, Cyprus, British and foreign Colonies on the East and West Coasts of Africa, and other places in South Africa, Seychelles and Mauritius.

Not very long ago investors in submarine telegraph undertakings were somewhat startled by the reports which appeared from time to time as to the possibilities of wireless telegraphy and the probability of its supplanting submarine cables. Without in any way discounting its usefulness under certain conditions, I do not think anything has transpired to alter the opinion which I expressed some time ago, that instead of becoming a rival to our system, it might possibly form a useful adjunct under certain circumstances.

You will notice that we have subscribed to the Transvaal War Fund, the City of London Imperial Volunteer Fund, and the Indian Famine Fund, and since the date of the report we have given an additional contribution of £500 to the Indian Famine Fund. We feel assured that the stockholders will approve of our action in these matters, seeing the close association of this Company with South Africa and India.

I have ventured to occupy your time at more than usual length this afternoon with a brief reference to the past as well as to the present condition of the Company, because this is the last time I shall have the honour of addressing you from the chair. Advancing years, together with the large increase in the business of the Company, render it most desirable that the chair should be filled by a younger man. We have, in the person of one of our directors, a gentleman who is, we consider, admirably fitted to occupy the place which I shall so soon vacate—I mean Sir John Wolfe Barry, whose distinguished career as an engineer and in other capacities points him out as one who will, in our opinion admirably fill the post of chairman. I am naturally glad to make this announcement at a time when the condition of the Company is so satisfactory, from every point of view, as I think I have been able to show it to be. After 28 years this state of things would not exist if you had not been served with the utmost zeal, and with unremitting attention to the business of the Company, both by your Directors and by the staff at home and abroad, and, let me add, if we had not enjoyed from first to last the confidence and unswerving support of our stockholders. I gladly avail myself of this opportunity to thank the staff individually and collectively, and I include, of course, our captains and their crews, for the admirable manner in which they have at all times and under all circumstances seconded the efforts of the Directors to provide a thoroughly efficient telegraph service for the public as well as a fair, though I myself personally consider a somewhat meagre, return for our stockholders on their investment. With these observations I beg to move:—

"*That the printed report and accounts of the Directors to March 31, 1900, submitted to this meeting, be and the same are hereby received and approved. That the dividend to be paid on the preference stock of the Company to June 30, 1900, at the rate of 3½ per cent. per annum, less income tax, be approved; and that, in accordance with the Directors' recommendation, a dividend be and is now declared of 1¼ per cent., with a bonus of ¾ per cent., both free of income tax, on the ordinary stock of the Company, making with previous payments by way of dividend on account a total payment of 7 per cent. on that stock for the year ended March 31, 1900.*"

Sir J. WOLFE BARRY: I beg to second the motion which has been proposed by the Chairman, and I think that I ought on this occasion to take the opportunity of expressing to his lordship my sincere acknowledgment of the kind way in which he has referred to me personally. The Directors have asked me to take the chair on its being vacated by Lord Tweeddale, and I am sure that in doing so I express their view as well as that of everyone else connected with the Company when I say that we shall deeply regret the absence of Lord Tweeddale's guidance in the future as Chairman, while looking forward with gratification to retaining the benefit of his advice on the direction of the Company. The noble lord has briefly drawn a very instructive and encouraging view of the prospects of the Company, and I will only say, for myself, that I have yielded to the unanimous wish of the Directors in accepting the post vacated by Lord Tweeddale, and that the position was none of my seeking; but I venture to put my services at the disposal of the Directors and of the Company, feeling that it is one of the most interesting and powerful companies in the whole world, and that the interests confided to me are not merely commercial, but are national in importance.

Mr. JOHN NEWTON said he did not think the resolution should be passed without an expression of feeling on the stockholders' side of the

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table at the loss which the Company was going to sustain by the resignation of Lord Tweeddale from the position of Chairman. Of course this did not mean that the noble lord was going to leave the Company, of which he would continue to be a Director. Lord Tweeddale had been a member of the Board during the whole of the period the record of which he had placed before the meeting that day, and the Company had had the benefit of his advice during that period, as well as of the work done by his celebrated predecessor, the late Sir John Pender. They could not but feel extreme regret to hear that his lordship was not going to preside over any more of their general meetings, but it was very gratifying to know that they would continue to have the benefit of his services as a member of the Board, and that he would have a first-class successor. He could not but help feeling that the statement made to the meeting that day by Lord Tweeddale was to some extent a reply to the gross attacks which had been made on the property of the Eastern and the Eastern Extension Companies in the last few years by gentlemen who really ought not to talk so much until they knew something more about the actual work done by the companies. They were accused of being one of the most monstrous monopolies that existed, and yet, as they had just heard from the Chairman, the shareholders had received an average return of rather less than 5½ per cent on their investment, despite the enormous national services which had been rendered by their undertaking. In the last few days there had been a break in the communication between Shanghai and Taku, and it was regarded as a deplorable calamity that this bit of communication did not exist. Let them consider the enormous difference between that short bit of line and the whole of the system of this Company between this country and South Africa, and of the enormous value of the services rendered to the nation by this system; and yet this was just the time when they were being attacked as "gigantic monopolists," and other companies were proposed to be started, aided by the taxpayers' money, for the purpose of preventing the shareholders of this Company from enjoying the "tremendous return" which they had so far had on their investment. He regarded Lord Tweeddale's statement as unanswerable, and he had been extremely glad to hear it.

The motion was then carried unanimously.

A cordial vote of thanks was afterwards passed to the Chairman and Directors.

The CHAIRMAN, in reply, after recognising the extremely flattering manner in which the resolution had been proposed and seconded, said that he was also very much indebted to Mr. Newton for his kind remarks. He believed that that gentlemen had been present at their meetings ever since the establishment of the Company. Mr. Newton had been a free critic on many occasions, and he therefore thought that the stockholders might take that gentleman's remarks as representing fairly accurately the feelings of the stockholders generally towards the Chairman and the Board. The business of the Company was daily making greater demands on the Directors' attention, but he felt quite sure that under the presidency of Sir John Wolfe Barry the Company would continue to be successfully administered in the future as it had been in the past.

The proceedings then terminated.

Telegraph Construction & Maintenance Co. (Ltd.).

A half-yearly general meeting of this Company was held at the offices, on Tuesday, under the presidency of Sir R. G. W. HERBERT, G.C.B.

The SECRETARY (Mr. E. Dickens) having read the notice calling the meeting,

The CHAIRMAN said: As you are aware, there is no formal business to be transacted at this meeting, there are no resolutions to be carried, and there are no accounts to be rendered. These come at the other half of the year. We have, therefore, only a somewhat monotonous, but not on that account unacceptable, statement to make to you of the continued prosperity and industry of the Company. Our factories have been closely employed since we met you last, doing good work, and so have our ships. The new ship "Anglia," which we have mentioned to you several times as having been a very satisfactory acquisition, has lately completed one voyage and is about to enter upon another, laden with a greater amount of cable than has ever before been carried, as I understand, by any telegraph cable ship. On the occasion of her last voyage, as on every previous occasion, she gave the most perfect satisfaction to us in all ways, and she is a great strength to the Company. We have work in hand which will occupy us sufficiently well during the remainder of this year, and we do not anticipate that there will be any less favourable accounts to render to you when our annual meeting comes round than on the last and on several preceding occasions.

Mr. CROFT said there was one matter of absorbing interest to everyone at the present moment—he referred to the Pacific cable. Probably everyone had seen an advertisement in the papers with respect to tenders being asked for on behalf of that cable. He thought it would be satisfactory to the shareholders if the chairman were enabled to say whether the Company was in a favourable position as regarded tendering for that cable, or if he could give any other information to the shareholders. Of course he knew that there were matters which it was not advisable for the chairman to enter into very closely, but if it were possible to enlighten the shareholders on the point he had mentioned, he felt sure that it would be very satisfactory to them, having regard to the fact that many months must elapse before they would meet again in March.

The CHAIRMAN: With respect to the Pacific cable, Mr. Croft is right in saying that a notice has appeared in the papers that tenders were about to be called for. We have only just received the detailed specifications, and the Board has not had time to give that very close consideration to them which they must certainly receive. The proposals of the Government are that the work should be divided into sections—the long section from Vancouver to Fanning Island and the short sections from Fiji to Norfolk Island, Norfolk Island to New Zealand, and from Norfolk Island to Australia. Tenders may be offered for those sections. A company able to do the section from Vancouver to Fanning may, if it has the means in its establishment, be able to undertake other sections also. Whether we shall be able to offer to do this very exceptional work at prices which will satisfy the Australian colonies and Canada that they ought to incur the expenditure we cannot say, but we are quite sure that no other institution has a better prospect of being able to do the work, both economically and soundly, than the Telegraph Construction and Maintenance Co. We shall give the matter our very closest attention, and it is not impossible that we may see our way to take some part in the enterprise.

Mr. CROFT proposed a vote of thanks to the chairman, which was carried by acclamation, and the proceedings terminated.

Direct United States Cable Co. (Ltd.).

The report of the directors for the six months ended July 30 states that the half-year's revenue, after deducting out-payments, amounted to £52,204. 8s. 7d., compared with £51,951. 8s. 2d. for the corresponding period of 1899, an increase of £253. 0s. 5d. The working and other expenses for the same period, including income tax, amounted to £20,506. 8s. 10d., leaving £31,679. 19s. 9d. as net profit, making, with £6,347. 8s. 9d. brought forward, £38,045. 8s. 6d. For the corresponding period of 1899 the working expenses and other payments amounted to £20,411. 8d. 1d. Three quarterly interim dividends of 3s. each per share, amounting to £27.319. 10s. have been declared and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 2s. per share, making 3½ per cent. for the year (absorbing £42,497).

After transferring £10,000 to reserve, the balance of £3,761. 8s. 6d. is proposed to be carried forward. The reserve fund account having been credited with interest on investments, realised profit, proceeds of sale, &c., of property at Torbay, Nova Scotia, and the sum now transferred from revenue, amounts to £418,875. 5s. 9d., taking investments at cost price.

Anglo-American Telegraph Co. (Ltd.)

The report of the directors states that the total receipts from Jan. 1 to June 30, including £1,355. 2s. 11d. brought forward, amounted to £186,526. 8s. 11d. The traffic receipts show an increase of £982 compared with the half-year ended June 30, 1899. The total expenses of the half-year, including repair of cables, &c., amounted to £60,784. 1s. 4d, a decrease of £243. 2s. 11d. compared with the corresponding period of 1899. The directors have, before declaring the net profits, set aside £12,000 for renewal fund, leaving £113,742. 7s. 7d.

One quarterly interim dividend of 15s. per cent. on the ordinary, and of £1. 10s. per cent. on the preferred stock was paid on May 1, absorbing £52,500, and a second quarterly dividend of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, absorbing £52,500 will be paid on Aug. 1. The balance of £8,742. 7s. 7d. will be carried forward.

The cables and land lines of the company are in good working order.

National Telephone Co. (Ltd.)

The report of the directors for the half-year ended June 30, states that the income of the half-year amounts to £700,140. 11s., compared with £602,640. 3s. 2d. for the corresponding period of 1899, an increase of £97,500. 7s. 10d. The working expenses (including special expenditure of £25,013. 3s. 8d. in repairing the damage caused by the snowstorm in February last) amount to £404,520. 13s. 8d., compared with £327,497. 18s., an increase of £77,022. 15s. 8d. The net result for the half-year (after deducting Post Office royalties amounting to £68,357. 9s. 7d.) is a profit balance of £227,262 7s. 9d., compared with £216,257. 6s. 7d. for the corresponding period of 1899, an increase of £11,005. 1s. 2d. The rentals carried forward for unexpired terms of running contracts amount to £733,614. 16s. 5d., compared with £651,741. 5s., an increase of £81,873. 11s. 5d. Out of the available balance of £178,195. 9s. 1d. the board recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum, less tax, on the First and Second preference shares, 5 per cent. per annum, less tax, on the Third preference shares, and 6 per cent. per annum, less tax, on the ordinary shares. The board further propose to transfer £55,000 to reserve, and to carry forward £4,325. 9s. 1d. £366,223. 16s. 9d. has been expended on capital account during the half year in the erection of 11,696 additional exchange and private lines, and in the construction of underground lines. The directors state that in considering the profit results of the half-year's working, it must be remembered that they have been very adversely affected by two exceptional causes: First, the large amount of £25,013. 3s. 8d. to repair the damage arising from the snowstorm in February, and second, the considerable increase in the cost of materials and labour consequent upon the abnormal commercial activity existing throughout the country.

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—The ordinary general meeting of this company was held on Friday last. The directors' report stated that during the year at the San Remo works 67 applications were received for electric current, while the equivalent number of 8 c.p. lamps added was 3,189, against 2,150 for the preceding year. The gross receipts from sale of current show an increase of 70 per cent. over those of last year, and the net receipts increased from £191. 6s. to £805. 2s. 6d. Owing to the price of coal, the working expenses were again exceptionally heavy. After setting aside £33. 1s. 8d. as depreciation, making a reserve of £20 for bad debts, and writing off £60 from preliminary expenses, the balance standing to credit of revenue was £805. 2s. 6d., out of which £227. 5s. 9d. has been employed in the payment of interim dividend at the rate of 5½ per cent. per annum on the cumulative preference shares, leaving £577. 16s. 9d. to be dealt with, which the directors recommended

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should be appropriated to a dividend at rate of 2¾ per cent. per annum on the cumulative preference shares for the six months to April 30, 1899; a dividend at rate of 5½ per cent. per annum on the cumulative preference shares for the past half-year, making the full dividend for the year; a dividend at the rate of 2 per cent. per annum for the past half-year on the ordinary shares, leaving £139. 13s. to be carried forward. £857. 0s. 5d. was spent on capital account during the year, in addition to a deposit of £330. 3s. 4d. on new machinery ordered for next season. The report was adopted.

CALCUTTA TRAMWAYS CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. E. C. Morgan) said the company lost no time in getting forward with the necessary surveys and plans for the conversion of the lines to electric traction, and they had now entered into a contract with Messrs. Dick, Kerr & Co. for the completion of the work by Dec. 31, 1901, at a cost not to exceed £170,000. The preliminary contract was based upon net cost of materials and labour, plus 10 per cent., which was to include engineering charges, and was not to exceed £170,000 as a maximum, whereas if it is found that the net cost of the materials and labour should prove less than the estimates, the reduction will be for the benefit of the company. That was, he thought, a satisfactory arrangement, particularly under the present conditions of the electrical industry. The doubling of the line across the Maidan to the docks, which is also to be equipped electrically, was now almost complete, and had been found to afford the greatest convenience to the public. Messrs. Dick, Kerr & Co.'s contract covers the electrical equipment of this line as well as that of all the other lines existing within the municipal boundaries, but it does not cover the cost of erecting the power-house and the alteration of the car sheds for the reception of the motor cars. That work was now being prosecuted by their own staff, and would be vigorously pushed forward so that all might be in readiness for the reception of the engines, boilers, and dynamos, which were in course of construction, and which would be forwarded to Calcutta with the least possible delay. In order to provide the necessary funds the directors had created an issue of first debenture stock for £350,000, and had offered £250,000 for public subscription in March last. The response to this invitation was very satisfactory, and they were now in ample funds. The company's relations with the authorities in Calcutta have undergone a complete revolution, and they were now on excellent terms. The company had been approached regarding the construction of extensions, which might prove of the highest advantage, especially in bringing the suburbs into communication with the centre of the town, and by rendering the transport within the town itself swift and easy. Any great expansion in the receipts could not be looked for until they had mechanical power, for it was impossible for them to greatly increase their mileage without an increased number of horses; but it was satisfactory to know that their traffics increased in direct ratio to the mileage run, showing not only that the service continued as popular as ever, but that there was an unlimited demand for riding accommodation the moment it could be supplied. With electrical energy there was practically no limit to their ability to supply accommodation.

SOUTH STAFFORDSHIRE TRAMWAYS CO. (LTD.)—At the meeting oe this company on Tuesday the chairman (Mr. W. S. L. Schuster) said thd total receipts had increased by £2,023. 4s. 8d., but the total expenses hay increased by £2,885. 7s. 3d., which was largely caused by the enormously enhanced prices of materials. As a result of the year's operations thef were left with £922. 12s. 11d. available for distribution. The dividend o 2s. 5d. per share on the preference shares would absorb £918. 6s. 8d., leaving £4. 6s. 3d. to be carried forward. The terms of the agreement entered into with the lessee company during the year were the best which the directors could possibly obtain. The agreement secured them a minimum rent of £4,500 a year, which became reducible as the local authorities purchased the various sections of the line. Then there was a sliding scale of so much a mile run over a certain mileage. There were important provisions with regard to re-equipment, the object being that the lessee company should have the right to re-equip those portions of the line which were now worked by steam with electricity, the tramway company to pay the cost of the re-equipment in debentures. The resolution for the adoption of the report and accounts was unanimously agreed to.

NEW COMPANIES, STATUTORY RETURNS, &c.

ALLEN & BARKER (LTD.).—This company was registered on July 10, with a capital of £7,500 in £1 shares, to carry on the business of electrical and general engineers, motor car manufacturers, &c. The first managing directors are G. P. Martin, W. Allen and L. C. Barker.

BROCKIE-PELL ARC LAMP (LTD.)—This company was registered on July 12, with a capital of £80,000 in £1 shares, to adopt an agreement with the Brockie-Pell Arc Lamp (Ltd.), incorporated in 1896, and to carry on the business of arc and incandescent lamp manufacturers, electrical and general engineers, suppliers of electric light and power, &c.

DARGUE ACETYLENE GAS CO. (LTD.)—This company was registered on June 26 with a capital of £6,000, in £1 shares, to acquire the business of the Dargue Acetylene Gas & Electrical Co. (Ltd.), and to carry on the business calcium carbide manufacturers and merchants, makers of electrical, gas and other appliances, suppliers of electricity for light, &c. The first directors are W. H. Dargue and H. A. Macfadyen.

JOHN DAVIS & SON (DERBY) (LTD.)—This company was registered on July 13, with a capital of £35,000 in £1 shares, to acquire the business carried on as John Davis & Son, and to carry on the business of manufacturers of mining, engineering, electrical and scientific apparatus, makers of miners' safety lamps wire drawers, manufacturers of electrical and other carriages, motors and accessories, suppliers of electricity, &c. The subscribers are H. Davis (engineer), L. W. de Grave (engineer), C. P. Stevenson, M. Attwood, W. H. Evans, J. A. Ashby (electrical engineer), and J. J. Barnett. The first directors are H. Davis (governing), L. W. de Grave, M. Attwood and C. P. Stevenson.

EGERTON AND CO. (LTD.)—This company was registered on June 8, with a capital of £3,000, in £1 shares, to carry on the business of electrical and general engineers, manufacturers of electrical apparatus, contractors, and suppliers of electricity for all purposes.

FAIRBAIRN-LAWSON-COMBE-BARBOUR (LTD.)—This company was registered on July 11, with a capital of £800,000, in £1 shares (300,000 preference), to acquire the businesses of Fairbairn, Naylor, Macpherson & Co. (Ltd.), S. Lawson & Sons, and Combe, Barbour & Combe, and to carry on the business of electrical and general engineers, metal founders, &c.

SANDYCROFT FOUNDRY CO. (LTD.)—This company was registered on July 4, with a capital of £32,000, in £1 shares, to take over the business of electrical and mechanical engineers, founders, &c., carried on by the Sandycroft Foundry & Engine Works Co. (Ltd.).

TAYLOR, TUNNICLIFF & CO. (1900) (LTD.)—This company was registered on July 9, with a capital of £100,000 in £1 shares (40,000 preference), to acquire the business carried on by Taylor, Tunnicliff & Co. (Ltd.) and to carry on the business of manufacturers of electrical appliances, &c.

R. WAYGOOD & CO. (LTD.).—This company was registered on June 28 with a capital of £210,000, in £1 shares (105,000 preference), to take over the business of R. Waygood & Co. (Ltd.) (in liquidation), and to carry on the business of lift machinery manufacturers, hydraulic, electrical and general engineers, &c. The first directors are H. C. Walker, W. R. Green, C. Day, E. P. Okeden, D. W. R. Green, and R. J. White.

J. G. WHITE & CO. (LTD.)—This company was registered on July 10, with a capital of £100,000 in 5,000 £10 preference shares and £50,000 £1 ordinary shares, to carry on the business of railway, tramway and telegraph proprietors, electrical and general engineers, &c., and to enter into an agreement with J. G. White & Co., of New York. The subscribers are J. G. White (electrical engineer) (500 shares) and A. H. P. Stoneham P. H. Baldwin (engineer), E. B. Wyman, W. C. Burton, C. Wren and A. N. Connett (engineer) (with 100 shares each).

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The annual return to May 23 gives the capital as £220,000, in 16,000 ordinary and 6,000 preference shares of £10 each, all of which have been taken up and paid for in full.

ELECTRIC TRACTION CO. (LTD.)—According to the annual return to May 10 the capital is £300,000 in 1,200 shares of £1 each, and 29,830 shares of £10 each, all of which have been taken up. The full amount has been called up on each share, and £300,000 has been received.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The annual return to June 13 has been filed. The capital is £2,445,630 in 200,000 ordinary, 34,563 first preference and 10,000 second preference shares of £10 each, of which 88,321 ordinary, 34,563 first preference, and 4,669 second preference have been taken up. £10 has been called up on each share and £1,275,530 has been received.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (July 19, 1900). Price of silver 28 3/16d. per oz. (July 19). Consols (2¾ per cent.) 97 1/16—97 1/16 for money, 97⅞—98 for account; 2½ per cent. 97¼—97¾ (July 19). Stock Exchange Settling Day: Consols, Aug. 2; Stocks and Shares Continuation Days, July 25 and Aug. 13; Ticket Days, July 26 and Aug. 14; Pay Days, July 27 and Aug. 15; Mining Share Carry-over Days, July 24 and Aug. 11.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The directors' report for the year ended March 31 states that the net earnings amounted to £40,512, against £33,238 last year. The ratio of working expenses to gross earnings has fallen by 4·18 per cent., which, on last year's earnings, would represent a saving of £3,554. The net profit, after deducting London office expenses, amounts to £38,216, besides the balance forward, £189. After payment of debenture interest (£11,250), preference share interest (£6,028), interim dividend on ordinary shares (£4,000), there remains for distribution £17,127. A further 20 per cent. is written off preliminary expenses (£1,218), a final dividend is proposed on ordinary shares of 2 per cent., making 4 per cent. for the year (£4,276), £500 is transferred to general reserve (now £12,500), £5,500 is devoted to capital amortisation, and £5,500 to reserve for depreciation, and £132 is carried forward. The directors recently made a further issue of 1,600 5 per cent. non-cumulative preference shares of £10 each.

BRITISH INSULATED WIRE CO. (LTD.)—Dividend warrants on the 6 per cent. preference shares for the half-year ended June 30 have been posted.

BUENOS AYRES GRAND NATIONAL TRAMWAYS CO.—The chairman announced at the general meeting on Monday that the directors were strongly opposed, at the present time at all events, to any attempt to alter their mode of traction. It might be found as time went on that they were wrong, and that electric traction in Buenos Ayres was the right thing, but he had "grave doots."

CASTNER ELECTROLYTIC ALKALI CO. (U.S.A.)—On behalf of this company the Castner-Kellner Alkali Co. has invited subscriptions for £150,000 5 per cent. first mortgage sterling debentures of £100.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.).—Mr. Joseph Bevan Braithwaite, jun., of 27, Austin Friars, E.C., and Mr. Herbert Samuel

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Leon, J.P., of Bletchley Park, Bletchley, Bucks, have been elected directors of this company. The transfer books and share register of the 6 per cent. cumulative preference shares are closed from 19th inst. to Aug. 2 inclusive.

CITY & SOUTH LONDON RAILWAY CO. (LTD.)—The directors announce that the accounts for the half-year ended 30th ult. show a balance, after providing for debenture interest, the full dividend on the 5 per cent. preference stock "1891," and on the 5 per cent. preference stock "1896" (less two months' dividend paid out of capital of latter), sufficient to allow a dividend on the consolidated ordinary stock at the rate of 1¼ per cent. per annum (against 2¼ per cent. last year) and to carry forward £788.

COVENTRY GAS FITTINGS, ELECTRIC & ENGINEERING CO. (LTD.)—The directors' report for the year ended 31st March states that, notwithstanding the opening of branches mentioned in last year's report, the turnover was still £10,000 below that of 1898. The net result of the year's trading was a loss of £948, which, with the adverse balance from last year, has been deducted from revenue account, now standing at £1,172.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—Interest on this company's 4 per cent. mortgage debenture stock for the half-year to July 31 will be paid by warrant on Aug. 1. The register of this stock will be closed from 27th to 31st inst. inclusive.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The directors recommend payment of a dividend in respect of the six months ended June 30 at the rate of 6 per cent. per annum on the "A" shares as now paid up, making, with the interim dividend at the same rate paid in February, 6 per cent. for the year. Dividend warrants will be posted on 31st inst.

ELEKTRICITATS AKTIENGESELLSCHAFT vorm. SCHUCKERT & CO.—The profit for the year ended March 31 was £462,451, and a dividend of 15 per cent., the same as last year, has been declared.

STOCK EXCHANGE NOTICES.—26th inst. has been appointed a special settling day in £70,000 4½ per cent. debenture stock of the *Bournemouth and Poole Electricity Co.* (*Ltd.*), and the stock has also been ordered to be quoted in the official list. Application has been made to the committee to appoint a special settling day in, and to grant a quotation to, the further issue of 20,000 5 per cent. cumulative preference £5 fully-paid shares of *Callender's Cable & Construction Co.* (*Ltd.*).

TAYLOR, TUNNICLIFF & CO. (1900) (LTD.)—This company, which has a nominal capital of £100,000 in 40,000 preference and 60,000 ordinary shares of £1 each, has invited subscriptions for 35,000 preference and 37,000 ordinary shares.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	July 14	4,676	+ 119	1	4,676	+ 119
Blackpool Corporation...	„ 12	890	+ 213	15	8,030	+ 1,971
Blackpool and Fleetwood	„ 14	948	+ 35	2	1,750	− 212
Bolton Corporation ...	„ 8	1,421	...	15	21,654	...
	„ 15	1,576				
Bradford Corporation...	„ 15	523	+ 97	15	7,415	+ 1,532
Brisbane Trams	May 30	1,825	+ 656	21	38,956	+11,146
*Bristol Trams & Carriage	July 13	3,604	+ 25	2	6,826	+ 93
*Buenos Ayres & Belgrano	June 17	2,212	+ 19	24	54,324	+ 4,418
City & South London Ry.	July 15	1,436	+ 575	2	2,883	+ 985
Cork Elec. Trams	„ 12	526	+ 64	23	10,600	+ 1,206
Dover Corporation	„ 14	272	+ 14	15	3,140	+ 276
Dublin & Lucan Rly. ...	„ 14	130	+ 45	2	242	+ 67
Dublin United	„ 13	3,886	+ 624	2	7,036	+ 968
Dublin Southern Dist....	„ 13	1,145	+ 122	2	1,992	+ 92
*Glasgow Corporation ...	„ 14	9,855	+ 262	...	...	...
Hull Corporation	„ 14	1,357	+ 801	2	2,679	+ 1,845
*Liverpool Corporation...	„ 7	8,439	+1,204	27	197,181	+24,083
Liverpool Overhead Rly.	„ 15	1,755	+ 162	2	3,442	+ 310
*Sheffield Tramways	„ 15	2,534	+1,089	28	58,060	+19,344
*South Staffs. Trams....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 11.	Price Wednesday, July 18.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 18. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	60 63	59 62	5 19 9	Feb., May, Aug., Nov.	...	...
£3,088,640	Stock	30/0	Do. Preferred	113½ 114½	113½ 114	5 6 8	„ „	114½	113⅜
£3,088,640	Stock	27/0	Do. Deferred	12⅝ 13	11¾ 12⅛	11 0 5	„ „	12 1/16	11 15/16
$13,333,300	$100	$1¼	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	10.¼	101¼
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	6 1 3	„ „	15	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100⅞ 104⅞	100⅞ 104⅞	4 6 7	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11⅝ 12	5 16 8	Jan., Apr., July, Oct.	11⅝	11⅜
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	100⅜	...
£4,000,000	Stock	5%	Eastern Ordinary	148 153	148 153	4 12 5	Jan., Apr., July, Oct.	151	148
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock .....xd	97 100	93 99	3 10 8	„ „	98	96
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	2/6	Eastern Extension.....xd	14¾ 15½	14¾ 15½	4 11 10	Jan., Apr., July, Oct.	15⅛	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 117	112 117	3 9 2	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	100⅞ 103⅞	100⅞ 103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11 7/16	11½
180,042	10	3/0	Do. 6 per Cent. Preference	15 15½	15 15⅜	3 18 8	„ „	15⅜	15⅜
150,000	10	5/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July.....	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)..	98 101	98 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	52 56	52 56	4 9 3	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7⅛ 8⅛	7⅛ 8⅛	4 14 1	April and October.....	7⅜	7⅛
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America.....	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 14 7	January and July.....	...	...
88,321	10	1/0	West India and Panama	⅝ ⅞	⅝ ⅞	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£30,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	104	102⅝
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	...	...	4 15 3	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	15	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1903)	104 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,850	10/0	1¼d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¼ ½	¼ ½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National	4⅜ 5⅜	4⅜ 5⅜	5 17 1	February and August	5 3/16	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 15	13 15	4 5 9	„ „	14 5/16	13⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5½	5 5½	4 15 3	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December ...	93	...
171,504	1	0/3	Oriental	7/8 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate .....xd	5 5½	4¼ 5½	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference.....	5 5½	5 5½	4 10 11	June and December ...	6½	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 11.	Price Wednesday, July 18.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 18. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	...	...	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅛ 12⅛	11⅛ 12⅛	3 11 3	...	11⅛	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8⅛ 9⅛	8⅛ 9⅛	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 6⅝	6½ 6⅝	...	...	6¼	6 1/16
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9⅛ 10⅛	9⅛ 10⅛	4 5 9	February and August	10⅛	10
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅛ 6	5⅛ 6	3 15 0	...	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6 7	6 7	4 5 9	March ,, ,,	6⅞	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107 110	107 110	4 1 8	June and December...	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	109 110	109 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8⅛ 9⅛	8 9	4 8 11	February and August	8 1/16	8⅛
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 11	June and December ...	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	8⅛ 9⅛	8⅛ 9⅛	4 4 3	...	9⅛	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11⅛ 12⅛	11⅛ 12⅛	4 16 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	108 111	107 110	4 1 10	...	107⅛	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12⅛ 13⅛	12⅛ 13⅛	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6⅝ 7⅛	6⅝ 7⅛	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1⅛	1 1⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4 4⅛	4 4⅛	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98 100	93 100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	14⅛ 15⅛	14⅛ 15⅛	3 4 6	April and October	15	1 ⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December ...	...	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	96 98	3 11 6	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15⅛ 16⅛	15⅛ 16⅛	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6 6⅛	6 6⅛	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	⅞ 1	⅞ 1	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	13⅛ 14⅛	13⅛ 14⅛	4 16 8	February and August	14⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅛ 9⅛	8⅛ 9⅛	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2⅛	2 2⅛	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	—	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3⅞ 4⅛	3⅞ 4⅛	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	12 13	12 13	5 8 4	March and September	13	12 7/16
			ELECTRIC MANUFACTURING &c. COMPANIES.						
125,000	1	7¼d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅝ ¾	⅝ ¾	8 0 0	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅞ 1	⅞ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16 1⅛	1/16 1⅛	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	11⅛	...
40,000	5	3/0	Do. 6 per Cent. Preference xd	6 6½	5⅞ 6⅛	4 16 0	...	...	...
100,000	5	1/6⅛	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,060	2	1/2⅜	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	4 5 4	September	...	...
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cum.	2 2⅛	2 2⅛	5 6 8	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 114	109 114	3 19 10	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 103	101 103	4 7 5	June and December ...	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13 14	13 14	5 7 2	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛ 5⅜	5⅛ 5⅜	4 6 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
100,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1 1⅛	6 8 0	...	1 1/16	1⅛
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	102	100
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3⅛ 4	3⅛ 4⅛	5 5 10	January and July	4	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	2 1/16	2
17,139	5	2/9⅜	Do. (£5 paid)	3⅛ 4⅛	3⅛ 4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91 93	91 93	4 6 0	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs. (50% pd)	48 52	48 52	...	...	...	...
26,100	5	6/0	Edmundson's Electric Corporation Ord. (fully pd, xd	4⅛ 5	4⅛ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.) ...xd	101 104	99 102	4 8 3	...	99	...
112,100	2	1/2⅛	Electric Construction Co. (Limited)	2 2⅛	2 2⅛	5 6 8	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3 3⅛	3 3⅛	4 0 0	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) ...xd	104 107	102 105	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13 14	13 14	6 15 9	February and August	14⅛	13⅛
30,000	5	1/6	Do. 4½ per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 103	103 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	35 39	35 39	4 12 4	March and July	35	37
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10⅛ 11⅛	10 11	5 9 1	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛ 6	5⅛ 6	4 3 4	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10⅛ 11⅛	10⅛ 11⅛	5 4 4	April and October	11⅛	10⅛
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6⅛ 7	6⅛ 7	4 5 9	,, ,,	6⅞	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	106⅛	103
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½ 18½	17½ 18½	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	102 104	103 105	4 17 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd & new	22½ 23½	22½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd) xd & new	10½ 11⅜	10½ 11⅜	3 14 5	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd & new	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10⅞	10½ 10⅞	4 13 0	May and November	...	...
30,000	10	11/0	British Elec. Trac. Ord. (Nos. 1 to 30,000)	14 15	14 15	4 0 0	...	14 1/16	14⅛
15,000	10	8/7½	Do. (Nos. 60,001 to 75,000)	14 15	14 15	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	13⅛	12⅞
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 128	125 128	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (Issued Feb. 5, 1900)	121 124	120 123	...	...	...	...
40,000	5	2/8 7/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5 5⅛	5 5⅛	5 14 4	...	5 1/16	5
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	102 105	100 103	4 17 1	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	96 99	93 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	9⅛ 10	9 9⅛	3 3 2	June and December	9⅛	9⅛
£335,000	Stock	1½%	City and South London Railway Con. Ordinary	6⅛ 6⅜	6⅛ 6⅜	2 19 6	February and August	6⅜	...
37,500	10	1/3 1/16	Do. (Nos. 23,501 to 60,000)	6 7	6 7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	132 137	132 137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123 128	123 123	3 2 6	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	23⅛ 23⅝	23⅛ 23⅝	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15⅛ 15⅝	15⅛ 15⅝	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	⅛ 3/16	⅛ 3/16	31 0 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16 ⅛	⅛ 3/16	32 0 0	,, ,,	...	...
20,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10 10⅛	10 10⅛	4 17 6	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 9⅛	9 1/16 9⅛	3 19 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13⅛ 13⅝	13⅛ 13⅝	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103 107	103 105	3 16 2	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅛ 3⅝	3⅛ 3⅝	...	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4⅛ 5⅛	4⅛ 5⅛	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 19	16 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅛ 10⅝	10⅛ 10⅝	4 13 0	,, ,,	...	...
13,384	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£40,000	Stock	3%	Waterloo and City Ordinary	97 100	94 97	3 2 10	June and December	...	...

In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,158. [No. 14, Vol. XLV.] FRIDAY, JULY 27, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 30c., or 70pf.

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NOTES.

MR. RITCHIE, President of the Board of Trade, received, on Tuesday, a representative deputation from the London electricity supply companies with regard to a most important matter. The existing Board of Trade Regulations "for securing the safety of the public" and "for ensuring a proper and sufficient supply of electrical energy" permit the maintenance of a pressure up to 250 volts within a consumer's premises instead of only 150 volts alternating or 300 volts continuous, which were the maximum limits before the revision of the regulations in 1896. The same rules also fix the permissible variation and define the meaning to be attached to the terms "low," "high," and "extra high" pressure, and we were able last November (*The Electrician*, Vol. XLIV., p. 31) to give an authoritative opinion as to the interpretation of certain ambiguities on these points.

THE 1896 regulations, although sanctioning a supply of alternating or continuous current on the three-wire system at 2 × 200 volts or slightly higher, contained a qualification which has prevented central station engineers from the full enjoyment of the new privilege. In laying down a new supply system, the engineer is free to adopt this pressure, and the consumer must accept or refuse the supply at the pressure offered to him so long as it is within the prescribed limits. But a system may only be changed over from 100 volts to 200 volts "provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations [1896] are supplied with energy by the undertakers except with the consent of the consumers" (see the second part of clause B6 in the existing Board of Trade regulations). It appears that some obstinate individuals, representing only a small proportion of the whole body of consumers on the mains of the various metropolitan companies, have withheld their consent to being supplied at 200 volts instead of 100 volts, and have thereby prevented a complete change-over of the system, for the companies are bound by statute to continue to supply them with electrical energy. Appeals have been made at various times, and with varying degrees of emphasis, but with no avail, and now the companies have done what they ought to have done long ago, and begged the Board of Trade to substitute for the last seven words of the objectionable sentence: "except on such terms and conditions as may be agreed upon between the undertakers and the consumers, or, failing agreement, as may be settled by an arbitrator appointed by the Board of Trade."

WE have pointed out on previous occasions that the employment of the higher supply pressure, now that efficient 200-volt lamps and apparatus are obtainable, is to the benefit of the consumer as well as the supplier; and it is disappointing that Prof. KENNEDY, who acted as chief spokesman for his colleagues, should not have been able to impress Mr. RITCHIE with the justice of his plea. When the notes and figures have been put in by the companies as to the relative importance of the "conscientious objectors," the capital expenditure involved, and the effect of this on the price of current to the consumers who are amenable to reason, perhaps the Board of Trade will be convinced. It would surprise us if their electrical adviser had not been convinced already.

THE description of some experiments by Prof. ERNEST WILSON in this week's issue raises an interesting point in connection with the excitation of polyphase rotatory converters. Using a two-phase bipolar machine with a smooth core armature and testing under conditions of constant frequency and potential at the slip rings, and maximum power factor for all loads, Prof. WILSON finds that as the load increases it is necessary slightly to decrease the excitation of the converter while at the same time increasing the excitation of the generator. The diminution in current required for the converter field is, however, very small, being only 2 per cent. with a rise of load from 0 kw. to 8½ kw. The remarkable point is that the results obtained with this two-phase machine are diametrically opposed to the results obtained by Messrs. PARSHALL and HOBART with a three-phase

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rotatory converter run under the same conditions as to voltage, frequency and power factor. Messrs. PARSHALL and HOBART found, indeed, that the field excitation of the converter required to be increased as the load increased, the effect being most marked as the full load was more closely approached. It is by no means clear whether this radical difference in the results is due to the essential differences between three-phase and two-phase converters or whether it is the accident of the particular combinations of plant used in the two sets of experiment. We trust that Prof. WILSON will pursue the investigation further and arrive at a conclusion of a more general nature with regard to this important point in the regulation of polyphase sub-station plant.

THE exact determination of the elasticity of metals in the form of wires or thin rods is a matter of considerable importance both to electrical engineers and to physicists. Some time ago Mr. L. R. WILBERFORCE introduced an ingenious method of determining YOUNG's modulus from the observed longitudinal and angular vibrations of a load hung at the end of a helical spring composed of the metal to be tested. Knowing the moment of inertia of the mass forming the load, the modulus could, of course readily be determined. A simplification of WILBERFORCE's method has recently been introduced by Mr. G. F. C. SEARLE, of the Cavendish Laboratory. The essential difference between Mr. SEARLE's and Mr. WILBERFORCE's method is that, instead of a helix, a long, straight sample of the metal is tested, the upper end being rigidly clamped and the lower end loaded, as in the Wilberforce method. It is claimed that this method not only admits of simpler mathematical treatment, as regards the elasticity of the structure, but also lends itself to the testing of materials which cannot readily be made in the form of a helix.

AT the same time, however, we fear that Mr. SEARLE's modification suffers from one or two serious defects which are not to be found in the Wilberforce method as usually employed. In the first place a straight wire, unless very long, must be heavily loaded if the time of angular or longitudinal vibration is to be sufficiently lengthy to eliminate errors of observation, while the addition of a very heavy load is liable to strain the material, in parts at any rate, beyond the elastic limit. Moreover, when a straight rod or wire is subjected to torsion the distribution of stress over the section is much more uneven than in the case of a helix, the outer portions of the metal being heavily strained, while the inner portions are subjected to very little strain. In the case of materials having a low elastic limit, therefore, the adoption of SEARLE's method is liable to give misleading results. Mr. SEARLE admits, however, that neither his modification nor the original Wilberforce method really gives what is required by YOUNG's modulus of a test piece of material, owing to the almost inevitable lack of isotropy in a test piece of the size required for either method. Indeed, the methods serve rather to indicate lack of isotropy in the material than to give YOUNG's modulus for the theoretically perfect material. To engineers this may appear an advantage, since it gives the actual practical results; but pure physicists, we fear, would look at such discrepancies somewhat askance.

A CURIOUS ending was announced, in the Queen's Bench Division of the High Court of Justice last Tuesday, to the dispute between the National Telephone Co., the London County Council and the POSTMASTER-GENERAL with regard to underground wayleaves. It will be remembered that the Telephone Company, having failed to obtain sanction from the London County Council to lay its wires underground, applied for permission from several London vestries, the application in some instances being granted and wires being actually laid underground. The POSTMASTER-GENERAL in the meantime circularised all these vestries, warning them that he alone had the right to lay underground wires for telegraphic and telephonic purposes, and that he had not relegated any of his powers in this respect to the National Telephone Co. Litigation followed, the ATTORNEY-GENERAL seeking for an injunction to restrain the company from opening and breaking up the streets, and after a number of postponements it was announced on Tuesday that an agreement had been come to between the parties whereby the company consented to judgment with costs in favour of the Crown on every point. Thus it has been declared that the company exceeded their powers in laying underground wires in London unless by licence of the POSTMASTER-GENERAL, and an injunction has been granted restraining the company from doing so in the future. It is not clear whether the company expect anything as a *quid pro quo*. From the absence of specific reference to the matter at the National Telephone Co.'s meeting yesterday, however, it might be understood that the company had received nothing, but expected something. Mr. J. S. FORBES gave the meeting to understand that although the negotiations with the Post Office had come to nothing he could not imagine that the company would receive other than equitable treatment, but he did not make it clear whether he referred to this particular case or to the broad question of competition generally.

The Hookham and Thomson Meter Case.—The report of the directors of the British Thomson-Houston Co. announces that notice of appeal has been given in the action of Chamberlain and Hookham v. Bradford Corporation (British Thomson-Houston Co. third parties).

Obituary.—We regret to announce that Mr. Harris H. Eley, district manager of the National Telephone Co.'s Cumberland district, was killed while on his holidays at Kenilworth, near Leamington, on Monday afternoon, through the overturning of a motor car in which he was riding.

Personal.—The Lords of the Committee of Privy Council on Education in Scotland have appointed Mr. F. Grant Ogilvie, Principal of the Heriot-Watt College, Edinburgh, to be Director of the Museum of Science and Art, Edinburgh. The late Sir R. Murdoch Smith previously held this post.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Paramaribo—Cayenne	Feb. 16, 1900 ...	July 19, 1900
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—

Birmingham University.—Another munificient donation has been received to the funds of the Birmingham University: Sir James T. Chance has presented £50,000, subject to conditions to be arranged with the University Council. The endowment fund now amounts to about £400,000, and some £200,000 is still required to complete the endowments.

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Central London Railway.—The Central London Railway will be opened to the public on Monday next. Trains will commence running from Shepherd's Bush at 5.15 a.m., and from the Bank at 5.20 a.m., stopping at all stations except Bond-street, the opening of which is temporarily deferred. The fares from 5.15 a.m. to 7.30 a.m. will be 2d. return any distance, and from 7.30 a.m. to 12 p.m. 2d. single any distance. Books of 24 single-journey tickets will be sold at all stations.

Telephony in Russia.—The telephone systems of St. Petersburg, Moscow, Warsaw, Odessa and Riga, at present owned by the Bell Telephone Company, will, from November 1st next, revert to the State, who, however, are prepared to let them to private undertakers. Either Russian or foreign firms are eligible, and offers should be sent to the Russian Postal Administration by August 15, O.S. (August 28), 1900. Particulars must be given as to the amount of capital the undertaker is prepared to invest, as to the constitution of the firm, and whether it has already worked other telephone systems or electrical undertakings.

Accidents on the Liverpool Tramways.—On Tuesday afternoon last two slight mishaps occurred on the Liverpool Corporation electric tramway system. The first was the snapping of a trolley wire at the junction of Dale-street and Byron-street, which resulted in throwing all the street traffic over this portion of the line out of gear for nearly an hour. At about the same time—viz., 2 o'clock—the trolley arm of a car in Renshaw-street jumped the wire, and coming in contact with the suspension wire of a street pole, the trolley head and its attachment were wrenched off, and remained suspended in mid air. No one was injured, however, and no very serious stoppage of the tramcar service seems to have occurred.

Boiler Explosion at the Crystal Palace District Electric Supply Co.'s Works.—A regretable boiler explosion occurred on Wednesday afternoon in the works of the Crystal Palace District Electric Supply Co. A boiler burst with a loud report and wrecked two large buildings, the force of the explosion being so great that the roofs were blown off and the walls and windows shattered. Five men were buried under the débris; one of them, W. J. Philbrook, was killed, and two others, F. Elliston and C. Barker, seriously injured, Elliston having since died. The other two men were also injured but less seriously. The explosion was followed by a fire in two adjoining buildings which was not extinguished without some trouble.

Thunderstorms.—Severe thunderstorms were experienced all over the country during the latter part of last week. At Darlaston the trolley wires were broken as the result of a violent storm, and falling on a passing vehicle, the shock overturned the horse, besides affecting the occupants of the vehicle. In other parts of the Black Country fires are reported as due to lightning, whilst a chapel was practically demolished at Bradley, near Bilston. Similar damage was done at Northampton, Leicester, Birmingham, where the School of Art was partly destroyed, East Anglia, Hampshire, and the Isle of Wight. At Nenagh, Tipperary, two men were killed by lightning, besides a good deal of valuable cattle. The damage caused by the heaviness of the hail appears to be very considerable, whilst the number of deaths due to lightning is numerous.

Ritchie's Telautograph.—We had an opportunity of inspecting on Monday a new writing and picture telegraph, the invention of Mr. Foster Ritchie. It differs from the majority of other picture telegraphs in the rapidity with which the sketch or message is transmitted, the pen on the receiving instrument moving as fast as an ordinary writer moves the pencil of the sending instrument. No skilled operator is required, and the transmitting pencil is moved by the writer of the message. We tested the instrument ourselves and found that, although the handwriting may be slightly distorted, its character is not changed, and a diagram sketched was faithfully reproduced. The instrument is so arranged that no impression is made on the receiving instrument when the pen is moved above the paper, a contact being made by the pressure of the pencil. The instrument will work on an ordinary metallic circuit line. Owing to the fact that the foreign patents are not fully secured we have been requested to postpone our description of the working parts of the instrument.

Wireless Telegraphy.—It is stated that wireless telegraph apparatus was sent with the British reinforcements which arrived at Tientsin at the end of last week.—During the French naval manœuvres off Cherbourg, communication was, it is said, maintained between vessels over 40 miles apart by means of wireless telegraphy. It will be remembered that the record at the British naval manœuvres last year was over 67 miles. On the other hand, one of the newspaper correspondents with the naval manœuvres this year reports that on one occasion communication had failed at a distance of 25 miles.—The daily papers state that the Marconi system of wireless telegraphy is to be established on the mail packets running between Dover and Ostend. This announcement has, however, been made on previous occasions, but up to the present no steps seem to have been taken towards fitting up the apparatus.

Paris "Metropolitain" Railway.—The first section of the "Metropolitain" Railway in Paris has at last been completed. Schemes for an underground railway in Paris were projected before electric traction was even considered as an economical possibility; but by the time it had finally been decided to build the line, electric motive power was evidently the only rational one to use. The line should have been completed in time for the opening of the Exhibition, but the first section from Vincennes to the Porte Maillot was only opened on Thursday last. The intermediate stations are at the Place de la Nation, Gare de Lyon, Bastille, Hôtel de Ville, Palais Royal, Champs Elyseés and Place de l'Etoile. The line will pass the Champs Elyseés entrance to the Exhibition, and will also facilitate access to the Vincennes section of the Exhibition. A mishap on the line has already been reported, although it does not appear to have been serious. The *Times* Paris correspondent states that on Sunday the electrical apparatus was out of order and "the train went for half a mile at a headlong pace without stopping at the station, causing a panic among the passengers." The train was brought to a standstill, however, without any accident. Presumably the occurrence was due to some failure in the controller.

Municipal Opposition to the Electric Power Bills.—The following extract from a letter by Mr. H. Seaton-Karr, M.P., to last Saturday's *Times* is instructive, and should be taken to heart by the municipal opponents of the electric power bills:—

It is satisfactory to think that the electric power bills have now passed their third reading in the House of Commons after a most exhaustive examination before a strong committee; but it is also worthy of note that this has been done in spite of all efforts of the Association of Municipal Corporations to the contrary. . . . That the opponents of the bills failed to go to a division on the second and third readings was due, not to want of effort on their part, but to the inherent weakness of their case in opposition, the temper of which may be judged from a remark overheard in the lobby that they rejoiced to have put the promoters to the heaviest possible expense.

But all municipal corporations must not be included in this category. The following is an extract from a letter I received a few days ago, unsolicited on my part, from the town clerk of the Lancashire borough I have the honour to represent in Parliament (St. Helens) in reference to the Lancashire Electric Power Bill. This borough has an electric lighting and traction installation of its own. He writes: "I understand opposition is to be offered to the third reading of the Lancashire Electric Power Bill. . . . I may say for your information that the St. Helens Corporation have all through felt that their interests were sufficiently safeguarded, and they would like to see the bill pass in its present state. The provisions relating to the protection of local authorities as to the streets are in the shape in which St. Helens influenced their being drawn." I quote this letter as evidence that some municipal authorities, at all events, are sufficiently alive to the great importance of cheap electricity to the industrial enterprise of this country, do not approve of a dog-in-the-manger policy, and duly recognise that the production of cheap electric power is a subject too great for their monopoly, and that this country is lamentably behind the rest of the world in such production.

For a parallel to the bigoted opposition in other quarters than the industrial borough I am proud to represent that has delayed the passing of these bills for at least a year, one must go back not only to the days of George Stephenson and Parliamentary opposition to his locomotive on the ground that it could be upset by a cow, or alternatively would poison the atmosphere with its smoke and drive all game out of the country, but even to the dark ages, when a Spanish monarch executed, as a wizard, the first inventor of a steamboat that ran against wind and tide.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Change of Resistance by Magnetisation.—The influence of magnetisation upon the resistance of a wire has not yet been studied with the care which the importance of the subject demands. Electromagnetic theory cannot but be greatly affected by any facts which are elicited, and the influence of changes in the earth's magnetic field upon magnetic conductors may be of some practical interest. Results attained in the case of bismuth would seem to indicate that there is no connection between magnetisation and change of resistance. But A. Gray and E. Taylor Jones have been led to the opposite conclusion by the results of some experiments on soft iron wires. They determined simultaneous values of the magnetising force, the magnetisation, and the resistance. To equalise the heating effects, they wound two identical lengths of the same wire on the same core, one longitudinally and the other transversely, and inserted the compound coil in the interior of a magnetising coil. The transverse coil was of course only very feebly magnetised. Both wires were traversed by the same current, but the longitudinal coil always showed the greater increase of resistance, the difference between the two fractional increments being about 3×10^{-4} in a field of 30 units, and 15×10^{-4} in a field of 300 units. The change of resistance appears to be proportional to the fourth power of the intensity of magnetisation.

[Gray and Jones, *Proc. Roy. Soc.*, June 21, 1900.]

Electric Properties of Different Glasses.—A. Gray and J. J. Dobbie have continued their researches on the effect of chemical composition upon the electrical properties of glass. That this effect can be very great is shown by a single case, in which the resistance of a lead-potash glass was reduced 130 times by substituting soda for the potash. Barium glasses have very peculiar properties. A glass manufactured by Schott, of Jena, and composed mainly of barium, oxide and alumina in combination with silica and boron trioxide, has a very high resistance, one quite unmeasureable, indeed, within the range of temperatures commanded by the authors. Moreover, the inductive capacity in a plate of this glass is exceedingly low, and the glass shows little or no effects of dielectric polarisation. The authors thought that the barium might be the determining factor in the high resistance. But a barium-potash glass made by Powell & Sons showed comparatively a very low resistance, which is exceeded even by ordinary commercial lead glass. The effect of annealing glass is greatly to increase the resistance, often to three times its original value. An annealed lead-potash glass, containing 48 per cent. of silica and 41 per cent. of lead oxide had a specific resistance of over $29,000 \times 10^{10}$ ohms at 140deg., and a dielectric constant of 7·42. The resistances were studied by the method of flasks filled with mercury.

[Gray and Dobbie, *Proc. Roy. Soc.*, June 21, 1900.]

Ionic Conductivity of the Atmosphere.—Lenard's remarkable discovery that ultra-violet light is capable of imparting conductivity to a non-conducting gas is utilised by J. Elster and H. Geitel to account for the dissipation of the charge of an electroscope by ordinary air. Since the sun's rays contain ultra-violet light before they impinge upon the atmosphere this light must ionise the upper strata, and the ions produced will be gradually distributed through the whole of the atmosphere by diffusion and convection. Hence the air will contain stray ions of both signs, possibly differing in frequency with the altitude. It is these ions which gradually discharge a carefully insulated electroscope. This view is corroborated by the observation that a limited volume of air can be deprived of its conductivity by electrostatic force, all the ions being attracted to the surface of the body charged with the opposite kind of electricity and there discharged. This process is the quicker, the smaller the volume of air thus treated, *i.e.*, the smaller the number of stray ions. Particles of dust, smoke, or fog produce a retardation of discharge instead of an acceleration. On the summit of high mountains there is a more rapid discharge of negative than of positive electricity, probably owing to the retention of a large proportion of the positive ions in the higher strata.

[Elster and Geitel, *Ann. der Physik*, No. 7, 1900.]

Point Discharges.—E. Warburg has brought out the differences between positive and negative ionisation by keeping a point at a constant potential face to face with a large plate connected to earth, and arranging the supply from an influence machine in such a manner that the glow was confined to the immediate neighbourhood of the point. On employing very carefully purified nitrogen as a medium, he found that the current intensity obtained by charging the point to −3,810 volts was 200 times as great as that obtained with +5,180 volts. This enormous difference was reduced to a ratio of 4 : 1 by a slight admixture of oxygen. If we assume, with Thomson, that ionisation consists in splitting the atom into two parts, one of which, the negative ion, is very small, and has a great velocity, while the other is much larger and slower, it may easily happen that the negative nitrogen ions are considerably retarded by combining with stray oxygen atoms, while the positive ions would be much less affected in comparison. This is the author's idea of the effect of an admixture of oxygen as an impurity. In the transition from the brush to the glow discharge, the author noticed a sudden decrease of the potential gradient near a positively charged point, but not near a negatively charged point. He attributes this to greater ionic density in the former case.

[E. Warburg, *Ann. der Physik*, No. 6, 1900.]

Absorption and Ionisation.—Lenard showed in 1894 that cathode rays are absorbed by a gas in exact proportion to its density. Since the energy is probably all spent in ionising the gas it should follow that the ionisation is also proportional to the density. This has been verified by J. C. McLennan. He found an agreement between the ionisation in hydrogen at atmospheric pressure, and that in air at a pressure of 53mm. At these pressurs the two gases had the same density, and in both cases, therefore, according to Lenard's absorption law, the disposition of the rays, their actual intensities, and the amount of them absorbed from point to point in the ionising chamber were precisely the same. Under these conditions the equal ionisations obtained not only form a strong confirmation of Lenard's absorption law, but they also show that where equal absorption of cathode rays occurs, equal ionisation is produced. In order to test the conclusion more closely experiments were made with air, hydrogen, carbon dioxide, oxygen, nitrogen, and nitrous oxide, and in all cases it was found that, when these gases were reduced to the same density, the same ionisation was produced in them by rays of constant intensity. It follows, therefore, that an ionisation law exists exactly analogous to that of absorption—namely, that when cathode rays of a given strength pass through a gas, the number of ions produced per second in 1cc. depends only upon the density of the gas, and is independent of its chemical composition. From the results thus obtained, the author concludes that, when cathode rays are absorbed to any extent, the positive and negative ions produced by these absorbed rays are of a definite amount which bears a constant ratio to the quantity of the rays absorbed; that is to say, in order to ascertain the relative ionisations produced in any two gases by cathode rays of the same intensity, it is sufficient to determine the absorbing powers of the two gases for the same rays. In other words, the coefficients of ionisation are determined when the coefficients of absorption for the same gases are known. The author then deals with the ionisation in any particular gas under varying pressures. The inference is drawn that, under rays of constant intensity, the ionisation in a particular gas varies directly with the pressure.

[J. C. McLennan, *Proc. Roy. Soc.*, Abstract, July 9, 1900.]

The German Electro-Chemical Society.—The German Electro-Chemical Society is arranging to hold its seventh annual meeting at Zürich from August 5 to August 7. In addition to the reading of a number of papers, visits are to be paid to the Polytechnic and to the works of the Oerlikon Co.

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THE PARIS EXHIBITION.—II.*

(BY OUR SPECIAL CORRESPONDENT.)

The administration of the Paris Exhibition had a difficult problem before it to decide in what manner electrical energy should be supplied for light and power. It was essential that the major portion of the exhibition lighting should be electric, although there would of necessity be samples of illumination by incandescent gas and alcohol and acetylene burners, and it was also evident that electric cables and motors should replace steam pipes or countershafting for the transmission of power to drive the various exhibits. But the authorities were loth to expend a large sum on boilers, engines, and plant, which were only to be used for a few months, and which would probably realise only a small fraction of their original cost when sold second hand. Besides, this plant would occupy a great deal of space which might otherwise have been allotted to exhibitors, for the total capacity of the generating plant for the service of the exhibition has amounted to over 20,000kw.

The exhibition authorities have therefore adopted the following plan: Exhibitors were invited to erect direct-coupled condensing engines and dynamos in the Electricity Palace, to serve the double purpose of generating current for the service of the exhibition, and of exhibiting samples of the most recent designs of the firms in question. Steam at a pressure of 10kg. per sq. cm. and condensing water is supplied free of charge to the engines, and in addition a sum is paid per horse-power towards the expenses of erection, and a further sum for every hour the set is running for the supply of current. These sums are fixed by the following sliding scales:—

Contribution towards Cost of Erection.

	Engine. fr.	Dynamo. fr.	Total. fr.
For every H.P. up to 1,000	9·95	4·08	14·03
Do. do. from 1,000 to 1,500	7·10	1·25	8·35
Do. do. over 1,500	5·20	0·95	6·15

Contribution towards Running Expenses,

per I.H.P.-hour, the I.H.P. being taken as the normal for which the machine has been accepted by the administration.

	Engine. fr.	Dynamo. fr.	Total. fr.
For every H.P. up to 1,000	0·00840	0·00707	0·01547
Do. do. between 1,000 and 1,500..	0·00382	0·00293	0·00675
Do. do. over 1,500	0·00288	0·00240	0·00528

In view of the delay that took place in starting the machinery, it is of interest to add that the contractors were to commence laying the foundations by October 15, 1899, and that the machines were to be erected and ready to run by March 15, 1900, allowing therefore a month for tests and alterations before the opening of the exhibition. If the machines were not ready to time, fines were to be levied upon the payments mentioned above, and if the plant was not ready by May 15, 1900, the exhibition authorities were entitled to consider the contract void. As a mater of fact, only a small proportion of the machines were ready at the last-mentioned date, but the fault hardly lay with the contractors, for everything in connection with the exhibition was belated, and they were unable to start the work of erection as soon as they desired. Thus the engineer representing one of the English firms informed me that he left England for Paris some time after his engine had been despatched. Not until six weeks after his arrival at Paris did the engine arrive outside the exhibition. Then the Easter holidays intervened, and the authorities had not yet delivered it to his stand; and finally, when the cases had come within the building, all had to be cleared away with a number of others before being opened, in order that the exhibition might not present too unhandsome an appearance to the President of the French Republic on April 15th; it having been considered more important to open the exhibition than the cases containing the exhibits. I regret to say that the three English sets were almost the last to be running, the first of these only being completed the first week in July. Possibly the English engineers were not as able as the French and Germans in coping with the barrier of red-tape which is opposed in France to every effort at what our American cousins term "hustling," and possibly they were not backed by the British Commission as energetically as the German firms have been by the German Commission.

But to return from this digression. Each generating set has its own switchboard, which is in telephonic communication with either the continuous current or alternating current switchboard of the exhibition engineering department. At the individual machine switchboards the pressure is kept constant, but only one circuit leaves from each of them. No regulating is done at the main switchboards, which form merely the connecting links between the machines and the circuits. The chief distributing areas into which the exhibition has been divided were shown by the shading on the map published in the last issue of *The Electrician* (Fig. 1). The main building on the Champs de Mars is supplied with continuous current on the three-wire system at 2 × 220 volts, both for lighting and power. These circuits require about 3,000 amperes at 500 volts delivered from the switchboard, the Château d'Eau alone requiring 1,400 amperes when fully illuminated but at a time when the galleries of the exhibition are closed and there is no great demand for motive power. Around the outside of this building is a single-phase alternating-current circuit at 2,200 volts. Each consumer has a transformer, transforming down to 110 volts, and there are also eight sub-stations, each containing a single transformer large enough to supply 60 public arc lamps. A similar arrangement is made in the three-phase area which extends from the Trocadero to the Eiffel tower (the tower itself has its own generating plant); the current is three-phase at 2,200 volts, each consumer has his three-phase transformer, and there are sub-stations for the public lighting. In this area 2,000kw. have been provided for, but is not yet all required. For the circuits in Old Paris, part of the Rue des Nations and the banks of the Seine, 800kw. are supplied at 3,000 volts three-phase. The Porte Monumentale at the Place de la Concorde entrance is a "bit of Cromarty" attached to the circuits lighting the Pont Alexandre and about a quarter of the Esplanade des Invalides; these are supplied at 110 volts three-phase transformed down from 5,000 volts. The remainder of the Esplanade des Invalides is supplied for lighting by three-phase current at 110 volts transformed down from 2,200 volts. Power in the Esplanade des Invalides is supplied by two converter sub-stations, one Thomson-Houston and one Alioth, the current received being two-phase at 2,200 volts and 42·5 ∿ per second, and the current distributed being at 500 volts continuous. This is the only example of two-phase transmission in the exhibition. Two other rotatory converters supply the Beaux Arts section between the Seine and the Champs Elysées. One is a Thomson-Houston machine at 25 ∽ per second, receiving three-phase current at 5,500 volts and distributing it at 500 volts continuous; the other distributes at the same pressure, but receives at 3,000 volts and 50 ∽ per second, also three-phase. These two rotatory converters run on alternate days, and have each to supply 20 circuits of 10 arcs each. With the exceptions already mentioned, the alternating current is practically all at 50 ∿ per second frequency. A few parts of the exhibition are supplied from the mains of one of the Paris supply companies.

Before proceeding to enumerate and describe the generating plant, a few notes as to the consumers' circuits may be added. The consumer is furnished with electrical energy for power purposes free of charge; only if he desires extra light for his exhibit is he furnished with a meter, and requested to pay for the energy supplied to his lamps. This being the arrangement, it is only natural that the consumer should have to do his own wiring, and he does do it—usually badly. The administration has not directed enough supervision to this department, and peculiarly enough, on the score of expense, as I was informed, has not put a locked fuse in every consumer's

* The first article appeared in *The Electrician* of July 20.

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circuit. The consequence is that short-circuits are continually taking place; in fact, during the first two months that the exhibition was opened it happened several times a day that circuits were cut off by the circuit-breakers on the main switchboard. The consumers have also used shunt motors to a large extent, and these being in very few instances provided with switches to switch off automatically when supply is cut off, it is necessary to leave a circuit dead for 5min. whenever its circuit-breaker has acted, in order to give consumers time to switch off their motors to prevent the armatures being burnt up on resumption of supply, An example of another kind of the foolishness of consumers attracted my attention in Old Paris one evening. There the supply is by alternating current, as already stated, and the concert room, where concerts by the famous Colonne orchestra are held, is lit with arc lamps, which start humming in an irregular manner every now and then.

Another source of trouble has been damage to the cables, which has occurred during the laying, while the exhibits were being brought in. Thus several short circuits in the high-pressure feeders are reported to have interrupted the supply, and even the continuous-current mains have been giving trouble. The latter are for the most part ordinary lead-covered cables laid under the floor, with service joints which may best be described by saying that they are, of course, of a temporary nature, and only intended to serve during the few months the exhibition is open. A practical form of cable head is employed, however, for the main cables between the generators and the exhibits. It is a funnel-shaped piece of ebonite which is passed over the trimmed end of the cable, fastened to the lead, and then filled with paraffin wax, the end of the copper conductor with its lug for screwing on at back of the switchboard being all that appears above the wax. Another example of the want of care in some matters of detail is a distributing board on the gallery of the electricity building and within reach of everyone. It apparently has upon it the fuses and switches of a number of important branch circuits, and is not even protected by a cover, so that it is within the the power of any visitor, who is not frightened by the legend, "Appareils de service. Défense d'y Toucher," to switch off all the circuits and walk away. Some of the exhibitors have been complaining that no alternating current supply was available within the electricity buildings, and Messrs. Siemens & Halske have found it necessary to put in a motor-generator in order to obtain the alternating current required for some of their exhibits. In the electricity section it would have been only fair to give every exhibitor the choice of continuous and alternating current.

However, it does not do to be hypercritical, and the electricity department is blamed for far too much in connection with the exhibition. Their task has been a gigantic one, and they as well as the other departments have been affected by strikes and *force majeure* which would have been deemed sufficient excuse for any ordinary contractor on any ordinary job. The electrical department is served by an expert staff of engineers under M. R. V. Picon, who at my request kindly put one of his assistants at my disposition one afternoon. His help was most valuable to me in obtaining particulars of the general conditions governing the electrical supply in the exhibition and the arrangement of the different supply areas and circuits.

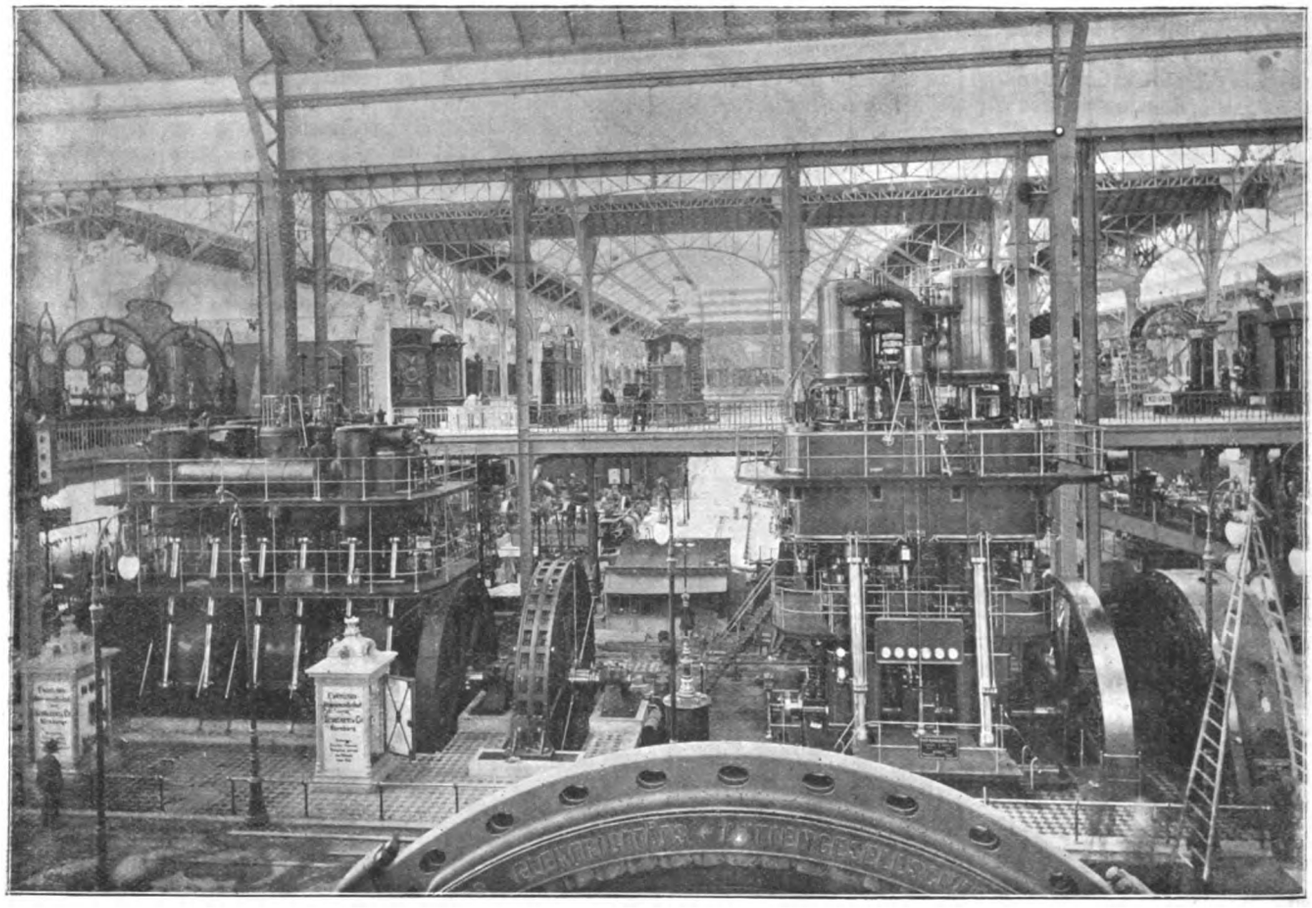

Fig. 7.—General View of Interior Electricity Building from Gallery.

The mechanical and electrical service are quite distinct, and under a separate staff of engineers. This makes it somewhat more difficult for the contractors, who have to obtain their steam from the mechanical department, and to supply current to the order of, and under conditions imposed by, the electrical department. However, the two departments pull well together, only unfortunately if there is a deficiency of steam or feed water, or if an alteration in the steam pipes delays the commencement of supply, it is always the electrical department that is blamed by the general public and the noisy Parisian press. An amusing example, on the other hand, of a difference between two departments occurred in connection with the symbolic figure of electricity surmounting the Palais de

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l'Electricité. M. d'Arsonval had devised some fine high-pressure discharge effects which were to surround this figure, and add to the evening decorations of the façade already alluded to. For this purpose he employed a condenser charged by a high-pressure alternating current transformer. The transformer is of 30kw. size, and of the closed magnetic circuit type, and receives current at 110 volts or 55 volts, and 42·5 ∽ per second, transforming up to a maximum of 90,000 volts. The condenser is formed of plants of micanite, 2mm. thick and measuring 365 × 285mm., sandwiched between sheets of tin-plate, the micanite extending 5cm. over the edge of the metal, and the whole being plunged in petroleum. Twenty plates are used, and the capacity is about 0·01 microfarad. An ingenious discharger proposed for the purpose and already constructed by M. d'Arsonval in his laboratory, consisted of two metal spheres made to revolve in a circle in such a way that the current of air formed blows out the spark, and increases its length and noisiness, while if the speed of rotation is regulated so that the path moved through between two discharges is equal to the length of each spark, a continuous ring of fire is produced. As a spark up to 20cm. in length can be obtained by charging the condenser with 50,000 volts, and 600 discharges per second can be produced, 60 discharges can be seen in a tenth of a second, which gives the impression of a spark 1·20 metres in length. This discharger has not yet found its way to the top of the electricity building, because it still remains to be decided whether the duty of erecting and paying for it belongs to the electricity or the architect's department.

For 1fr. 50c. one can visit, between the hours of 10 a.m. and 7 p.m., the cellars beneath the Château d'Eau, in which the switches and drivers, arc lamps and projectors for the illumination of the Château and fountains are situated. A large part of the switchboards here was burnt down recently, the fire delaying considerably the first illumination of the water palace, and by the roughness of the wiring we should not be surprised to hear of a repetition of this occurrence. It is only fair to state that this work has not been done by the exhibition authorities, but by the Compagnie Générale de Constructions Electriques, who are the contractors for the illumination of the fountains. The wires are fastened against wooden boards, sometimes with iron staples, at other times

BOILERS.

Names of makers.	No.	Type.	Production of steam in kg. per hour.
MM. J. and A. Niclausse, Paris	21	multitubular	35,000
M. Crepelle-Fontaine, la Madelaine-les-Lille	1	„	3,000
Société des Generateurs Mathot, Rœux-les-Arras	7	„	28,500
Compagnie Babcock et Wilcox, Paris	14	„	35,000
MM. Roser et Cie, St. Denis	6	„	20,000
M. Montupet, Paris	5	„	10,000
	1	semi-tubular	
MM. Biétrix, Leflaive, Nicolet, St. Etienne	1	multitubular	2,700
MM. Solignac, Grille et Cie, Paris	1	„	1,150
Compagnie de Fives-Lille, Lille	3	semi-tubular	6,250
MM. de Naeyer et Cie, Willebroeck	10	multitubular	35,000
Galloways, Manchester	6	Galloway	15,000
MM. Fitzner et Gamper, Sosnowicz	1	multitubular	2,000
M. Steinmüller, Gummersbach	5	„	17,500
MM. Petry-Deveux, Düren	1	„	3,720
M. Ewald Berninghaus, Duisburg	5	Cornish	12,700
M. Petzold, Düren	1	„	2,160
MM. Simonis et Lanz, Berlin	1	multitubular	3,250
M. Paucksch	2	Cornish	1,700

FRENCH GENERATING SETS.

Names of makers.		Ind. H.P.	Power in kw.	Type of current.	Current in amperes.	Voltage.	Frequency.
Steam engines.	Dynamos.						
Société Alsacienne de Constructions Mecaniques	Société Alsacienne de Constructions Mecaniques	1,200	675	Continuous	1,400	500	...
Crepelle et Garand	Decauville aîné	1,200	675	Ditto	2,800	250	...
Société de Laval	Maison Breguet	300	170	Ditto	700	250	...
Ditto	Ditto	300	170	Ditto	700	250	...
Compagnie de Fives-Lille	Compagnie de Fives-Lille	1,200	675	3-phase	180	2,200	50
Piguet et Cie	A. Grammont	600	340	Ditto	90	2,200	50
Garnier	Etablissement Postel-Vinay	400	225	Continuous	450	500	...
Do.	Ditto ditto	135	75	Ditto	150	500	...
Dujardin et Cie	Soc. l'Eclairage Electrique	800	440	3-phase	95	3,000	50
Biètrix, Nicolet & Co.	Ditto ditto	350	190	Continuous	760	250	...
P. et A. Farcot	P. et A. Farcot	850	480	2-phase	155	2,200	42·5
Weyher et Richemond	Daydé et Pillé	1,000	560	Continuous	2,240	250	...
Ditto ditto	Compagnie Générale Electrique, Nancy	500	280	3-phase	52	3,000	50
Ditto ditto	Electricité et Hydraulique	1,000	550	Ditto	150	2,200	50
Delauney-Belleville	Maison Bréguet	1,250	700	Ditto	190	2,200	50
Soc. Anciens Etab. Cail	Compagnie Thomson-Houston	1,200	675	Ditto	65	5,500	25
Dujardin et Cie	Schneider et Cie	1,500	840	Ditto	230	3,000	50
Société Anonyme Hauts-Fourneaux, Maubeuge	Société Anonyme Hauts-Fourneaux, Maubeuge	500	280	Continuous	1,120	250	...
Société des Ind. Economiques (Charon gas eng.)	Compagnie Générale Electrique, Nancy	120	65	Ditto	260	250	...

GENERATING SETS FROM OTHER COUNTRIES.

Country.	Names of makers.		Indicated H.P.	Power in kw.	Type of current.	Current in amperes.	Pressure in volts.	Frequency.
	Engines.	Dynamos.						
England	Robey & Co.	Ernest Scott & Mountain	500	280	Continuous	1 120	250	...
Ditto	Willans & Robinson	Siemens Bros.	2,400	1,340	Ditto	2,630	500	...
Ditto	Galloway	Mather & Platt	500	280	Ditto	1,120	250	...
Netherlands	Stork	Electrotechniche Industrie	550	300	Ditto	600	500	...
Germany	Augsburg-Nuremberg Co.	Helios Co.	1,900	1,020	Single-phase alt.	480	2,200	50
Ditto	Ditto	Schuckert*	2 000	1,120	Three-phase	100	5,000	50
Ditto	Borsig	Siemens & Halske	2,230	1,250	Ditto	340	2,200	50
Ditto	Augsburg-Nuremberg Co.	Lahmeyer†	1,400	785	Ditto	95	5,000	50
Belgium	Carels	Kolben	1,000	560	Ditto	150	3,000	50
Ditto	Bollincks	Electricité et Hydraulique	1,100	620	Ditto	170	2,200	42
Ditto	Van den Kerchove	Pieper	1,000	560	Ditto	150	2,200	50
Austria	Ringhoffer	Siemens & Halske	1,600	900	Continuous	1,800	500	...
Ditto	Erste Brunner	Ganz	910	510	Three-phase	140	2,200	42
Hungary	Lang	Ditto	1,200	670	Ditto	180	2,200	50
Switzerland	Sulzer	Oerlikon	400	250	Single-phase alt.	110	2,200	50
Ditto	Escher Wyss	Ditto	900	500	Three-phase	135	2,200	50
Ditto	Mertz	Alioth	360	200	Continuous	400	500	...
Italy	Tosi	Schuckert	1,200	675	Ditto	1,400	500	...
Ditto	Ditto	Bacini	630	350	Ditto	700	500	...

* Also supplies continuous current, 1,600 amperes at 250 volts. † Also supplies continuous current, 1,400 amperes at 250 volts.

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tied with tape tightly to sharp corners, and only occasionally on insulators fixed on rough wooden bases. Connections are also made with clips attached to bare wires, and the apparatus—the solenoids for moving the coloured glass in front of the arcs, the nickel-plated zinc mirrors, and even the dimmers and change-over switches for the different effects—show a serious lack of finish. The largest arc is a 75-ampere, with one pair of carbons, and the remainder 25-ampere.

For the supply of steam, boilers have been erected by a number of firms, half French, half foreign, on somewhat similar terms to the generating sets. On the preceding page is a list of them, and also of the generating plant. It should be explained that in the column headed "Power in kw," the figures represent only the number of kilowatts contracted for. In some cases, which will be mentioned when the individual machines are described, larger units have been put down in order to exhibit them. The machines are placed on the ground floor of the electricity building among the other exhibits, or perhaps it would be more correct to say that the other exhibits are grouped round these machines, for these generating sets are the most prominent. Fig. 7 is a view of the interior of the electricity building, taken from the end of the gallery above the German section. The top of the large Helios machine is seen, and the two other machines in the foreground are the Schuckert and Lahmeyer generators, both driven by Augsburg-Nuremberg engines. Views of the separate machines will be given in succeeding articles. This illustration merely gives an idea of the extent and general appearance of the electricity section. The next article will deal with the generating sets supplied by English firms.

SOUTHPORT COMBINED LIGHTING AND TRACTION SYSTEM.

The town of Southport faces the north-west, and can hardly be described accurately as a port. Although nominally on the Irish Sea, it is often more than a mile away, the intervening space, however, being filled with artificial sea lakes. Notwithstanding the odity of its name Southport has a Corporation which differs little from the corporations of the average northern town. It has had an electric lighting station running since 1891. It has now just combined it with a traction system using an overhead trolley, and it has a decided aversion to large electric power and tramway schemes promoted by companies, especially those proposing to establish themselves in southern Lancashire.

The lighting station originally contained three Mather & Platt dynamos driven by ropes from Browett-Lindley horizontal engines, the three sets aggregating only 250 H.P. These have given place to Musgrave-Ferranti direct-driven sets, the equipment of the station for lighting being now on the usual Ferranti lines. Current is generated at 2,000 volts pressure and transformed down to 100 and 200 volts, the former pressure being for a two-wire supply from sub-stations in various parts of the town, and the latter for outlying districts, the station itself being situated nearly two miles from the centre of the supply district. Although the lighting system is a single phase alternating one, and the tramways are run from a 500-volt continuous current supply, the Southport Corporation has been well advised in combining them in a single station. At present there is only one generating set for the tramway current, and it is, of course, an economy to run it from the same set of boilers and with the same staff of engineers as the lighting plant. An interesting feature

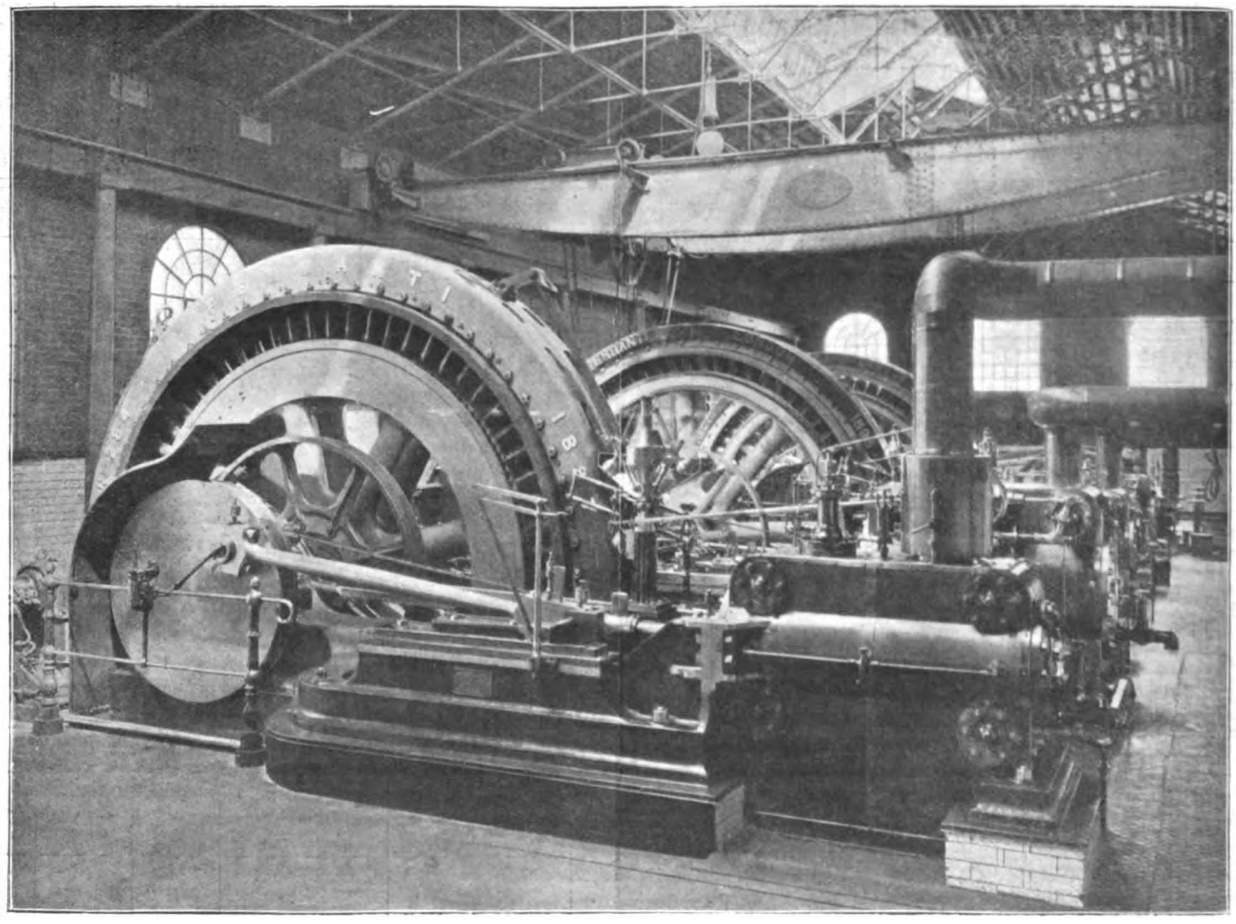

FIG. 1.—VIEW OF STATION, SHOWING FERRANTI SETS.

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of the station is that a comparison can be made between the Ferranti revolving field type of alternator and that known as the "copper" or stationary field type. There are three of the former and one of the latter, the machines with the stationary field type having been the last to be erected. The first two machines erected were, by a peculiar coincidence, put down in 1895 and 1896 by Mr. Taite, the present borough electrical engineer, who was at that time with Messrs. Ferranti. They are rated at 250 H.P. (125 kw.), and, as seen in Fig. 1 are of the flywheel type and driven by cross compound Corliss condensing engines by Messrs. Musgrave & Co. The third machine was also erected by Mr. Taite, this time as borough electrical engineer to the Corporation of Southport during the great engineering strike of 1897, which, it will be remembered, affected Messrs. Ferranti's works. It is a 500 H.P. (300 kw.) machine, also driven by a Musgrave engine. The armature winding of this machine is composed of stranded copper insulated by a cotton covering and braiding, and is carried through the laminated iron core in micanite tubes, the end of the winding and connections being protected from damage and dirt by German silver boxes lined with ebonite. The armature is connected in series and is lap-wound. The laminated iron core itself is

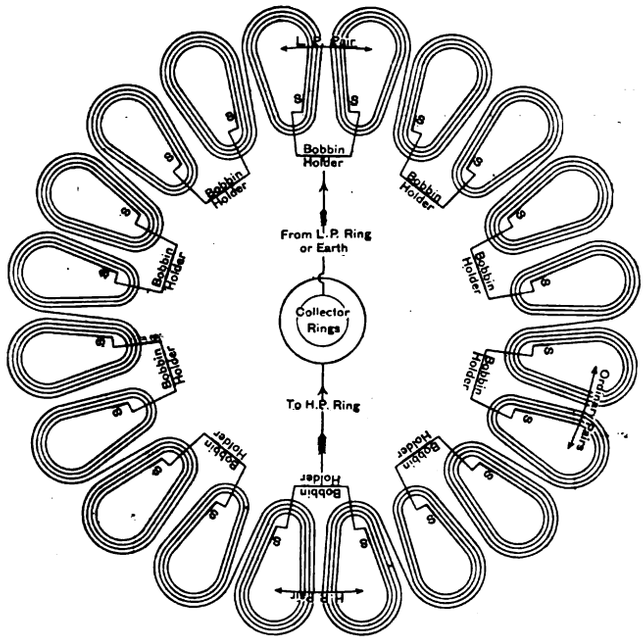

FIG. 2.—DIAGRAM OF FERRANTI "COPPER" ARMATURE.

built in sections which, with the winding and the protecting end boxes, can easily be removed and replaced by a complete spare section. The armature, as a whole, is securely held in a strong cast-iron frame, which rests on feet and is bolted to strong girders embedded in the concrete foundations. The field magnets are oval, and are fixed to the periphery of a cast-iron flywheel, and securely held in position by bolts passing through the rim. The field winding is of the usual form of copper strip wound on edge, and takes current from a small Parker exciter, driven by ropes off a pulley on the main shaft.

The following are the leading dimensions of the 1897 side-by-side horizontal Corliss engine, and particulars of tests made by Messrs. J. Musgrave at their works. Cylinder diameters: High pressure $17\frac{1}{32}$in, low-pressure $33\frac{1}{64}$in., not jacketted. Stroke of each cylinder 3ft. 6in. Piston rod diameters: high pressure $3\frac{3}{4}$in., low pressure 4in. Air pump: vertical, 25in. diameter, 12in. stroke. During the full-load trial the mean speed of the engine was 96 revs. per min., mean piston speed 672ft., and mean total I.H.P. 490·3. Mean boiler pressure 132lb. per sq. in. Mean vacuum in condenser 27in. 15lbs. of steam were supplied to the engine per I.H.P. per hour, and 1·81lbs. of coal were fired, the boilers being two in number, of the Lancashire type, each 28ft. by 7ft., hand fired and worked in connection with a Roberts economiser. Grate area 66 sq. ft. At the three-quarters load test the weight of steam supplied per I.H.P. per hour was 15·31lb., and the weight of coal fired ·861b. At one-half load the corresponding figures were 16lb. and 1·79lb.

The "copper" or revolving armature machine is built on the lines usually followed by Messrs. Ferranti in this type of generator, which, however, is not seen so frequently as the revolving field type. To remind our readers of the connection of the Ferranti armature we reproduce a diagram Fig. 2.

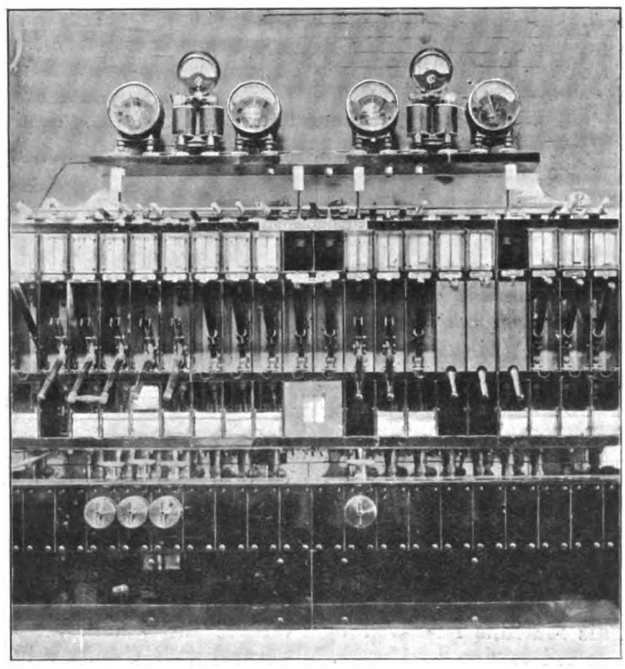

FIG. 3.—FERRANTI HIGH PRESSURE SWITCHBOARD.

The machine is designed to give 286 amperes at 2,100 volts, the frequency of course being the same as the other two machines—viz., 50 ∽ per second, and it is noteworthy that all the machines behave perfectly in parallel, the "iron" machines running quite harmoniously with the "copper" machine. The wheel on which the armature is mounted is

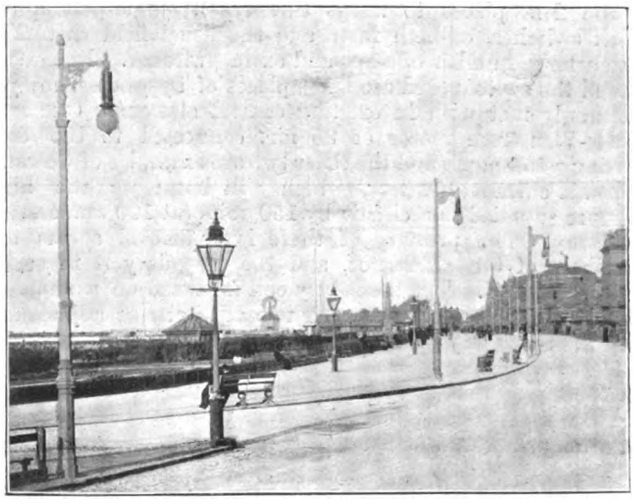

FIG. 4.—ARC LIGHTING ON PROMENADE.

made in one casting, and is of ample strength to withstand the stresses set up when running at 214 revs. per min. It is secured to the shaft in the usual way by mild steel rings shrunk over the bosses. As it is an "out end" combined plant, the shaft on which the wheel is mounted is separate from the crank shaft, but coupled to it by a solid forged flange, and is 15in. diameter in the swell, with journals measuring

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10in. by 30in., supported by bearings lined with white-metal and lubricated by oil supplied under pressure from the under side of each bearing. The armature, consisting of 28 coils, is wound on cores built up in alternate layers of strips of brass and asbestos. It is of the usual form of Ferranti corrugated copper strip which ensures the winding being kept securely in position. Each pair of coils is firmly held between, but insulated from machined gun-metal holders which are rivetted together. Connected with bosses on these carriers are steel bolts, which, after passing through the outside of the wheel rim, screw into cast-iron blocks, which are themselves embedded in a special sulphur compound run into cored pockets in the the wheel rim. In order to secure good insulation, the bolts carrying the holders are covered with ebonite before being placed in position. The manner in which the armature is connected up in two parallel halves is clearly seen in Fig. 2.

The construction of the collector gear is simple and efficient, and the current, after passing down specially-insulated connections, is collected off a gun-metal ring which is carried by, but insulated from, the wheel boss.

On each side of the armature, allowing an air-gap of about $\frac{3}{8}$in., are ranged the 28 poles, which are fixed into bored holes in the cast-iron yoke which itself forms part of the massive frame. To facilitate easy adjustment of the air-gap and to reduce the friction in opening the two halves for purposes of cleaning or inspection, the feet of the frames are mounted on rollers.

The field winding is of the usual construction and composed of copper strip wound on edge around each pole. It receives the current from the armature of a rope-driven exciter. A special precaution against a flash-over from the armature to poles is taken by placing micanite caps on the faces, which also allows the air-gap to be made smaller than would otherwise be possible.

This machine is driven by a vertical three-crank tandem compound engine by Messrs. Musgrave, with Corliss valves, four to each cylinder, actuated in this case by a piston gear instead of by a trip gear. The speed of 214 revs. per min. is fairly high for this type of valve. The exciter is of the same type as on the other dynamos, and driven in the same way. It may be noted that each of the three parts of the engine is complete in itself, with its own jet condenser, so that in the case of one set of cylinders being disabled the machine may in certain circumstances still be kept running.

Fig. 3 is a view of the switchboard, which is of the standard Ferranti design, with edgewise ammeters (Southport being one of the first places to adopt this type), single-pole quick break switches, oil-bath fuses and the usual field rheostats, with a large number of stops and extra switches. In a room behind the switchboard are three pieces of apparatus not yet commonly met with in existing central stations. One is a Fuller-Wenstrom motor of 35 H.P. connected to the condensing water pump and the other two are examples of Cowan's alternate-current boosters, which will boost up the high pressure supplied to a circuit by 150 volts (at 100 amperes) if necessary. The primary of these is connected across the terminals of the alternator, and the secondary is in series with the circuit. The secondary coil is placed on a shaft so that the relative position of the two coils can be adjusted to vary the secondary pressure.

The arc lighting is by Ferranti rectifiers, there being in all 42 15-ampere arcs. There are two rectifiers, but each is capable of taking the full load of arc lamps. Fig. 4 shows the arc lighting on the promenade facing the sea.

(To be concluded.)

MAXIMUM POWER FACTOR AT CONSTANT VOLTS IN A TWO-PHASE ROTARY CONVERTER.

BY PROF. ERNEST WILSON.

It has been shown by Messrs. Parshall and Hobart,* that, if a three-phase rotary converter be run at constant frequency, with constant potential difference between its slip-rings at all loads and maximum power-factor at the slip-rings, the field excitation has to be *increased* as the converter is loaded. The effect mainly develops between half and full load. In the particular case alluded to, the excitation of the converter at full load is about 15 per cent. greater than it is when the converter is run unloaded.

The following experiments are addressed to testing this point in connection with a two-phase rotary converter. The machine experimented upon is of the bi-polar type with smooth core drum armature, and is intended to deliver 140 volts 80 amperes at 880 revs. per min., as a shunt-wound generator. It is fitted with four slip-rings which make contact with the commutator at 0deg., 90deg., 180deg. and 270deg., and receives current from a similar machine, also fitted with four slip-rings, and driven by a steam engine and leather link belt. The circuits between the slip-rings of generator and converter consist of four conductors (non-inductive) of resistance 0·054 ohms each, and the resistance of each armature between the brushes on the commutator is 0·042 ohms.† The machines were separately excited from a set of storage cells through adjustable resistances.

Three experiments have been made, and the results are given in the Table below. They correspond to about full load, half load, and the converter on open circuit. The results for the one-phase only are given: the other phase is the same but displaced one-quarter period in time. The method of experiment was to adjust the excitations of the generator and converter until the potential difference, as read on a Kelvin multicellular voltmeter placed across one phase at the slip-rings, was the same in each experiment for the same frequency and for maximum power factor. The curves of potential difference and current were observed by aid of a revolving contact maker and Kelvin quadrant electrometer in the usual manner. It will be seen from the table that the power factor is very nearly unity in each experiment. In experiments 1 and 2 respectively the curves of current and potential difference cross the axis of time at the same point. In experiment 3 the current curve leads about 9deg. The curves of potential difference in the respective experiments have the same wave-form, and the same remark applies to the curves of current. The generator excitation had to be increased as the load was increased; the converter excitation showed a diminution of about 2 per cent., as the load was increased from 0 to 8,240 watts. Further experiments might be made to see if the observed variation in the converter exciting current is connected with the mechanical phase displacement of the converter armature, and the phase of the alternate current; or if it is due to error in instrumentation. In either case the exciting current of the converter is substantially *constant* for all loads.

It may be mentioned that an exciting current of 3·2 amperes corresponds to a fairly high excitation in this machine, but not so high as when normally excited.

* See *Engineering*, April 20, 1900, Figs. 48, 49.

† For further particulars see *Proc.* Institution of Electrical Engineers, Part 144, Vol. XXIX., p. 409; also *Proc.* Roy. Soc., Vol. 51, p. 49; also *The Electrician*, Vol. XXVII., p. 609.

No. of experiment.	Volts across one phase at slip-rings.		$\sqrt{\text{mean}^2}$ amperes in one phase, calculated from curve.	Watts delivered per phase at slip-rings.		Power factor.	Volts on direct-current side, as measured by Weston voltmeter.	Amperes on direct-current side, as measured by Kelvin balance.	Direct-current watts.	Efficiency of armature, including brushes.	Revs. per min.	Exciting current in amperes. Turns on each machine = 3,968.		Phase displacement of potential difference from position on open circuit. 360deg. = 1 period.	Lead of direct-current brushes.
	Observed on Kelvin multi-cellular voltmeter.	Calculated from curve.		Apparent—i.e., product of $\sqrt{\text{mean}^2}$ values.	True—calculated from curves.							Generator	Converter.		
1	82·1	82·5	56·5	4,660	4,613	0·99	113·5	72·6	8,240	89·3	813	3·84	3·14	9·0deg. lag	0deg.
2	81·7	82·2	30·96	2,550	2,520	0·99	113·7	37·8	4,298	85·3	815	3·29	3·19	6·3deg. lag	0deg
3	82·2	83·0	4·23	351·7	350·8	0·998	115·2	0·0	0	0·0	812	3·00	3·20	0·0deg.	0deg

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A FRICTIONLESS MOTOR METER.*

BY S. EVERSHED.

(Concluded from page 439.)

APPENDIX.—CALCULATION OF ARMATURE TORQUE, BRAKE TORQUE, AND FRICTIONAL RESISTANCE.

I. *Armature Torque.*

In designing an Ayrton-Perry motor meter the driving torque may be calculated from the formula—

$$d = HaNC/\pi,$$

which gives the torque d in terms of H the field of the main current coils, a the area of the average turn of wire on the armature, N the total number of turns in the armature winding, and C the whole pressure current from brush to brush.

A sufficiently close approximation to the true mean value of the field throughout the space occupied by the armature is obtained by calculating H at several points of the axis of the main coils, and taking an average. When the coils are rectangular, the field on the axial line may be deduced from the formula $H = 8C\sqrt{p^2+q^2}/pq$, which gives the field at the centre of a wire rectangle who sides are p and q. If the coil is square, this reduces to $H = 8\sqrt{2C/p}$, p being now the side of the square. The field at the centre of a circular wire being $H = 2\pi C/r$, we find that if $r = 0{\cdot}56\,p$ the circular and square wires will have the same field ; hence, for purposes of calculation, a circular coil of appropriate radius may be substituted for the square coil.

There are, of course, various methods for arriving at an exact value for H, but as they involve applications of spherical harmonics they are far too cumbersome for practical use in design.

When the meter is made, its driving torque is easily measured by passing a fine thread round the axle and hanging a known weight on the end. When the axle is vertical, the thread is brought out in a horizontal direction from the axle and passed over a freely pivotted pulley, from which it hangs down carrying the weight at its end. To avoid side pressure against the axle bearings it is desirable to use two threads brought away from the axle in opposite directions and each carrying half the weight, so that a proper turning moment is produced. Having adjusted the thread and weights, current is turned on, and varied until the armature torque just balances the weight. When the full-load torque is small, it is desirable to make this measurement with two or three times the full-load current, otherwise the weight required will be too small to enable accurate results to be obtained. The calculated torque is found to agree within 2 or 3 per cent. with that obtained directly by measurement.

II. *Brake Torque.*

The difficulty of determining the average path of the eddy current in a given brake conductor prevents us from predetermining the torque unless we have previously ascertained the effective electrical resistance of the current path in a brake of similar shape. There are, however, some general principles applying to the design of Foucault brakes which may be shortly stated here.

Consider a cylindrical conductor, of radius r, spinning on its axis between the poles of a magnet. Let the polar gap have a breadth b and axial length l, and let the field within the gap be H. Then if x is the electrical resistance of the current path, and ω the angular velocity of the cylinder, the current generated will be—

$$C = Hlr\omega/x$$

Now the force between conductor and magnet is HlC, hence the torque will be

$$M = H^2l^2r^2\omega/x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

When the cylinder extends axially for some distance beyond the poles in both directions, x becomes simply proportional to the resistance of the metal in the gap. Now this resistance is $\rho l/bt$, t being the thickness of the metal. We can therefore write $x = k\rho l/bt$.

The value of k depends on the shape of the polar area, and on the extent of conductor outside that area. The author finds k varies from about 3 for a square or circular area of gap up to 6 or 7 with oblong poles, even as high as 9 or 10 when there is very little metal beyond the poles. Inserting the value just given for x in equation (1) and multiplying both numerator and denominator by b, we get—

$$M = H^2t^2b^2r^2\omega t/k\rho bl,$$

$$M = B^2r^2\omega t/krbl \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

from which we see that for a given value of total induction B passing through the brake cylinder, the torque increases as the area bl is diminished. This deduction is well borne out in practice, and by giving the brake magnets conical poles ending in a circular gap of small diameter the torque for a given weight of magnet is considerably increased ; or, what is generally more important, for a given torque the weight of metal in the brake may be greatly reduced by using magnets with conical poles.

The formula also shows the advantage to be gained by increasing the diameter of a cylindrical brake ; since the weight only increases in simple proportion, while the torque increases in proportion to the square of the radius.

III. *Frictional Resistance.*

When mechanical friction is a fairly large percentage of the full-load torque, air friction may be safely neglected ; the only retarding forces are then mechanical friction, which is practically constant, and the brake, which is proportional to the speed. Hence if s_1 and s_2 are the observed speeds with two torques d_1 and d_2, we have—

$$d_1 = f + bs_1 \quad d_2 = f + bs_2,$$

where f is the torque required to overcome friction, and b is the brake torque at unit speed. Hence

$$b = d_2 - d_1/(s_2 - s_1), \text{ and } f = d_2s_1 - d_1s_2/(s_2 - s_1).$$

To get accurate results, stray fields must be eliminated by reversing the current in the main coils and taking a second set of readings with the same numerical values for d_1 and d_2.

In testing the friction of a "frictionless" meter, the greatest care is required in measuring speeds and torques, and it is necessary to reduce the strength of the brake to a small fraction of its normal value in order to obtain anything like accurate results, for obviously errors of observation have a rapidly increasing effect on the determination of f as the two quantities d_2s_1 and d_1s_2 approach each other in magnitude. Each of the results given in Tables III. and IV. is the mean of a number of observations, and to avoid effects due to want of truth in the brush wheels the speeds were deduced from the times taken to make 12 (and multiples of 12) revs. of the armature, corresponding with whole revolutions of the brush wheels. Even with the utmost care, discrepancies of as much as 10 or 15 per cent. in successive tests are quite usual when the friction is under 3 dyne cm.

When the armature and brake of a "frictionless" meter are both figures of revolution with smooth surfaces air friction is inappreciable up to speeds of 40 or 50 revs. per min., but when there are any parts attached to the axle which can have a fan action, air friction becomes evident, and although it would cause no appreciable error in the registration of the meter when the normal brake is in use, it will, if not taken into account, lead to an under-estimate of the mechanical friction. To avoid this, observations are made at three speeds in order to determine a, the coefficient of air friction, as well as f and b.

Thus, assuming the air friction of a rotating body to be proportional to the square of the speed, we have—

$$d_1 = f + bs_1 + as_1^2 ; \; d_2 = f + bs_2 + as_2^2 ; \; d_3 = f + bs_3 + as_3^2,$$

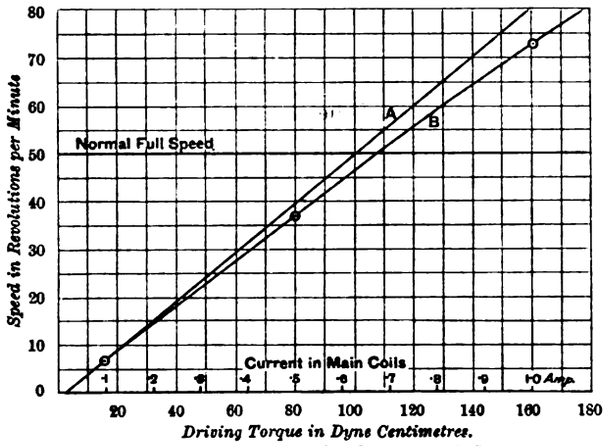
from which we first find a, then b, and finally the mean value of f.

$$a = \frac{(d_3 - d_2)(s_2 - s_1) - (d_2 - d_1)(s_3 - s_2)}{(s_3 - s_2)(s_3 - s_1)(s_2 - s_1)} ;$$

$$2b = \frac{d_3 - d_2}{s_3 - s_2} + \frac{d_2 - d_1}{s_2 - s_1} - a(s_3 + 2s_2 + s_1) ;$$

$$3f = d_3 + d_2 + d_1 - b(s_3 + s_2 + s_1) - a(s_3^2 + s_2^2 + s_1^2).$$

The air friction of a rotating body is probably not exactly proportional to the square of the speed, but the formula is found to agree very closely with experiment.



A. Curve drawn from equation $d = 3{\cdot}16 + 1{\cdot}96\,S$.
B. Curve drawn from equation $d = 3{\cdot}16 + 1{\cdot}95\,S + 0{\cdot}003\,S^2$.
⊙ Points determined by experiment.

FIG. 15.—Torque-speed Curves for Meter No. 5 (effect of air friction exaggerated by use of a weak brake).

An example of the effect of air friction is afforded by meter No. 5, in which each of the two parts of the astatic armature is made up of four oblong coils wound on open "formers." Such an arrangement naturally fans the air, and experiment showed that air friction at speeds of from 40 to 50 revs. per min. was by no means small compared with mechanical friction. The brake having been reduced to about one-sixteenth of its full strength the following readings of torque and speed were taken :—

Meter No. 5.

Full-load, 100 volts × 10 amperes.
Full-load torque, 1,610 dynes cm. ; drop 0·6 volt.
Effect of air friction exaggerated by use of a weak brake.

Volts.	Amperes.	d dyne cm.	s revs. per min.
100	0·10	16·1	6·58
100	0·50	80·5	37·40
100	1·00	161·0	72·60

By inserting these values in the above equations we find—

$$f = 3{\cdot}16 \; ; \; b = 1{\cdot}95 \; ; \; a = 0{\cdot}003.$$

The curve of the meter with its weakened brake is shown in Fig. 15, where the lower curve line is drawn to the equation—

$$d = 3{\cdot}16 + 1{\cdot}95\,s + 0{\cdot}003\,s^2,$$

* Paper read before the Institution of Electrical Engineers, May 10.

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while the upper curve (a straight line) shows what the law of this meter would have been if no air friction existed. It will be seen that at 80 revs. per min. air friction amounts to as much as 19 dyne cm.

At full speed (50 revs. per min.) the driving torque is expended as follows :—

	dyne cm.
In overcoming mechanical friction	3·2
Ditto air friction	7·5
Ditto brake torque	97·8
	——108·5

That is to say, with the weak brake air friction amounts to about 7 per cent. of the whole resistance to rotation. With the brake restored to its normal strength the corresponding figures are—

	dyne cm.
Mechanical friction	3·2
Air friction	7·5
Brake (full strength)	1600·0
	——1610·7

It will be seen that the air friction is now less than one-half per cent. of the total resistance, although this particular meter has less torque than the standard now adopted.

Another method of determining friction, which seemed at first sight to offer several advantages, is to run the meter at about full load, and, having carefully determined the speed, at a given instant cut off the currents and note the time taken by the meter in coming to rest. If at any instant the angular velocity is ω, we have the equation—

$$I d\omega/dt = f + b\omega, \quad \ldots\ldots\ldots \quad (1)$$

where I is the moment of inertia of the meter axle and parts attached to it ; f is the mechanical friction as before, but b now stands for brake torque at unit *angular* velocity. (1) give the value—

$$t = \frac{I}{b}\int \frac{d\omega}{\frac{f}{b} + \omega},$$

hence

$$f = \frac{b\omega_1}{e^{\frac{tb}{I}} - 1}, \quad \ldots\ldots\ldots\ldots \quad (2)$$

ω_1 being the initial angular velocity. The moment of inertia is easily determined by attaching a hair-spring, of known strength, s, to the axle, and observing the period of oscillation τ ; then—

$$I = s\tau^2/4\pi^2.$$

s must be taken in dyne cm. per radian of torsion.

In practice this method has not given good results. A meter—especially a frictionless meter—comes to rest so gradually that it is exceedingly difficult to determine with exactness the instant when it stops. Again, if there is the least want of balance in the axle it will very rarely happen that the meter comes to rest at its position of stable equilibrium without first making one or more very slow oscillations about that point. Hence there are often very large discrepancies in successive observations, and on the whole the average time taken in coming to rest will be greater than it would be if the meter were perfectly balanced. Some early experiments with meter No. 2 may be quoted as an illustration of this uncertainty. Measured by the torque-speed curve the friction was 2·65 dyne cm. ; the mean of two fairly good observations of the time of stopping gave the value 2·98 dyne cm. This result being considered encouraging, a large number of similar tests were made, with the result that the average of the whole series gave 1·27 dyne cm. as the friction. This figure is undoubtedly a good deal lower than the true value, and, except as a rough and ready means of comparison, the stopping test has not since been employed. All the friction values given in the Paper are deduced from torque-speed curves.

An improvement on the stopping test would be to record on a chronograph the times of successive revolutions of the meter, beginning as soon as the currents are cut off and ending a little before the meter comes to rest. The chronograph record would enable a time-speed curve to be plotted, and the slope of the curve would give the total retardation, from which the brake torque would have, of course, to be deducted in order to arrive at the value of friction.

Calculated Friction.—It is useful to compare the value of friction given by direct experiment with the value calculated on the assumption that the bearings are the sole cause of friction. This comparison has been made in the case of meter No. 2, and shows a considerable margin of friction unaccounted for. If the diameter of contact between the steel point and the cup forming the step-bearing were measurable, the friction moment could be estimated from the formula—

$$f = kPd/3,$$

where k is the co-efficient of friction, P is the total pressure on the bearing and d is the diameter of contact.

It is, however, impossible to measure the contact diameter when the point and cup are spherical surfaces, and recourse was had to experiment. The total friction having been taken by the torque-speed method, a weight of about 50 grammes was added to the armature, and the friction again determined. The weight being removed, the first test was repeated. The result of these tests was to show that this particular point and jewel offered a frictional resistance of 0·092 dyne cm. per gramme weight pressing on the jewel. Now before the meter started running on Oct. 12, 1899, the pressure on the jewel was measured and found to be 12 grammes ; hence the step-bearing friction would be $0{\cdot}092 \times 12 = 1{\cdot}1$ dyne cm.

The friction added by each brush wheel is roughly as follows :—

Brush-wheel step bearing : pivot assumed to have a flat end in contact with flat step plate. Weight of wheel and its axle, 1·2 grammes ; or P = 1,200 dynes nearly enough. Diameter of contact, say equal to diameter of pivot, namely, 0·035cm. Co-efficient of friction 0·20. Then using the formula —

$$f = kPd/3,$$

we find the frictional resistance of the bearing is 2·8 dyne cm.

The commutator wires press against the wheels and force the brush pivots against the sides of the holes in which they run. The mean pressure on each wheel is about 50 dynes, and the radius of the pivot being 0·018cm., the friction moment is roughly $50 \times 0{\cdot}2 \times 0{\cdot}018 = 1{\cdot}8$ dyne cm. Adding this to the step friction and multiplying by two to include both brush wheels, we find they require a torque of nearly 6 dyne cm. applied to their own axles to overcome friction. This figure must of course be divided by 13—the ratio of the diameters of wheels and commutator—to give the frictional moment of the brush wheels upon the armature axle. That is to say, the brush wheels account for about 0·5 dyne cm., while the meter axle bearing accounts for 1·1, making a total of 1·6 dyne cm. estimated friction.

The lowest observed friction in meter No. 2 was 2·1 dyne cm. (see Table IV., Oct. 12, 1899), so that, remembering that brush-wheel friction is an over-estimate, there is at least 0·5 dyne cm. unaccounted for. No doubt the rolling of the commutator wires on the brush wheels accounts for some of this, and there is also the work done in overcoming cohesion as the wires pull themselves off the wheels. This is a form of work which is probably not completely or even at all reversible, so that it is not given back when the wires come into contact with the wheels. There may also be a very small resistance to rotation due to hysteresis in the steel axle. The magnetic field of the brake magnets tends to produce a non-uniform distribution of induction at the surface of the axle, and if this want of uniform density extends to any depth below the surface, some part of the volume of steel will be going through two small magnetic cycles in each revolution of the axle.

LONDON ELECTRIC LIGHTING COMPANIES AND THE CHANGE OF VOLTAGE.

On Tuesday, the President of the Board of Trade received a deputation from the representatives of the following London electricity supply companies: Westminster, Metropolitan, Chelsea, City of London, County of London and Brush Provincial, Notting Hill, Brompton and Kensington, and Kensington and Knightsbridge. The object sought by the deputation was an alteration of Clause 6 of Section B of the Regulations made by the Board of Trade on March 4, 1896.* That section declares the pressure at consumer's terminals and ends as follows: "Provided that no change shall be made in the pressure of the supply to any premises" (and so on) "except with the consent of the consumer." The proposal of the deputation was to alter "except with the consent of the consumers" by substituting "except on such terms and conditions as may be agreed upon between the undertakers and the consumer, or failing agreement as may be settled by an arbitrator appointed by the Board of Trade."

The officials of the Board of Trade accompanying the President (Mr. Ritchie) were Sir Courtenay Boyle, the Hon. T. H. W. Pelham, Mr. Garnham Roper, and Mr. A. P. Trotter, the Electrical Adviser.

The deputation was headed by Lord Suffield, and included Mr. Boulnois, M.P., General Webber, and the managers of the electricity supply companies.

Prof. A. B. W. KENNEDY said the actual way in which the proviso worked in practice was that it not only gave the right to bona fide objections to the change of voltage—objectors who objected on perfectly reasonable and proper grounds—but it gave the right to any casual consumer to object. Their present object was, or might be, to avoid the blackmailer—that was to say, one who had no reason and did not wish to give any reason, but wished to be paid whatever he chose to demand. In a case of that kind a supply company was bound to go on supplying him, because although in all their districts, with very few exceptions, the policy of the Board had been to keep two competing supplies, it was not their policy to say, will you please go on to the other company to supply you at 100 volts? The consumer, was of course, entitled to say that he would not change, and, in fact, it had been stated in another place that they were not entitled to hand the consumer over to another company, although he might be a consumer who took only a very few shillings' worth of current in the course of the year. When most of the London companies started supply there was a particular limit of what was called low pressure, until that most important conference, presided over by Sir Courtenay Boyle, and that particular clause was put on one side to be discussed in connection with the question of what might be considered low pressure. One of the most important results of the conference had been that the use of higher voltage lamps had become very general practically throughout the whole of the country. It was understood at the end of that conference that the provision as to changes of pressure would be allowed subject to certain regulations which the Board of Trade would propose, or which they would make ; they did not, however, know at the time that there would be an absolute veto given to the change on the part of certain people. He would like to make reference to one paragraph in a letter from the Board in reference to the way in which the change had already been made. It was a letter dated May 24, and contained the following paragraph: "I am, further, to state that although a change of pressure has been effected in respect of several electric lighting undertakings throughout the country the Board are not aware that any difficulties have arisen by reason of the

* See "The Electrician" Electrical Trades Directory and Handbook for 1900, pp. 127-134.

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existence of the proviso except in the case of one of the memorialist companies." He wished to put before the Board, however, the fact that difficulties had arisen in many other places. The only exception to his knowledge being the municipal station at Edinburgh. They were able there to adopt a means which it was not possible for a private company to adopt. Municipalities had powers which no private companies possessed. The case of the London companies was much more difficult than the case of municipalities, many of the companies having started 10 years ago and at the date of the regulations they had about 3,000 consumers connected with the mains, any one of whom had the power of veto. In the case of Edinburgh there were only a few hundred consumers. The Westminster Company was the first London company to carry out the change thoroughly and systematically. The other companies had begun, and their engineers or directors had told him, he thought without any exception, that they already found difficulties from this clause. It was only at the last moment that the difficulties became absolutely insurmountable. In the particular case of the Westminster Company, to show how hard it was, out of 5,300 consumers they had only 10 now who absolutely refused to change over. One of these consumers only used 3s. worth of current in the year, and another used but a few shillings' worth.

In reply to Mr. Ritchie, who asked what kind of blackmail there could be on 3s. per annum, Prof. KENNEDY said that particular consumer was not blackmailing at all. He mentioned another case in which the company had offered, without prejudice, the sum of £500, which they considered was very ample for the change. This amount was refused, £800 being asked for. The £500 would have covered the alterations very amply indeed. Of course the County Council could impose terms and conditions upon them, and they had imposed certain terms and conditions to which they were bound to work, which they thought very onerous, but they had accepted them and worked under them. Those conditions had involved them in very heavy expenditure, although they had complied with them and had incurred the expenditure. Actually a very infinitesimal number of consumers could at present prevent them carrying out the change to a higher pressure.

Mr. RITCHIE: You have very fairly told me about one or two consumers that you had to deal with, but you made a general application of the possibility of blackmail or something of that nature, and you gave an illustration of the gentleman who wanted £800 when you thought £500 was all that was necessary. You have given that illustration as being an extreme case, I suppose?

Prof. KENNEDY: I do not want to go into details.

Mr. RITCHIE: But it is to some extent a question of detail. There is a certain arrangement—a bargain. These people are quite entitled to say, "We do not want your 200 volts; we prefer 100 volts." It may be that they think there may be more danger connected with the 200 volts than with the 100 volts, or that they might consume more current. And they say, "We do not want 200 volts but to adhere to our bargain." Then you say, with regard to one of these gentlemen, who wishes to be supplied with everything if you give him £800, we are willing to give him £500, and the difference between us is £300. You have 10 objectors on the whole, and therefore you come for the purpose of asking us to make an alteration in the regulations which were agreed to by you and other companies.

Prof. KENNEDY: Never.

Mr. RITCHIE: Which was settled at any rate after conference, and settled by certain eminent gentlemen.

Prof. KENNEDY: Not after conference with the companies.

Sir COURTENAY BOYLE: All the companies were heard. This regulation was discussed at that meeting.

Mr. RITCHIE: What I want to get at is really what is the burden which was imposed upon you to arrange with these gentlemen rather than to come to us for a change in the regulations. You have told us in regard to one of your 10, who was a gentleman who consumed 3s. worth, but that is not a man difficult to arrange with.

Prof. KENNEDY: He is most difficult; I cannot arrange with him.

Mr. RITCHIE: It would be an impossibility for a man who consumes 3s. worth of current to wrestle long. But putting him on one side, you spoke of a possible arrangement with the man who wanted £800, and you proposed to give him £500. What about the others?

Prof. KENNEDY: We should not allow a few hundred pounds to stand in the way. He is a gentleman, and he says under your clause he can prevent us. Then there is a small shopkeeper, who consumes £2, and he absolutely stops us.

Mr. RITCHIE: Have you ever offered to give him his light for nothing if he took it?

Prof. KENNEDY: I am sure the 3s. man would not take it.

Mr. RITCHIE: But what about the £2 man.

Prof. KENNEDY: We have tried everything. There is another gentleman in a very good position who objects on the ground of safety; he is a large consumer of current, and to him no question of difference in price would alter his decision.

Mr. RITCHIE: Are you sure that the Westminster has gone the right way to propitiate people, because I have seen circulars sent by your company which do not seem to go on conciliatory lines. [Mr. Ritchie then read half-a-dozen letters addressed by the Westminster Company to their customers.] Those notices were *ultra vires*, for the Westminster could not insist upon supplying their customers with 200 volts or refuse to supply them with 100 volts.

Mr. BOULNOIS: We can charge them 8d.

Mr. RITCHIE: Yes.

Prof. KENNEDY: We have offered a reduction of 8 per cent. for this matter. But he should like to deal with one point which had often been raised that this change was a matter which was going to make a large profit to the companies. It was not a change which enabled them to sell for less in any way, except for a certain time it saved in cost of main, because they could transmit through a main of a given size, but it did not save in generating expenses. The actual figures were these: Taking 20 years hence, and making a very careful estimate of the Westminster Company's outgoings, supposing they could not change over and spend £800 or £900 a year on mains, including current loss, the expenditure would be £412,000, whereas, if they could make this change at the end of the same time the cost would be £214,000, including interest and so forth at the same rate. That worked out one-seventh of a penny per unit. That was the whole of the saving, but it enabled them not to pull up the streets or otherwise go on laying mains continually.

Mr. RITCHIE: But the company would, roughly speaking, save £200,000.

Prof. KENNEDY: But that would be spread over several million units.

Mr. RITCHIE: That is not material, but it is the large saving I am thinking of.

Prof. KENNEDY: But the public are gainers, because our mains have a much greater capacity, and we have not to pull up the streets to relay the mains, and we are fairly entitled to say that whatever money we save here the public will save afterwards, because they will have the power to buy us up 30 years hence. Then it was said that these lamps used more power than others. They had made a most careful examination of lamps using 100 volts and 200 volts to satisfy themselves whether the higher voltage used more energy. The result was that over one million and a-half there was only an increase of 2 per cent. There was a difference in the use of good and bad lamps at high pressure, but there was no difference *per se* actually due to the pressure. The companies had agreed on what they should like to suggest as a possible alteration of this regulation.

General WEBBER said the Board of Trade hardly realised that at the conference of 1895 it was considered that it must be in the interests of the whole of the public of London that the voltage generally should be raised from 100 volts to 200 volts. They hoped the Board would be able to remove a disability which would not work any injustice to the consumer.

Mr. RITCHIE, in reply, said he had listened very carefully to what Prof. Kennedy had said. Of course the representations which he had made and which had been supported by the other gentlemen present would receive his careful consideration, and the suggestions which Prof. Kennedy had made he should be glad to consider in association with those who advised him on matters of that kind. He admitted at once that on the face of it it did seem a strong order that a very small number of persons such as was named by the Westminster Company (about 10) should be able to stand in the way of a complete application of the new system of which they had spoken. At the same time it must be borne in mind that those gentlemen were really within their rights and that if the Board of Trade were to assent to what the companies proposed they would be practically overriding the rights which those consumers at present possessed. He did not want to enter into the reasons why those various gentlemen had refused to fall into line with the large number of consumers who were supplied by the company. Some of them might be actuated by motives which were laudable, and others not, but in any case the Board of Trade was asked by the proposal that was made to override the rights which those gentlemen possessed. If it could be conclusively shown that the difficulties which were encountered by the opposition of that small number were of such a nature as really greatly to interfere with the companies, of course it would be a strong argument in favour of some such amendment as was suggested. He could not say that it had yet been conclusively shown that everything that could be done to bring these gentlemen into line had been done. All the notices to which he had referred had proceeded from the Westminster Electric Supply Corporation, and he thought everybody would admit that those notices, if they were addressed to persons who had a present right to take up the position that they did take up, were rather strong, and they were not of a nature which he himself, if he had been asked to conciliate persons who did not do what one wished them to do should have adopted.

Mr. BOULNOIS: These were after two years' negotiation.

Mr. RITCHIE: Never mind, that may be so, and that very much mitigates the force of my observations. But at the same time if they were addressed—we have not the names, only the circulars—to persons who had the right to demand supply at 100 volts, and whom you could not refuse to supply, they were too strong. I do not make these observations with an idea of leading you to believe that I will not consider the representations that you have made, but it has occurred to me in reading these that all the resources of civilisation have not yet been exhausted, and that it is quite possible that so far as the Westminster, at any rate is concerned, further negotiations may perhaps remove the difficulties.

Lord SUFFIELD: To meet your difficulty I would like to say that there were earlier letters for two years to my knowledge, for I never failed to be present at the board meeting, and those letters were the most courteous letters that were ever penned. It was only lately, when it was evidently as much to the advantage of the consumer as to the company, that the other letters were written. I admit that they were a bit strong, but every other method had been tried first.

Mr. RITCHIE: The fact remains that you cannot, as far as I understand the law, refuse to supply any consumer at 100 volts if he desires to have it. I have not yet heard what was the particular inconvenience suffered by the company in supplying those customers who are now being supplied with 100 volts. What particular inconvenience was suffered by the lighting company, and what was the measure of the inconvenience in pounds, shillings and pence?

Prof. KENNEDY: It simply means that they were more or less scattered. We could not supply 100 volts and 200 volts because we had not the means.

Mr. RITCHIE: You are supplying consumers at those 200 volts?

Prof. KENNEDY: I believe the letters you have read were directed to

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persons who had no right of supply before 1896. We should have to send out special mains from the station to supply these consumers at 100 volts.

Mr. RITCHIE: You are supplying them now with 100 volts?

Prof. KENNEDY: 200 volts, I think.

Mr. RITCHIE: Within the district that you are supplying 200 volts there are certain individuals who get 100 volts. What is the particular inconvenience in pounds, shillings and pence?

Prof. KENNEDY: We have to set apart for those consumers mains which cost us a good many thousand pounds and special generating plant.

General WEBBER: We must keep for those people a special generating station.

Mr. RITCHIE: Would it be many thousand pounds per annum?

Prof. KENNEDY: No. Capital expenditure.

Mr. RITCHIE: But your capital expenditure only has been incurred.

Prof. KENNEDY: It represents 1s. per unit.

Mr. RITCHIE: And you get 6d.

Prof. KENNEDY: 8d.

Mr. RITCHIE: So that the actual cost is 4d. per unit upon their consumption. If it costs you a shilling at 100 volts and you only get 8d. for that you lose 4d. on the supply. On the consumer who takes 3s. worth that would not be much.

Prof. KENNEDY: We cannot get at him.

Mr. RITCHIE: Perhaps, you will give me some particulars as to what the actual cost in pounds shillings and pence would be about, without counting capital expenditure which has already been incurred. What is the loss to you on the 10 consumers who are recalcitrant?

Prof. KENNEDY: I will give it.

Mr. RITCHIE: I will then consider that along with the other matters.

General WEBBER: The companies would like to be allowed to go more into detail considering that now your mind is on the subject, and we might be able to submit our case to you later on. Each company has got its difficulties in various changes from 100 volts to 200 volts, and the Chelsea Company has encountered these difficulties in every street in their district. Shall I write a letter to the Board of Trade to that effect?

Mr. RITCHIE: By all means. My observation is not directed to the Westminster Company, but to all the companies interested.

A vote of thanks was accorded to Mr. Ritchie.

PARLIAMENTARY INTELLIGENCE.

MUNICIPAL TRADING.

At the July 14 sitting of the Joint Committee of Lords and Commons on Municipal Trading, the Earl of Crewe presiding,

Mr. W. JEEVES, town clerk of Leeds, and formerly town clerk of St. Helen's and assistant town clerk of Peterborough, said that, speaking from experience, he was perfectly certain that the actuating motive of corporations in taking up gas, electric, and other undertakings was not a pecuniary one, but was the better service of the community in matters which, if not absolutely essential to life, were certainly essential to the well-being of the community. As to tramways, he was more and more convinced that they were an absolute necessity in any large community, and he saw no possibility of solving the difficulty of housing the working classes and some of the classes above the working classes except by the extension of tramways. Whether gas, water, electric lighting, and tramways undertakings were in the hands of companies or corporations, he thought they ought to be in one set of hands—that they should be monopolies. A certain power of veto by local authorities over tramways was necessary.

Asked by the chairman whether he thought that the Parliamentary and departmental checks on the introduction of novel and experimental powers were sufficient, witness said he thought they were. Special powers were never obtained without a special inquiry by a Parliamentary Committee and after they had been subject to the criticism of the ratepayers. He did not wish to say it offensively, but the Local Government Board reports on private bills were really a terror to municipal authorities. One never knew what the Board was going to say. They never let a point slip, and they very often, he thought, took many points that might very well be left alone. But he thought the Local Government Board reports were of great value.

Do you think it possible to lay down any hard and fast rule on this subject?—I think not. If you lay down a general rule that a corporation shall not manufacture you put a stop to the manufacture of gas. If you say they shall not sell articles you make it impossible to sell or let gas or electric fittings on hire. Experience has shown that in many cases it is necessary to do this.

Why do you say necessary?—It is necessary for the purpose of developing the consumption of the article. In the matter of electric fittings at St. Helen's it was found that it was necessary for the electric lighting authorities to supply them. Neither the landlord nor the tenant would go to the capital expense of wiring their houses though they would pay so much a year on account of the wiring.

Sir W. FOSTER: But you are aware, are you not, that it is very hard on the small traders and manufacturers of St. Helen's for the Corporation to supply these fittings?—I do not think so. As to the manufacturers, I do not see why a corporation should manufacture the fittings: they could purchase from the manufacturer. As to the traders, they could not undertake the work as the corporation could. The corporations do not desire to compete with the retailer. At Leeds to-day the Corporation do not supply any fittings at all, though they supply stoves. If you went from town to town you would find that the amount of fittings supplied would be very small.

Sir W. FOSTER: But have they not crushed the stove dealers out of existence?—No, I think not, because, as a matter of fact, there are very few stoves used except those which are lent on hire. People will not buy them. I should say that manufacturers of stoves have benefitted infinitely more through the corporations taking up the gas business vigorously than the retailer has lost.

The CHAIRMAN: Do you think it right for a corporation to undertake a business which would admittedly damage a number of retailers?—It is hard to answer on general principles. I condemn it rather.

Would you go so far as to say that no retailer should ever be injured by corporation competition?—No; I should say that if the general good of the community requires, as in some cases it does, that there should be competition, competition should take place. Unless there is a balance of advantage I do not think that corporations ought to undertake competition, and I do not think they do undertake it.

WITNESS went on to give statistics as to working of the Leeds tramways by the Corporation. He said that many of the streets had had to be widened at enormous cost. When the Corporation took over the tramways in July, 1894, there were only about 8 miles of double and 22 miles of single lines. There were now 23 miles of double and 49 miles of single lines. Passengers had increased from 8½ to 27½ millions, and car receipts from £43,000 to £126,000 per annum. As the receipts had not quite doubled, while the number carried had increased nearly three and a-half times, it was evident that the users had benefitted. All the tramways were being converted as quickly as possible into electric lines. The employees were in a much better position than they were under the company, as they got better wages and worked shorter hours. In a statistical sheet laid before the Committee the number of boroughs working tramways in March, 1899, was 17, the number leasing tramways or lines to companies being 10. The total length of line worked by nine boroughs furnishing information as to the number of car miles run was 191¼ miles, the total number of car miles run being, in the year ended March, 1899, 11,934,000, the population served being 2,006,334, and the number of car miles run per mile of route 62,404¾. With regard to electric undertakings, there were 51 included in the return, the population represented being 5½ millions, and the rateable value £29,465,173. The capital expenditure to March, 1899, was £4,452,944, the total capital paid off, including sinking, redemption, and reserve funds, being £394,646, and the percentage paid off to capital expenditure 8·86. In this connection it must be observed that the average period of ownership had been less than four years. The number of Board of Trade units supplied during the year ended March, 1899, by 45 boroughs was 28,445,303, and the total income from charges to consumers for the year was £487,815. The number of boroughs in the return showing profit and loss to rates was 31, the profit was £21,625 and the loss £10,725. It was found, however, that in the earlier stages of an electric undertaking there must be a loss.

That you think justifies you in concluding that these enterprises have been well carried out?—Yes. It could not be shown in a single instance that there had been any lack of enterprise on the part of corporations in carrying on undertakings of this kind, nor could it be shown that the principles of management were bad, nor that the consumer or the community had suffered.

You do not think that these trading matters interfere with the other duties of corporations, such as sanitary and police duties?—I am absolutely sure that they do not. Witness added that he thought the decision of Sir J. Kitson's Committee on Electric Power Bills was a distinctly right and proper one, and one that fairly met the contending interests.

On July 17 Mr. MOORE HAYTON, town clerk of South Shields, said in the evidence of Mr. Swinton it had been stated that he (Mr. Hayton) had received a proportion of the fees paid to certain Parliamentary agents in connection with the Tyneside Electric Power Bill. It was the case that Messrs. Sharpe, Parker & Co., the Parliamentary agents, had written offering to hand him over a proportion of the fees, but he was prohibited by the terms of his appointment from receiving any such allowance, and the Town Council of South Shields understood that if Messrs. Sharpe, Parker & Co. were appointed no allowance would be made to him personally. The Town Council, knowing this to be so, appointed Messrs. Sharpe, Parker & Co. as their agents. It was usual now for town clerks to receive inclusive salaries.

Mr. G. LIVESEY, chairman of the Gas Companies Protection Association and chairman of the South Metropolitan Gas Co., expressed the opinion that the first and chief public consideration in connection with the supply of gas was unquestionably the interest of the consumers. He considered that their interest could be best promoted, not by local authorities, but by companies. One of the reasons given in favour of ownership by local authorities was that they alone had the right to do anything in the public streets. More could be said against this contention than in its favour. It was merely a sentiment. Since the application of auction clauses to gas companies in 1877, there was now very little in the contention that local authorities could raise money at lower rates than companies. The main reason why local authorities acquired gas undertakings was to be found in the desire to make a large surplus profit out of the gas consumers to aid the local rates. This he considered as being most unjust to gas consumers. Corporations, generally speaking, in England, kept up the price of gas as high as they dared, in order to get as large a sum as possible in aid of rates. These surplus profits ranged from 1·46d. per 1,000 feet in case of Birmingham to 6·75d. in Bolton. The gas committees of corporations were constantly changing, and were commonly, with some exceptions, indisposed to treat their responsible managers with the liberality and consideration necessary to secure the best service. Corporation gas works were more amenable to trade union control than companies. Leeds was a striking case in point. Even in such a well-managed place as the Glasgow gas works a determined attempt was made this year by the trade unions to obtain control. The interests of individual gas consumers were relatively too small to lead them to combine to ensure fair consideration of those interests by the elected representatives of the ratepayers. It

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might safely be said that if all the gas undertakings were in the hands of local authorities there would be practically no more reductions of price. The supply of gas being necessarily a monopoly, it was better, in his opinion, that it should be regulated by Parliament and controlled by the local authority. The introduction of the slot meter system was due to the companies, Liverpool taking the lead. Companies, whose continued prosperity depends on pleasing and satisfying their customers, must serve those customers better than corporations, where such incentive was lacking.

Mr. J. H. KELLY, of the Traders' Defence Association of Scotland, said he represented 2,800 members. He considered municipalities had facilities that established unfair conditions in trade and commerce. He regarded it as a menace to the State, in respect that a municipality, working with the object of having little or no profit, did not contribute to the State by paying income tax, with the result that traders had to pay increased taxation. With regard to local rates, the same thing happened. His association admitted the desirability of the municipalisation of water and gas, as these enterprises did not lend themselves to competition. He had not the same opinion regarding tramways or building operations. Tramways were merely a means of conveyance, and could be taken up by anyone. They had heard a great deal about the success of the tramways in Glasgow; but that success had been established by the preceding company, in the face of conditions laid down by the Corporation, and not adhered to in their own working. As to the employees question, municipal employees in Glasgow as a rule cast their votes in favour of the nine members of the Council who were trades unionists; and not only so, but they influenced other labour parties to do the same. There was the growing evil of increasing the number of employees so that they might have undue influence on the Council. There was not much to be said on the electric system of Glasgow. The Corporation took powers to prevent another company from getting it. His complaint was that, having taken the powers, the Corporation did not use them. The telephones in Glasgow had been taken over by the Corporation not so much from an admitted necessity, but from the desire to have these powers in their own hands. The licence was granted more because of the importunity of the Corporation than from the fact that the Postmaster-General was convinced in the matter. As regarded efficiency, he declared that the Corporation stood in the way of the system of the National Telephone Co. being improved by refusing to grant them facilities. He did not think it was necessary to take over a telephone system if the company could conduct it as well as any other body. Gas and water were about the limit he was inclined to admit corporations to go in respect of trading. He would not necessarily include electric lighting. Admitting the extent to which the corporations had taken up municipal trading, there were so many auxiliary trades involved that the difficulty of defining a limit was increased. Tramways, for instance, carried with them the making of cars, smiths' and painters' work, and other departments, and the possibility to which municipal trading might run to the detriment of private trading was increased almost indefinitely. In Greenock the corporation had had to impose a tax to make up a deficit in respect of their building operations.

On July 20, Mr. SHEPPARD, builder and contractor, Bermondsey, at one time a member of the late Metropolitan Board of Works, said: In his view, if a municipality wanted to undertake building works, they should be subject to an open competition with private firms.

Dr. KINGSBURY, Mayor of Blackpool, said: Blackpool Corporation's undertakings included gas, electric lighting, markets, tramways, cemetery, abattoirs, sanitorium, public lavatories, free library, technical schools, and, in partnership with other boroughs, the waterworks. The gas works had been established for upwards of 40 years. The Corporation had very much reduced the price of gas and had improved their plant very materially. They had devoted a certain amount of profits from the undertakings to the relief of the rates. In 1864 the price of gas was 5s. 10d. per 1,000, while at present it was 2s. 4d. The Corporation supplied meters. To the working classes they supplied slot meters, and to the public burners free. They also supplied "grillers" free to working people. The public lighting, which was very well managed, was at practically cost price.

The Blackpool electric lighting works had been established seven years. The capital was £117,000, and there was an accumulated sinking fund of over £9,000. The income in the seven years had been £74,000, gross profits £28,000, net profits £6,200. The average net profit had been 1 per cent. on the outlay. The street lamps were supplied at cost price, the meters being free. In 1894, with 56 customers, the price was 6d. per unit, now there were over 900 customers, and the price varied from 7d. to 2d. per unit. The customers numbered one in 50 of the population, and one in 10 of the inhabited houses. In Blackpool there were no manufactures, but some small works (such as printing works) were supplied with electric power.

The CHAIRMAN: Having gas works of your own, has this hampered electrical development?—No. There is friendly rivalry, but far from hampering, one stimulates the other. I think the public greatly benefit from having the two concerns in the same hands. We were the first borough in the country to adopt public electric lighting. Though we only got the order for the domestic supply seven years ago, our streets have been lighted by electricity longer than those of any town in England. The Corporation had had control of the tramways for eight years. Blackpool was the first English town to adopt electric traction in the streets. The actual outlay on the tramways in the eight years had been £98,000. The gross profit was £31,000, the net profit £13,000, the average annual net profit being 3 per cent. on the outlay. The fares were extremely low, and the Corporation had extended the system very much as compared with the company which formerly owned the tramways.

The CHAIRMAN: What do you say as to tramways outside your own area?—We have not yet acquired any tramways outside, but we have two tramway companies at work in Blackpool—the Lytham and the Fleetwood Companies. We have given them every facility within the borough. In each case we have allowed them to come up to a railway station as a terminus. One is an electric tramway and the other is worked by compressed gas We have constructed a line for them, and they pay us a rent which covers the repairs of the roads. We have brought our own system of tramways up to meet them, so that there is a constant interchange of passengers. Personally, I think it would be better if the Corporation controlled those other lines, because we should then have uniform management and a reduction of expenses.

The Committee then adjourned till July 24.

ELECTRIC LIGHTING IN THE EAST END OF LONDON.

Particulars of the proposed agreement between the County of London Company and the promoters of the bill confirming the provisional order for Limehouse, Mile End Old Town, and St. George's-in-the-East were fully set out in our last issue. On July 20 the Committee entered on the consideration of clauses.

Mr. PEMBER said the parties had come to partial agreement regarding the amount to be paid by the local authorities to the company on the company undertaking to abandon their order for the supply of the three districts referred to, but, as in so many cases, there was a difference of view as to the amount. Speaking for the County of London Company, it seemed to him they ought to ask the Committtee for the costs of preparing, obtaining, and passing the order of 1897 for the supply of the three districts; for the costs of the company in opposing the orders which the three local authorities had gained; and the bill to confirm them; and then he thought he was further entitled to such costs as an arbitrator, in default of agreement, might say the company had incurred for the purpose of supplying within these three districts, which costs he should not otherwise have incurred and which he could not otherwise use. The consideration for these grants would be that, in a district in which it would not be fair that there should be competition, the company would retire and leave the local authorities to supply themselves. He then handed in a clause carrying out the points he had indicated.

Mr. SHIRESS WILL objected *in toto* to the clause.

A prolonged discussion followed, in the course of which the counsel for the local authorities said they had no wish that the company should retire from the area but would prefer that they should remain and compete. The Committee adopted the somewhat unusual procedure of settling the details of the clause, after which argument took place as to whether it should be inserted at all, the representatives of the local authorities objecting and Mr. Pember (for the company) supporting the suggestion. The Committee deliberated, and in the result decided that the clause should be inserted. Further disussion followed, chiefly as to drafting, and eventually the clause was adopted in the following form:—

Clause 3A. For the protection of the County of London and Brush Provincial Electric Lighting Co. (Ltd.):—

1. If, within six months from the date of the passing of this Act, the County of London & Brush Provincial Electric Lighting Co. (Ltd.) (in this section called "the company") serve upon the Board of Works for the Limehouse District and the vestries of Mile End Old Town and St. George's-in-the-East or their successors (hereinafter called "the local authorities") notice in writing specifying the amount which they claim as representing the cost of preparing, obtaining, and passing the County of London East Electric Lighting Order, 1897, and so much of any costs properly incurred by the company with the object of affording a supply of electricity within the district of the local authorities as shall, in the opinion of the arbitrator, to be appointed as hereinafter mentioned, have been incurred beyond what the company would otherwise have incurred, regard being had to whether any such costs incurred for works has been or may hereafter be utilised by the company, such local authorities shall, within three months from the receipt of such notice, unless they dispute the amount claimed therein, paying the same in equal shares to the company, provided that, except as aforesaid, such costs shall not include legal or Parliamentary expenses connected with the promotion by or opposition to bills in Parliament or provisional orders.

2. If the local authorities or any of them dispute the amount so claimed the question of the amount of such costs shall be determined by an arbitrator to be appointed on the application of the company or any of the local authorities by the Board of Trade, and within three months from the date of the award of such arbitrator, the amount thereby awarded shall be paid by the local authorities to the company.

3. Upon the payment by the local authorities of the amount so claimed or awarded as aforesaid the County of London East Electric Lighting Order, 1897, shall be and is hereby revoked, and the powers, rights, privileges, authorities, and obligations thereby conferred or imposed upon the company shall cease.

4. No part of any payment made under this section by the Corporation of the borough of Stepney shall be charged upon that part of the said borough which is at the date of the passing of this act the district of Whitechapel.

The remaining clauses having been adjusted, the bill was ordered to be reported.

GLASGOW TRAMWAYS.

The Select Committee of the House of Commons, presided over by Sir Lewis McIver, on July 19, had under consideration the bill of the Glasgow Tramways Co., seeking powers to construct and work a new series of electrical tramways in and around Paisley and Renfrew, the promoter being Mr. W. M. Murphy of Dublin. Some proceedings in connection with this bill were reported in our last issue, p. 491.

Mr. PEMBROKE STEPHENS, Q.C., said the proposed tramways would serve a very considerable district, including Paisley, Johnstone, Renfrew, Ellerslie, and many other towns, and the project had received universal support.

Mr. BARRINGTON, C.E., of Limerick, engineer of the scheme, said existing railways would not be interfered with. The estimates for the

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tramways, including what had been imposed upon them by the local authorities, was £227,669.

Evidence was given by local witnesses as to the need of the tramway, and the public feeling in favour of its construction.

Mr. W. M. MURPHY said in his opinion the tramways would be entirely successful. The existing railways would not be injured by the tramways, which would indeed be found to be useful feeders of their lines.

Mr. CHARLES FORMAN, for the opponents, the Paisley & Barrhead District Railway Co., said he had constructed the railway which was authorised in 1897. It was completed and was on the point of being opened for traffic. It was purely a local line, and the proposed tramway would seriously compete with it. One of the sections of the proposed tramway was from Potterhill to Glenfield, and if this part were sanctioned it would take away a part of the workmen's traffic at Glenfield, for whose accommodation the company had provided.

The CHAIRMAN said the Committee were impressed with the excellence of the scheme, but they realised that Mr. Murphy had been encountered by a number of different public bodies with conflicting views and with different degrees of capacity. This line had been given up on the opposition of Glasgow, and all that remained of the excellent scheme was the line to Johnstone, which would tap the centre of Paisley and feed Glenfield. That was the result of a system of blackmail on the part of the local bodies. All of them approved of a gentleman of experience and capital coming from Ireland and providing them with what they could not get for themselves. They were all very glad, but they had their joy from Mr. Murphy, and screwed as much out of him as they could. Then there was the mileage rate for wayleaves, the legality of which might be questioned. In his view the proper business of a municipality was to maintain the roads for the use of the public and not to sell wayleaves. He asked Mr. Murphy whether he now considered the scheme was worth going on with.

Mr. MURPHY said in his opinion the workability of the scheme had not been seriously affected.

The CHAIRMAN said the Committee found the preamble of the bill was not proved. They desired to put on record that, in their opinion, the original scheme was a good one and calculated to be of much use to the district; but it had been so mutilated and loaded with conditions by conflicting interests and the excessive demands of several local bodies, that it now appeared to the Committee to be wholly unworkable.

(Parliamentary Intelligence continued on page 525.)

ELECTRICITY WORKS ACCOUNTS.

Hanley Municipal Electric Supply Works.

The first of our two analyses this week deals with the accounts of the fifth year of working of the Hanley undertaking. In view of the figures in our table it is superfluous to observe that the results of the year's operations were most unsatisfactory. The fact that the unfortunate position of the concern is partly explained by the breakdowns in the plant hardly serves to relieve the general situation—rather the reverse. On the other hand there are some items of cost which indicate that when the immediate troubles have been met there is every prospect of a great improvement being shown in the accounts. These favourable figures are those of wages at the station and management and property charges, while the moderate capital expenditure should exercise a beneficial influence through limiting the capital charges on revenue.

Unfortunately, the tariff system of the undertaking appears to be much at fault. With a total average revenue from all sources of no more than about 3·93d. and from supply of not quite 3·16d. per unit, it is surprising to find that the output for the year indicates an increase of only 13·4 per cent., while the lamp connections at December last were not more than 15·7 per cent. above those at December, 1898. In view of this the conclusion is hardly avoidable that the comparatively low initial price per unit, and generally the tariff arrangement, has encouraged a class of consumer who, by the character of his demand, neither benefits the undertaking, nor is particularly benefited by being a customer of the department. It is interesting to learn from the report accompanying the official accounts how the present tariff came about. In the early part of 1896 the prices of 6d. and 3d. were decided on—the latter price coming into force after a certain consumption. Owing to opposition this tariff was replaced by one under which the simple price of 5d. per unit was charged, this remaining in force for two years. Unfortunately we learn that it was then "difficult to raise the price," and a tariff of 5d. to 2½d. was adopted.

Turning again to the expenditure out of revenue, we learn from the electrical engineer's report that of the fuel item the advance in the price of coal which commenced in June last year was responsible for nearly £400. Extraordinary amounts of fuel consumption occurred owing to the engines working non-condensing, both condensing plants having broken down. The repairs and maintenance item naturally suffered from the mishaps, the condenser repairs costing over £150, and the replacement of stokers by forced-draught furnaces entailing an outlay of £200.

Wolverhampton Municipal Electric Supply Works.

It is highly gratifying to find from the last accounts of this undertaking that its good progress is being so well maintained even in distinctly adverse circumstances.

After making allowance for the inevitable influence of the advanced prices of coal, the generating costs as well as the management charges have been reduced, and, with the exception of the item of oil, waste, &c., stand at most favourable figures. It is pointed out by the chairman of the Electric Lighting committee that the alteration in the system of supply has necessitated two systems being in operation for the latter six months of the year, involving increased consumption of fuel, while delay in the completion of the battery room at the station seriously handicapped the department.

Owing, however, to the very moderate costs other than the fuel item, the works and total costs exhibit figures which practically represent the average at the output and the low load factor of only 6·8 per cent.

In the original accounts there is included under the item of repairs and maintenance at the station a charge of £912, cost of changing over system of distribution. This item we have merely debited to the net revenue account, thus permitting of a more legitimate comparison of the ordinary costs. The following table gives an idea of the progress of the concern:—

Year.	No. of consumers.	Equiv. No. of lamps cnnctd.	Per cent. increase.	No. of units sold.	Per cent. increase.	Max. demand. k w.	Ultimate financial result.
1895–6	113	8,941	...	191,701	...	210	£1,403 loss
1896–7	154	11,307	26·0	224,709	17·2	240	£226 profit
1897–8	208	14,151	25·2	291,233	29·6	318	590 ,,
1898–9	276	19,932	40·8	371,830	27·7	420	1,004 ,,
1899–00	364	25,184	26·3	482,247	29·7	806	402 ,,

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	July 10, 1900
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, ,,
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	July 6, 1900	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, 1899	Liverpool (Municipal)	June 22, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	July 14, 1899	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, 1900	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 26, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 22, ,,	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, 1900	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	July 13, ,,
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, 1899
Croydon (Municipal)	July 20, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 18, 1900
Hanley (Municipal)	April 28, ,,	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, ,,	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	July 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, 1899	Woolwich (Company)	Jan. 12, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	July 13, ,,		

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	HANLEY.		WOLVERHAMPTON.	
Undertaking Worked by	Corporation of Hanley.		Wolverhampton Corporation.	
Date of Commencement of Supply	July, 1894.		Jan., 1895. [supplied by dynamotors at 220 v. 3-w. con.-curr., 440 & 220 v.; other portions of borough	
System of Supply	Alternate-current transformer sub-stations.			
Chief Engineer	C. A. Cowell.		C. E. C. Shawfield.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	MAR. 31, **1899.**	MAR. 31, **1900.**
QUANTITIES—				
Units generated	551,259	638,025	470,836	603,954
,, **SOLD (TOTAL)**	**474,247**	**537,893**	**371,830**	**482,277**
,, sold to consumers	355,753	414,823	291,387	401,027
,, sold for public lighting, &c.	118,494	123,070	80,443	81,250[f]
,, used on works	5,109	14,199	4,051	6,514
UNITS SOLD PER 8 C.P. LAMP CAPACITY	**23·7**	**14·0**	**19·2**	**14·5**
Maximum supply demanded	460 kilowatts	550 kilowatts	420 kilowatts	306 kilowatts
Number of public lamps	64 arc, 69 glow[a]	65 arc, 80 glow[g]	51	51 arc, 2 glow.
Number of consumers	344	456	276	364
Connections to mains in 8-c.p. lamps	30,380	35,160	19,932	25,184
CAPACITY OF PLANT IN 8-C.P. LAMPS	20,000	**38,300**	**19,400**	**33,200**
CAPACITY OF PLANT IN KILOWATTS	624	**1,224**	622	**1,062**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	**£64,990** / **£104**	**£70,009** / **£57·2**	**£47,800** / **£76·9**	**£76,670** / **£72·2**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	64,990 / 104	70,009 / 57·2	47,800 / 76·9	76,670 / 72·2
RECEIVED (TOTAL)	**46,110** / **73·9**	**64,990** / **53·1**	**33,122** / **53·3**	**38,984** / **36·7**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	46,110 / 73·9	64,990 / 53·1	33,122 / 53·3	38,984 / 36·7
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**18,880** / **30·3**	**5,019** / **4·10**	**14,678** / **23·6**	**37,685** / **35·5**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	18,880 / 30·3	5,019 / 4·10	14,678 / 23·6	37,685 / 35·5
REPAID (TOTAL)	nil / —	nil / —	807 / 1·30	1,280 / 1·21
RESERVE OR SINKING FUND	**4,037** / **6·47**	**5,638** / **4·61**	— / —	5,505 / 5·18
DEPRECIATION FUND	nil / —	nil / —	— / —	— / —
EXPENDED (TOTAL)	**60,785** / **97·4**	**67,829** / **55·4**	**49,834** / **80·1**	**74,066** / **69·8**
Lands and buildings	9,201 / 14·7	9,232 / 7·54	11,797 / 19·0	15,461 / 14·6
Plant	28,374 / 45·5	35,548[h] / 29·0	26,566[a] / 42·8	36,104 / 34·0
Mains	19,545 / 31·3	21,850 / 17·8	10,999 / 17·7	22,030 / 20·7
Miscellaneous	3,666[b] / 5·86	1,199 / 0·980	472 / 0·759	471 / 0·444
BALANCE OF CAPITAL ACCOUNT	−14,675[c] / −23·5	−2,839[c] / −2·32	−16,712[b] / −26·9	−35,082[b] / −33·0
REVENUE—	**Total.** / **Per unit sold.**	**Total.** / **Per unit sold**	**Total.** / **Per unit sold.**	**Total.** / **Per unit sold.**
TOTAL	**£7,715** / **3·900d.**	**£8,809** / **3·933d.**	**£7,746** / **5·000d.**	**£9,476** / **4·718d.**
Revenue from supply	6,141 / 3·106d.	7,068 / 3·155d.	6,323 / 4·080d.	7,981 / 3·973d.
,, meters, &c.	215 / 0·109d.	268 / 0·120d.	139 / 0·090d.	178 / 0·089d.
,, public lighting	1,345 / 0·680d.	1,447 / 0·646d.	1,275 / 0·823d.	1,279[g] / 0·637d.
,, sale of lamps, &c.	14 / 0·007d.	26 / 0·012d.	8 / 0·005d.	37 / 0·018d.
,, miscellaneous sources	— / —	— / —	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£5,295** / **2·678d.**	**£7,632** / **3·406d.**	**£4,109** / **2·653d.**	**£5,183** / **2·580d.**
WORKS COSTS	**4,113** / **2·080d.**	**6,400** / **2·857d.**	**2,802** / **1·809d.**	**3,974** / **1·978d.**
Generation of electricity	*3,306* / *1·672d.*	*5,301* / *2·366d.*	*2,558* / *1·652d.*	*3,707* / *1·845d.*
Fuel (including cartage, &c.)	1,398 / 0·707d.	2,540 / 1·134d.	950 / 0·613d.	1,888 / 0·940d.
Oil, waste, water, stores	331 / 0·168d.	460 / 0·205d.	336 / 0·217d.	365 / 0·182d.
Wages at station	778 / 0·393d.	975 / 0·435d.	997 / 0·644d.	1,209 / 0·602d.
Repairs and maintenance at station	799 / 0·404d.	1,326 / 0·592d.	274 / 0·177d.	245 / 0·122d.
Distribution of electricity	*421* / *0·213d.*	*613* / *0·274d.*	*26* / *0·017d.*	*82* / *0·041d.*
Wages, &c.	80 / 0·041d.	93 / 0·042d.	26 / 0·017d.	82 / 0·041d.
Repairs, renewals of mains, &c.	341 / 0·173d.	520 / 0·232d.		
Public lighting	*386* / *0·195d.*	*486* / *0·217d.*	*218* / *0·141d.*	*185* / *0·092d.*
Attendance	350 / 0·177d.	343 / 0·153d.	218 / 0·141d.	185 / 0·092d.
Renewals	36 / 0·018d.	142 / 0·063d.		
MANAGEMENT AND PROPERTY CHARGES	**1,181** / **0 598d.**	**1,233** / **0·551d.**	**1,307** / **0·844d.**	**1,209** / **0·602d.**
Royalties	*nil* / —	*nil* / —	— / —	— / —
Rent, rates, taxes	*553* / *0·280d.*	*586* / *0·262d.*	*133* / *0·086d.*	*183* / *0·091d.*
Management	*628* / *0·318d.*	*647* / *0·289d.*	*1,174* / *0·758d.*	*1,026* / *0·511d.*
Salaries	536 / 0·271d.	507 / 0·226d.	764 / 0·493d.	712 / 0·354d.
Stationery, &c.	21 / 0·011d.	31 / 0·013d.	93 / 0·060d.	59 / 0·029d.
Establishment charges	30 / 0·015d.	46 / 0·021d.	129 / 0·083d.	108 / 0·054d.
Law charges, &c.	41[d] / 0·021d.	63[i] / 0·028d.	188[c] / 0·121d.	147[i] / 0·073d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£2,420** / **4·30%**	**£1,177** / **1·83%**	**£3,637** / **7·94%**	**£4,294** / **6·93%**
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,316 / 2·34%	1,316 / 2·05%	1,312 / 2·86%	1,324 / 2·14%
Net interest on loans (incl. Debenture charges)	1,481 / 2·63%	2,131 / 3·32%	1,320 / 2·88%	1,655 / 2·67%
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	1,004 / 2·19%	402[h] / 0·65%
Deficit	*377*[e] / *0·671%*	*2,269* / *3·53%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	68·7%	86·6%	53·4%	54·7%
Expenditure per kilowatt capacity	£8. 9s. 10d.	£6. 4s. 7d.	£6. 12s. 2d.	£4. 17s. 7d.
REVENUE PER KILOWATT CAPACITY	**£12. 7s. 0d.**	**£7. 3s. 10d.**	**£12. 9s. 0d.**	**£8. 18s. 5d.**
Expenditure per 8-c. lamp capacity	5s. 3½d.	3s. 11¾d.	4s. 2¾d.	3s. 1½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**7s. 8½d.**	**4s. 7¼d.**	**7s. 11¾d.**	**5s. 8½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**5s. 1d.**	**5s. 0d.**	**7s. 8d.**	**7s. 6½d.**
Price charged for lighting, per unit	5d. to 2½d.[f]	5d. to 2½d.[f]	6d. to 3d.[d]	6d. to 3d.[d]
Price charged for power, per unit	2½d. to 1d.	2½d. to 1d.[j]	2d. to 1d.[e]	2d. to 1d.[e]
Price charged for public lighting	2·725d. per unit.	£19 per arc, £3 per incan.	£25 per lamp per ann.	£25 per arc lamp.

HANLEY.—REMARKS—*a* 60 400-watt arcs, 4 alternate-current arcs of 500 watts each and 69 incandescent (various c.p.) equivalent to 160 8-c.p. lamps. *b* Includes £2,525 to street lamps and posts. *c* Over-expended. *d* Including £39 to insurance, &c. *e* Met by general district rate. *f* By maximum demand system—5d. per unit for first two hours in winter and for first hour in summer half-year, 2½d. afterwards; chapels, 4d. per unit. *g* Includes 60 400-watt arcs and 5 500-watt alternating arcs. There are 80 columns and brackets with glow lamps equivalent to 192 30-watt lamps. *h* Includes £2,581 on street lamps and posts. *i* Includes £40 to insurances. *j* Maximum demand system—2½d. per unit for first four hours.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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ELECTRIC TRAMWAY POWER STATION DESIGN.

In a Paper recently read before the Tramways and Light Railways Association, Mr. PHILIP DAWSON discusses some general considerations governing the design of power stations for electric tramways. He confines himself to the economical aspects of the question, and, we may say at the outset, views the matter chiefly from the standpoint of a tramway engineer. The entire aim before him is to design a power station which will produce electrical energy at the cheapest possible cost. He does not believe that this affects the cost of distribution, stating that his experience in this country, as well as on the Continent and in America, shows that the location of a station on a site where power can be produced cheaply does not overload the outside expenses, provided that a proper system of transmission and distribution is adopted. The first question attacked in the Paper is the combination of a lighting with a tramway station. Differing in this respect from the speakers at the recent Municipal Association discussion, reported elsewhere in this issue, Mr. DAWSON views this essentially from the tramway company point of view, and consequently he is not in favour of such a combination. "The case is, however, entirely different," he goes on to say, "where traction and lighting are combined, and the best results are then obtainable, that is to say, "where a station has been designed by experienced traction engineers for traction and lighting." The considerations which lead him to this conclusion are chiefly that a lighting station has a very much lower load factor than a tramway station, the annual work of the former representing only three months continuous running at the most, whereas the annual work of a tramway station represents as much as 10 months or even 11 months. The tramway company pure and simple is not to be expected, therefore, to view with satisfaction the proposal to saddle its tramway station with a lighting load. We have always held the view that the addition of a lighting load to a tramway station is undesirable from the tramway point of view, whereas the addition of a tramway load to a lighting station is distinctly an advantage. It must not be forgotten, however, that, in the first place, lighting stations have had the start of tramway stations in this country, and, in the second

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place, both lighting and tramway work is gradually falling into the hands of the same authorities, viz., the local authorities. Accordingly, the real question is whether it is better to have two independent stations—one for lighting and the other for traction—or to combine these in a properly designed station suitable for both kinds of load. We think that, when the question is faced from this point of view, there can be little doubt that the combined station is superior to the employment of independent stations. The combination gives a far more satisfactory load factor for the entire lighting and traction works than is obtained when the load factors are separated, and, to quote Mr. DAWSON again, "the cost of producing power varies with the amount to be produced, decreasing as the amount increases. This shows the advisability of concentrating as much power as possible in one station and reducing the number of units."

With regard to the vexed question of single *versus* multiple stations for tramways, Mr. DAWSON casts his vote in favour of the single station. He points out that in a large single station it is practicable to introduce labour-saving devices and refinements of plant to a much greater degree and with much better results than can be done in each of a large batch of small stations. This is undoubtedly the case; for whilst it will not pay to put in extensive coal-handling plant, in a small station for example, where only a few men are employed in the boiler department, the introduction of such appliances is abundantly justified in a large station having a great number of boilers. For a system requiring anything above 5,000 kw. Mr. DAWSON is inclined to the view that the polyphase system of generation and transmission with rotatory converter sub-stations is the best. As regards the size of the individual units these should vary, he says, from two sets for stations of 200 H.P. maximum up to 10 sets for stations of 90,000 H.P. maximum, the individual sets being of 200 H.P. and 10,000 H.P. respectively.

Referring to the general question of the design of power stations, we think it is abundantly clear that the time has come when engineers must recognise that such stations must be designed to undertake any class of work. Lighting is steadily becoming of secondary importance as compared with power work. Stations designed for power supply can readily undertake lighting if necessary, but the converse is not always the case. The tendency at the present day to extend considerably the area over which any one undertaking may supply electric power, as well as the grouping of lighting, tramway and power work in combined undertakings, shows that the design of large power stations in the immediate future will have to be on broader and more universal lines than hitherto. Engineers, that is to say, will have to take into account the fact that power stations are no longer merely lighting stations: that before long they will be not merely even combined lighting and tramway stations; but that the duty of a power station engineer will be to supply electricity on demand, at a steady voltage, without any questions being asked as to the purposes for which it is to be used. Few existing stations could bear this strain. Indeed, there are not a few central station engineers who would look askance on the rapid growth of a motor load on their mains, because this would seriously affect the steadiness of the lighting. Such a condition of things is not as it should be. Modern electrical engineering is capable of producing better results than these. Central station engineers, indeed, and especially those controlling extensive industrial areas, will soon be called upon to supply current without reservation as to its use. This, in fact, is the justification, on political grounds, of the large power supply schemes so much in evidence just now in Parliament.

COMBINED MANAGEMENT OF TRAMWAY AND LIGHTING DEPARTMENTS.*

BY R. C. QUIN.

(Borough Electrical and Tramway Engineer, Blackpool.)

It will be admitted, by all members of the Association at least, that the municipal authority should be the lighting and tramway authority also. So far the author begs the question, and in dealing with it purposes to treat it solely from the municipal point of view. It does not follow that because both undertakings are owned by the municipality that it is necessarily the best policy to combine generating stations. In the majority of cases this question can readily be settled; but in some the tramway area and lighting area, or perhaps the author might more correctly say their "centres of gravity," are far from coinciding, and it may then be advisable to have separate generating stations.

Assuming, then, that in our hypothetical town separate generating stations are established for lighting and tramway purposes—is it advisable to combine the two undertakings? In order to find a satisfactory answer to this problem we must first consider whether the undertakings are, to any great extent, of a similar nature. In both cases we must have an engineer fully conversant with the problems of economical generation and distribution of electricity, and lastly, but by no means least, one who fully realises the importance of continuity of supply. Whatever tramway engineers may say to the contrary, continuity of supply is of much greater importance with electric lighting than with tramways. Who then best realises that continuity of supply should be the first aim? There can, I think, be but one answer to this question: The lighting engineer. I have used the term "lighting engineer" because it is the term most generally used to denote the engineer responsible for the works established for the general supply of electricity, but the description is certainly not a correct one. A general supply of electricity is not established for lighting only but for the supply of power also, and what "lighting engineer" is not familiar with motors? What new problems does traction supply call into existence? The question of load factor certainly arises in the calculation of sizes of cables, also the various stresses in connection with overhead line and posts will have to be provided for, and the starting, uniform running, and stopping of the tramcars be ensured by suitable arrangements. But every one of these problems is simple and any engineer worthy of the name could readily solve them. From this it will be seen that, in the author's opinion, the man best qualified to design and work a traction system is the qualified central station engineer. But having two stations is it now necessary that we should have two engineers? Certainly not. In many towns multiple stations even for general supply are established, yet they are invariably under one chief engineer.

The next phase of the question to be considered is how far the engineering side of the question is dominant in a tramway supply. In the maintenance of the traction system there are several points to be considered and I will enumerate them as follows:—(1) The maintenance of generating machinery, (2) the maintenance of cables, (3) the maintenance of overhead line and posts, (4) the maintenance of track, (5) the maintenance of cars and motors, (6) the cleansing of cars, (7) the regulation of traffic, (8) the collection of fares. The first five are entirely engineering, and without due regard to them the tramway system must cease to exist. The remaining three, though important, do not require that technical skill and training, nor the exercise of such resource as do the former. Suppose then that we appoint, as chief of our tramway department, one who has previously been manager of a horse or other tramway system. How far is he fit and capable of efficiently controlling and maintaining the system? He is certainly competent to give due regard to the last three points (6 to 8); he might also have had sufficient experience to enable him to maintain the track. But his electrical knowledge would probably be extremely slight, and it would then be necessary to have an electrical engineer, who would become the servant of the tramway manager. We shall find ourselves in this dilemma, that we have placed the maintenance and responsibility for good working of the most important part of our system upon a servant, and placed over him a man incapable, by reason of his want of knowledge, of properly controlling him. The engineering side is without doubt the most important in a mechanical, and especially electrical, system of traction. But it may be said that the collection of fares, and regulation of traffic requires experience which the electrical engineer may not have. Granted that it may be so, it does not necessarily follow that the engineer would control this. These duties could be placed upon a traffic manager. As to whether this traffic manager would be the servant of the engineer is largely a matter of the personality of the two men; and to the author, there appears no difficulty whatever, and he speaks from experience, in thus separating a tramway system, though there are advantages obtainable by placing the whole system

* Paper read before the Municipal Electrical Association, at Huddersfield, June 21st.

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under one responsible head. The question of collecting fares has some analogy to the collection of electricity or gas rents. In most towns, the author believes, this is not done by the electrical engineer, but by a separate department of the municipality. What the author would most wish to impress upon his readers is the fact that the design and working of an electric traction system is almost entirely an engineering problem, and that the man best qualified to carry out this work is the competent central station engineer.

The following is an abstract of the discussion on the above Paper:—

Mr. J. F. C. SNELL (Sunderland) said the matter was very important because the bulk of municipalities had to consider the question of traction, and many of them already had their lighting station. In the case of Sunderland the Corporation had combined the two departments and had one engineer; they had even gone a stage further than this, they had made the engineer not only the lighting and traction engineer, but also the general manager of the tramways. The engineer will have an assistant engineer for tramway purposes solely, who will take charge of the tram sheds and repairing shop and will keep the cars ready for placing on the track. The traffic manager will see to the motor-men, taking the cars on the track in the morning, and will have control of the cars for the time being. He will have to deal with the traffic and financial arrangements of the undertaking. As the engineering side of the department outweighed the other he thought the engineer-in-chief should have the greater authority, as they could not expect a non-technical man to take the duties.

Ald. G. PEARSON (Bristol) regretted that the Corporation had not bought out the tramway company in Bristol; he considered that by not so doing they had thrown away one of the greatest opportunities they had had in Bristol since he had been connected with it. He had considered the question of combination, and he felt that the right thing to do was to combine the electric lighting and tramway undertakings, and they should be in the hands of one committee to avoid friction. He agreed with Mr. Snell in the question of division of the department. He thought the electrical engineer should be responsible for the generation of electricity, the supervision of the tramways so far as the motors and overhead appliances were concerned, and the traffic manager should have control of the motor-men and collectors, and should arrange the times that the cars should run and have charge of the traffic. That was a simple way out of the difficulties of management, leaving the technical work in the hands of the electrical engineer and the business department in the hands of the traffic manager.

Mr. PHILLIP DAWSON (London) had found, when doing work in connection with tramways that it was much better to have one responsible engineer than to have two or more managers, as it was a difficult matter to please both gentlemen. There was not the slightest doubt that the corporation electrical engineer should have the whole superintendence of the installation.

Mr. S. E. FEDDEN (Sheffield) considered that if the tramways and lighting departments were divided there should still be one chief engineer who should also be general manager for both departments. He could then have a superintending engineer who should have control of the motor-men and engineering details, the track and the overhead work. The conductors and all matters relating to fares, &c., should come under the traffic manager, who should also be responsible to the chief engineer.

Ald. BRUCE (Sunderland) said it was an absurd position for any municipality to take up to have two stations, one for supplying light and the other power. This should be carried out from one works, and they should have one engineer. There was, however, two sides to the management, one the engineering and the other the commercial. At Sunderland they felt that they had a man who could advise them upon the electrical and engineering side, and the tramways committee had therefore appointed Mr. Snell as the engineer of their department, thus minimising the difficulties of two committees by having one engineer for lighting and tramways.

Ald. WOODHEAD (Halifax) was convinced that if they wished to work economically they must have a combined station; they would thus avoid the necessity of otherwise having two sets of men and two sets of duplicate plants. He thought the electrical engineer should have charge of everything electrical, and the traffic manager should be responsible for the traffic and the rolling stock so long as it remained capable of doing its work. In Halifax they had a tramway manager who did not interfere with the electrical portion of the business, and they had their electrical engineer. They had run without a hitch, and they had an Electricity committee and a Tramway committee, and he thought they should not be one committee.

Mr. W. R. WRIGHT (Burnley) asked Mr. Quin who had charge of the track.

Mr. H. C. BISHOP (Wigan) said they had a combined committee for lighting and tramways. They had started with a clear field and had a combined station. He considered it was the proper thing to do when they had not already a lighting works, but when they already had one works the matter was not quite as simple. He considered, however, that in any case they should have one chief engineer, who was responsible for both departments.

Mr. C. S. VESEY BROWN (Lincoln) would recommend the matter to be left to three sub-committees, viz., "Generation," "Distribution," and "Financial." He agreed that in large cities such as Glasgow, Liverpool, &c., there should be two works. He thought the question of whether there should be one or two stations depended upon local circumstances.

Mr. R. C. QUIN (Blackpool), in replying, stated that he thought the electrical engineer should be the chief, and that all others should be responsible to him. He thought, however, the management of the traffic and collection of fares, &c., should be left to a traffic manager. In answer to Mr. Wright he said that the Electric Lighting and Tramways committee lay the track, pave it, and repair it.

PROJECTED COMBINED ELECTRIC SUPPLY AND TRAMWAY WORKS FOR WILLESDEN.

The following are the full details of a scheme (briefly referred to in our issue of July 13th) for a combined electric supply and electric tramway works in the district of Willesden, near London, as set forth in the report and supplementary report of Mr. E. T. Ruthven-Murray, electrical engineer to the Willesden District Council. The scheme was passed in its entirety on Tuesday by a unanimous vote of the Council. Mr. Ruthven-Murray's scheme is of considerable importance, and is, moreover, the first in this country in which it has been definitely proposed to employ "double-current" generators, generating both three-phase and continuous current:—

. . . Nothing has been more remarkable than the almost spontaneous manner in which demands for electric light and power have been made where an efficient supply of electricity has been available at a reasonable cost. The consequence has been that, where works have been laid down without full appreciation of this fact, it has been necessary to extend them within a very limited period. As a single instance I may cite the case of a works designed by one of our most eminent consulting electrical engineers on the basis of a probable lamp connection of 7,000 in three years. Already, nine months after the works had commenced operations, 7,000 lamps had been connected; and at the end of three years, instead of 7,000, over 25,000 lamps were on the mains. In several instances where municipal electricity works were being laid down on what were thought to be liberal lines it has been necessary to order plant for extensions before the works were opened, and this has proved necessary in the most unpromising areas. Again, the chosen site has sometimes been unsuitable, or it has been impossible to extend the buildings, and, therefore, the original site has either been abandoned or superseded, and extensions have taken the form of entirely new works designed with more consideration for the districts requirements. It is manifest that alterations such as these must involve the waste of a large amount of capital, and thereby increase the future cost of production. . . If you decide to commence operations with works which will not be outgrown in a year or two, a course which I strongly recommend, you should clearly understand that the undertaking may not be sufficiently remunerative to pay all capital charges over and above working expenses for two or three years, but the increased profit when the works are loaded to a fair proportion of their full capacity will more than compensate for the deficits which will have to be met at the commencement.

. . . The compulsory area scheduled in your provisional order is somewhat unusually large, amounting as it does to nearly 5¼ miles of roads and streets, of which the farthest scheduled points are no less than 4 miles apart. . . I divide Willesden into three approximately equal sections, each of about 2¼ square miles in area. In one section the electricity works are located, and a transforming and battery sub-station will be necessary in each of the others. But for the present, and until the Neasden and Dollis Hill districts are developed, only one sub-station is required. The sub-stations will be depôts from which all outside work in the district in which they are situated will be controlled. Throughout the district, supply to consumers will be given from low-pressure distributing mains, fed with continuous current from both generating works and sub-station. The sub-station will be supplied by means of three-phase extra-high-pressure current, which will there be converted to continuous current for distribution. The scheme is designed not only to supply the entire district with energy for both light and power, but, if need be, also to operate tramways, either within or without the Willesden district, with the maximum of economy and efficiency. The combination of high-pressure-alternating-current transmission with low-pressure continuous-current distribution, already described, will fulfil these requirements.

. . . The total length of the distributing mains I recommend you to lay amounts to 15·03 miles. . . .

I recommend you to declare 240 volts as the consumer's pressure and to lay the mains on the three-wire system, so that a pressure of 480 volts is available for the larger motor works. By adopting the three-wire system of distribution a further economy in conductors results, as the "outers" are fed from the works at or somewhat above the pressure of 480 volts. I may also point out that the standard pressure for operating electric tramways is 500 volts, and the choice of a nearly similar pressure for the purpose of general supply enables dynamos to be constructed so that they may be used interchangeably on lighting or traction circuits. This promotes economy in capital expenditure. . . .

I have so calculated the sectional areas of the distributors that these cables will suffice for the probable demands for some years to come, but as the need arises additional feeders will be run from the works or sub-stations to new feeding points. At present five feeders are provided. . . . The connection between the feeders and distributors is made at a feeding point in a cast-iron box placed below the pavement. . . . I advise that all your mains, both high tension and low tension, be laid on the solid system. The extra high-tension feeders between the electricity works and the Salusbury-road sub-station will probably be laid in iron troughs or casings, the feeders and low-pressure distributors in wood or stoneware casings filled with bitumen.

. . . The Taylor's lane site is most suitably placed. It is about 3¼ acres in extent, approximately 600ft. by 250ft., adjoins the Midland and South Western Junction Railway, and indeed possesses in a greater or less degree the whole of the advantages set out above. The canal feeder from the Welsh Harp reservoir flows past the site at a small distance, so that, if at a later date the canal company reconsider their terms, we shall be able to obtain water from this source for condensing and boiler-feed. . . .

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. . . The works buildings take the form of a rectangular block, in which the boiler house, the engine house, and also the wing containing the battery room, offices, workshops and stores, are all parallel to each other. The railway siding will be constructed outside the boiler house, so that fuel may be discharged, through the doors provided, directly on to the stoke-hold floor in front of the boilers. The coal trucks will be moved by means of an electric capstan. At first the portion of the boiler house not required for other purposes will be employed for the storage of coal, and a temporary line of metals will be carried into the building for convenience in unloading the trucks.

The boiler house is 126ft. 9in. in length by 52ft. in width, and will take boilers having an aggregate of nearly 5,000 H.P. An 18in. gauge tramway will be laid along the stokehold floor, and by means of small skips, running on a similar tramway below, the clinkers and refuse from the boilers will be removed. The main flue (7ft. by 9ft. section) and the auxiliary flues, as well as the economiser chambers, will all be below ground level. The pump room is situated at the northern end of the boiler house. The floor is constructed on an iron and concrete platform bridging the main flue, so that there may be no risk of this being damaged by vibration from the pumping machinery above. Feed-water tanks are situated within the boiler house adjoining the pump room.

For the boilers to be erected at present about half of the boiler house will be required.

The chimney shaft, octagonal in plan, is 9ft. internal diameter at the top, and 180ft. in height above ground level. It is designed to take the gases, with natural draught, from the whole of the boilers arranged for in the full boiler house.

The engine house is 126ft. 9in. in length by 45ft. in width. A passage 10ft. in depth by 4ft. in width is carried below floor level adjoining the division wall between the engine and boiler house. This is provided to receive the condenser circulating water pipes. An under-floor passage 9ft. by 6ft. section, with access from the battery room, is constructed to receive all conductors and cables leading to and from the switchboard situated above it. An office for the engineer-in-charge is built in the north-west corner of the engine room, and a staircase at the side, and over this, gives access to a gallery from which doors connect with the offices and rooms on the first floor of the west wing.

The west wing contains, in the basement, the battery room with entrance by staircase from the engine room, and from the yard by way of a dry area. In this basement are also a household coal cellar and a heating chamber. On the ground floor are men's mess room and lavatories, an engineer's workshop measuring 29ft. 6in. by 16ft., general stores, engine stores, cable and outside stores, and carpenter's workshop. On the first floor are cloak room and lavatories for the staff, chief engineer's office, committee room, assistant engineers' mess room, photometer and meter testing room, meter stores and an additional store.

These stores and offices should still prove adequate after the works have been considerably extended, but I consider it of the greatest importance to build the necessary complement of offices and stores at the outset, as, without a place for everything and everything in its place, it is impossible to attain to the highest economy and efficiency in working.

The boiler house, flues and chimney shaft have been designed for about twice the boiler power now recommended to be laid down. The mechanical stokers will at present be charged from skips holding about 5 cwt. each. These will be combined with portable weighing machines, so that an accurate record may be kept of the fuel consumed, a matter of the utmost importance, as providing a check upon the efficiency of the steam-raising and steam-using plant.

I recommend the use of boilers of the water-tube type on account of the small space they occupy, their quick-steaming capabilities, their suitability for safely carrying high-steam pressures, and the facility and low cost at which repairs, if needed, may be executed. Repairs are practically confined to the occasional renewal of the tubes subjected to the direct action of the furnaces. Perhaps the greatest advantage this type of boiler possesses is to be found in the rapidity with which steam may be raised, and raised with safety. The important bearing this has on the cost of working will be realised if I point out that a very large proportion of the total fuel consumed in an electricity works is used in raising steam and not in making of steam, and that a boiler containing a large volume of water will require the expenditure of much more fuel to raise steam than one containing less. The objections generally advanced against this type of boiler are that it is expensive to clean, that the small steam and water space results in unsteadiness of steam pressure, and the bituminous coal cannot be burned without making smoke. I have made preparation to overcome these deficiencies, or rather to add to the advantages possessed by the water-tube type of boiler in the following manner :—

I recommend the use of mechanical stokers to enable bituminous coal to be burned without the production of smoke, although not alone for this reason, but also because by their use an increased evaporative efficiency will be obtained. Mechanical stokers on water-tube boilers are now giving satisfaction, as the fuel consumption may be varied within wide limits without the emission of smoke.

In order to obtain the highest efficiency from the steam-raising plant, and, at the same time, to improve the steadiness of steaming under varying loads, I recommend that economisers be fixed in chambers between the boilers and the main flue. In these the feed-water will be heated to a temperature somewhat above boiling point by the waste gases on their way to the chimney. At the steam pressure I recommend, the gases will enter the economiser chamber at from 500°F. to 600°F., and should leave at about 300°F. to 350°F., a large proportion of the difference between these temperatures having been imparted to the feed-water.

In order to reduce the cost of cleaning the boilers and economisers I propose to purify and soften the feed-water in a water-softening plant before it reaches the feed-water tanks. It should then be possible to use the boilers for lengthy periods without cleaning them. The total saving of fuel and in the cost of cleaning by this means will be far greater than the interest and sinking fund on the cost of the plant, plus the cost of softening the water. One-sixteenth of an inch of scale in a boiler has been found to increase the consumption of fuel by no less than 10 per cent., but it is difficult, without injury to a boiler, to chip off the scale until it has attained a thickness even greater than the above. . .

At the present time I recommend that four boilers be installed, one having an evaporative capacity of 5,600lb., and three of 12,500lb. of water per hour from and at 212°F. These would be set in pairs, with a passage 4ft. in width between them, so that a steam jet may be used for blowing the deposit of soot off the tubes. Each boiler will be provided with a full complement of fittings, in addition to the mechanical stokers. All the stokers will be operated from a shaft running below floor level, driven by an electric motor. Each pair of boilers will be equipped with an economiser which, as before stated, will intercept the gases on their way to the main flue. I have so arranged these economisers that, in the event of repairs being necessary, only one need be out of service, and so that, if more than a pair of boilers are under steam, the feed-water may be heated in another economiser and supplied to any boiler. This overcomes the difficulty experienced in the usual settings of economisers. Each economiser will contain about 6,000lb. of water. The tube scrapers will be operated by electric motors.

I recommend a working steam pressure of 180lb. per square inch, that the boilers and economisers be built for 200lb. working pressure, and that each boiler be fitted with a superheater capable of imparting not more than 100°F. of superheat to the steam. Superheating, if not carried so far as to interfere with the satisfactory lubrication of the engines, results in an improved efficiency owing to the steam being in a thoroughly dry, gaseous state.

Feed-water will be obtained from the water company. Before passing to the feed-water tanks, placed below the pump-room floor level, it will flow through a feed-water heater and the softening plant. The feed heater will take the exhaust steam from the feed pumps and from one engine.

For feeding the boilers two steam pumps and one electrically-operated pump are provided. They will be used under different conditions of load, according as one or the other proves the more economical. All feed-water will pass through a water meter before entering the economisers. The steam piping will be constructed entirely of mild steel. . . .

In the engine house a similar provision for extension to that allowed in the boiler house has been made, so that the plant provided for in this scheme occupies about half the total available space. . . . The four dynamos will be multipolar double-current machines. They will generate either continuous current, to be fed direct to the low-tension distributors, or three-phase currents, which may be transformed up to high voltage for transmission to the sub-station. The same dynamo can therefore supply, either simultaneously or separately, any proportion up to its full output of continuous or alternating current. By this means, under certain conditions of load, both adjacent and distant parts of the district, as well as electric tramcars, may be supplied from one steam dynamo. Each double-current dynamo will be of 250kw. capacity. They will generate continuous current at 480 volts to 580 volts pressure, and three-phase alternating current at from 290 volts to 350 volts, and 25 periods per sec., and will be of the revolving armature, multipolar type. . . . I recommend you to adopt the high-speed enclosed type of engine, . . . of the three-crank triple expansion type.

In order that the double current machines may supply the high-tension circuits, three variable ratio transformers each of 250 kw. capacity and a motor generator of 100kw. capacity are provided. The employment of the latter will often save running a second engine.

The switch gear for controlling the supply and distribution of electricity will be mounted on a switchboard to be erected on the fireproof gallery built parallel with the west wall of the engine room. This has been carefully designed to secure safety and convenience in working. It will be raised some 8ft. above the engine-house floor level, and the electrical connections at the back of the board will be 4½ft. clear from the wall, thus allowing ample room for safety in working. The switch gear will be operated from the front of the board, from which the whole of the machinery will be in view.

A balancing transformer set and a pair of booster dynamos for battery charging will be fixed beneath the switchboard platform.

For erecting and overhauling plant an overhead travelling crane capable of lifting 15 tons will traverse the length and breadth of the engine room. This crane will be suitable for conversion to an electrical power crane if this should be desirable in the future.

A large storage battery, already referred to, comprises part of the works equipment, and provision is made to double its size. This will be erected in the room specially built to receive it. The purpose of the battery will be to assist regulation and to supply light load demands such as may occur after midnight and during a portion of the daytime. . . . I have made every provision for condensers, water cooling towers and feed storage tanks, the value of such plant being essentially greatest when the engines are running under-loaded.

The site chosen for the sub-station is about 75ft. by 165ft. in area, and will accommodate an office block in addition to the sub-station buildings. The offices contain waiting and show room, clerks' and accountant's office, chief and assistant engineers' offices, and assistant engineers' and caretaker's quarters. A commodious basement will provide convenient storage for service-layers' tools, junction boxes, and other plant required for the execution of outside work. . . . The sub-station buildings comprise transformer basement, motor-generator room, battery room, drawing office, and test room, meter and cable store.

The extra high-pressure feeders for the works will be brought directly to the switchboard situated in the motor-generator room. This switch-

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board will be built 4ft. clear from the battery room wall, and the switch gear will be operated from floor level. The incoming three-phase current will be converted to continuous current in motor-generators, from whence, through the low-tension feeders, the distributors will be supplied. My scheme provides for four sets of motor-generators, one 50kw., one 100kw. and two 200kw.

For maintaining the balance on the three-wire system a balancing motor transformer will be provided. At each end of this machine a booster dynamo will be coupled, to assist in charging and discharging the battery, or, if required, to raise or lower the pressure on any local feeder.

A 10-ton hand-power travelling crane is arranged to traverse the motor-generator room.

I propose to instal in the sub-station a storage battery capable of supplying 4,000 8 c.p. lamps for two hours, or 1,000 lamps for 10 hours. This will permit the whole of the machinery to be shut down daily for probably 18 hours out of the 24, for at least a short while after the works are opened.

The candle-power and distance apart at which arc lamps are erected varies in different localities and with the need for lighting. In the principal streets of large cities and towns, arc lamps of 2,000 nominal candle-power, consuming ½ unit per hour, are spaced about 40 yds. apart; in residential districts they are frequently spaced from 70 yds. to 90 yds., and ever farther, apart. I believe that in a neighbouring parish, where there is a large amount of arc lighting, 80 yds. has been chosen as the standard spacing best suited to their needs. Except in the High-road, Kilburn, I do not think 80 yds. apart an excessive distance for you to place your arc lamps. The existing gas lamps are about 40 yds. apart. The Board of Trade require the trolley posts, used in connection with overhead electric traction, to be not more than 40 yds. apart; and, therefore, if these are available for supporting street lamps, you could adopt 80 yds. now, and at a later date, should the increased importance of the street justify it, an alteration to 40 yds. could be made by doubling the number of lamps.

I append a list of the streets and roads in which I recommend you to provide arc lamps. Those in the High-road, Kilburn, should be kept alight all night, but in the other roads I would recommend that the arc lamps be extinguished at midnight, and substituted by either two 32 c.p. or four 16 c.p. incandescent lamps. The annual cost of each lamp, based upon the charges for current recommended later, would be: For 2,000 nominal c.p. (10 ampere) arc lamps, burning all night, including carbons, trimming, attendance and repairs, £29. For similar lamps burning until midnight, to be then replaced by incandescent lamps as above described, £21. 10s. These prices are based upon the charge for current averaging only 2·69d. per unit.

I do not submit proposals for immediately lighting any street by means of incandescent electric lamps, but I suggest the matter as one worthy of careful consideration. The total number of arc lamps proposed is 94 (14 all-night and 80 half-night, the latter each with two substitutional incandescents) and the total annual cost £2,126.

With the exception of two lamps, the whole of the above streets and roads in the list are now lighted by means of incandescent gas. By adopting the above scheme of electric lighting 171 incandescent gas lamps will be released for use in other parts of the district. The present cost of gas lighting amounts to £524. 9s. 6d., so that the extra cost of the electric lighting would be £1,701. 10s. 6d. Thus, for four times the cost, the illumination would be increased about 150 times.

ESTIMATE OF CAPITAL EXPENDITURE.

Land, Railway Siding, and Buildings—			
Land, including charges incidental to acquisition...	£3,976	0	0
Railway siding	2,500	0	0
Electricity works buildings and chimney shaft ...	35,604	0	0
Sub-station buildings and offices	13,000	0	0
Total	£55,080	0	0
Works Equipment—			
Boiler-house plant	£7,487	0	0
Engine-house plant	24,929	0	0
Sub-station plant.....	10,251	0	0
Total.....	£42,667	0	0
Mains—			
Low-tension mains and feeders	£24,048	0	0
High-tension feeders	7,387	0	0
Street work, excavation, and reinstatement	3,082	0	0
Total.....	£34,517	0	0
Public Street Lighting—			
*94 arc lamps and auxiliary incandescent lamps connected with mains.....Total.....	£2,838	0	0
Summary—			
Land, railway siding, and buildings	£55,080	0	0
Works and sub-station equipment.....	42,667	0	0
Mains and street work.....	34,517	0	0
Public lighting	2,838	0	0
Meters and house connections (first year)	3,000	0	0
Total	£138,102	0	0
Add for quantity surveyor's charges & contingencies	5,522	0	0
Grand total	£143,624	0	0

(To be concluded.)

* If trolley posts are not available for the attachment of lamps, add £1,500.

THE ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS AT THE FRONT.

Reports from South Africa refer to the valuable services rendered by the Electrical Engineers (R.E.) contingent, under Major R. E. Crompton. When the Railway Pioneer Regiment was engaged in repairing the Bethulie railway bridge the electrical engineers volunteers fitted up search lights and arc lamps, in order that the work might be carried on at night-time. In other places also the search-light contingent has given great assistance, and has, it is said, been specially praised by Lord Roberts. The following is a letter received from a member of the corps. The action referred to is that of Leeuwspruit.

Near Vaal River, Friday, June 21, 1900.

It was hard lines. We were under orders to go from here (Vaal River) to Pretoria, when we had to come back again to repair the bridges which had been blown up a second time. We were getting on merrily with the work, and, in fact, were talking of going home, when on Thursday, June 14, at 2.30 in the morning, while we were all asleep, the Boers attacked us. The first intimation I got was a nigger jumping into the truck on the top of me. I woke up and shouted him to clear off, but he cried with terror and would not budge, then I realised what the curious crack, crack, meant going on all round me. I soon jumped out and got my rifle and ammunition, I can tell you. The Boers, we found, were ensconced on a kopje about 80 yards away, and under good cover, they poured in a heavy fire. We could only fire when we saw a flash. The kopje they were on was on one side of the train, so we all lay down on the other side and fought them, but presently they worked round to our side, and so had us practically surrounded. They fired several volleys from here, wounding several of our men. The Boer Commandant then sent in two of our men they had captured earlier in the fight and told us, through these men, that we were to surrender at once or they would blow the train to bits. We refused to surrender, and then the order came "E.E.'s in extended order on the veldt." We soon got into line, there were only 20 of us, and about 18 yards between each man. We then fixed bayonets and moved to rush the kopje on our side of the train. It was a trying time, I can tell you. We got the order "Advance!" from the left." I was left-hand man, which meant I was the first to rush. First I, then the others, rushed 20 yards at a time and then lay down. When we were about 50 yards from the kopje we all rushed forward, but the Boers did not wait for the bayonets, they had cleared.

We had to lie on the kopje for four hours, in point of fact, until daylight; bitterly cold it was too, and the worst of it was we had to take off our great coats on account of their colour and the brilliancy of the moon. As daylight came on we heard the welcome sound of big guns coming to our rescue, and as the day broke we saw our cavalry coming over the hills. I cannot imagine a prettier sight than those cavalrymen coming over the hills with the first light of day. If they had not come up, the Boers would have seen how few we were and would most likely have rushed the position and captured the train.

On our train there were altogether about 100 men and a lot of niggers, who were very much in the way. A lot of the men had no rifles—could not find them in the dark—so, you see, our fighting force was very small. However, we *defended* and *held* our train alone. When, however, all was quiet and the roll was called, we found we had lost rather heavily. Bigge was wounded through the neck and Mecklem through both ankles. There were seven missing, whose names are Colson,* A. Charlton, G. Charlton, Peart,* Landon,* Sellon* and Warder, so, you see, out of the 24 who went into the fight, we now have only 16. It is terrible to think of the treatment our men who are prisoners will get unless, as I hope, the accounts we get hold of are exaggerated. Altogether on the train there were two killed and seven wounded—the Boers must have been bad shots—and about 40 wounded niggers. Poor Bigge was quite near me when he was hit in the neck; the bullet just missed his spine, but he is now doing well. I don't know how I did it, but I managed to kneel down and bandage his neck up with my field bandage; it was a queer feeling though, with all the bullets flying around you.

The Major called us on to parade next morning and said he was awfully pleased with us. I don't suppose the papers will get hold of much news of this fight as the telegraph line was broken, and by the time it is repaired the whole affair will have been forgotten. The Major was simply grand under fire—as cool as a cucumber. He walked over to me while on the kopje and asked me how I felt; I told him, of course, that I was all right. I shall never forget it though to hear the bullets going with their incessant ping over your head, many of them hitting the ground close beside you. It was much worse, too, from the fact that they fired a lot of explosive bullets. They are frightful things. However, there were three Boers killed and 18 wounded, so we did pretty well.

We have now built up the bridge again and are on the road to Pretoria. I don't exactly see what there is to keep us there, however, as we are daily expecting orders to return home.

Another thing I must tell you; throughout the fight I had on a Balaclava helmet. Fancy the pictures you see of men fighting in ordinary helmets, &c., and then poor me to have to go into action in the romantic (though very unmilitary) helmet knitted of khaki wool. I was very glad of it though, as I should have been frozen without it.

Pretoria, Sunday, June 24.

Arrived here all safe to-day. Will write again soon. Best of health still.

* Colson, Peart, Landon and Sellon were, as announced in our last issue, among the prisoners unconditionally released and reported at Ladysmith.

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CORRESPONDENCE.

A SPARKING PHENOMENON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The No. 1,156 of *The Electrician*, July 13, 1900, p. 441, contains under the column "Contemporary Electrical Science" an abstract of a Paper by W. T. Humphreys (*Phys. Review*, May-June, 1900) on a "New Sparking Phenomenon." The original Paper not being at my disposal, I do not know whether the author himself has chosen this title or not. In any case I should like to draw the attention of your readers to the fact that the experiment in question is not new, but is already described by H. Hertz in the supplementary note, No. 8, at the end of the second volume of his complete works, p. 271 of the English translation by D. E. Jones. Hertz says (I quote the English translation just mentioned): "... Again, let a Töpler-Holtz induction machine, with a disc 40cm. in diameter, be turned rapidly so as to give sparks having a maximum length of about 15cm. Now draw the poles 20cm.-25cm. apart, so that the sparking entirely stops; it will now be found that a long crackling spark can again be regularly obtained every time a small spark is drawn from the negative conductor either with the knuckle of the hand or with the knob of a Leyden jar; or the negative pole may be connected to a long conductor, and sparks may be drawn from this with the same result. The 'releasing' spark may be quite short and weak; if it is drawn with the knob of a Leyden jar, the jar only appears slightly charged. The same effect cannot be obtained by drawing sparks from the positive pole. The phenomenon must have been often observed before, but I have not found any mention of it in the literature on the subject.

"I can give no explanation of these phenomena. They clearly have the same origin as the phenomena which Herr G. Jaumann has described in his Paper entitled 'Einfluss rascher Potentialänderungen auf den Entladungsvorgang' (*Sitzungsberichte d. Akad. d. Wissensch. zu Wien*, Bd. 97, Abth. IIa, July, 1888). Herr Jaumann arrives at the conclusion that 'not only the form, condition, and potential difference of the discharge field,' but also 'the manner in which the potential difference alters—probably by its rate of alteration—materially influence the discharge.' It is to be hoped that these phenomena will be further explained."—Yours, &c., J. VON GEITLER.

Prague, July 21.

[I am much obliged to Ritter von Geitler for pointing out this claim to priority, which appears to be complete. It is strange that Hertz's description should have escaped my own as well as Mr. Humphreys' recollection. Mr. Humphreys uses almost the very words of the last sentence in the first paragraph above. It is still more strange that no satisfactory explanation of this puzzling phenomenon should have been furnished within the last twelve years.—E. E. F. d'A.]

GAS ENGINE ELECTRIC SUPPLY STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice on pp. 467-468 of your issue of the 20th, that at the recent Convention of the Municipal Electrical Association it was stated, during the discussion on the question of the suitability of the gas engine as a means of producing electricity, that gas engine stations were a failure. This we think, though unfortunately true in one or two cases, is rather too sweeping a condemnation. Because a few stations have been unsuccessful for reasons which can be easily explained and obviated, it is hardly fair to argue that gas engine-driven stations must of necessity be failures. We notice that you refer to the Midland plant at Leicester, and it may interest you to know that we have recently completed four large engines there, as those originally supplied by us were not large enough for the increased demands of the station. As instances of other successful gas-driven plants put up by us, we may mention the Northwich Electrical Supply Co., where originally two, and now three, of our special electric light engines have been at work for some years, working up to 440 I.H.P.; 1,000 I.H.P. at the Blackpool Tower, 552 I.H.P. at the new Meat Market, Birmingham, 213 I.H.P. at the Rugby School Electric Lighting Co., and 208 I.H.P. for the Great Central Railway at Woodford. Our engines are also used extensively abroad, and are working at central stations in Madrid, Valencia, Caceres, Vigo, and Chioggia, in Spain; and in many towns in Italy. That there has been in the past a certain amount of prejudice against gas engines to live down cannot be denied, but if the number of orders on our books for engines for driving dynamos may be taken as a guide, we are rapidly getting over it. As a proof that a gas engine, when properly designed, is as reliable as a steam engine for long runs at full power, we may mention that one of our 150 H.P. engines coupled direct to a dynamo ran for 8,640 hours and 25 minutes last year out of a possible 8,960 hours, or 98·6 per cent.—Yours, &c., CROSSLEY BROS. (LTD.).

Manchester, July 24. D. H. Irwin, Director.

SINGLE-PHASE ALTERNATING CURRENT MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 481 of your current issue, in the discussion of Mr. Wilmshurst's Paper read before the Huddersfield Convention, you have ascribed to me the statement that "it sometimes happens that a motor is supplied which is not at all suitable for the periodicity." What I said was, that in view of the large number of periodicities in use, it is difficult to keep in stock such a number of different stampings, &c., as to give the *best possible* results for every periodicity, and that therefore it is necessary to design machines for an average set of conditions.—Yours, &c., W. LANGDON-DAVIES.

London, July 25, 1900.

PARLIAMENTARY INTELLIGENCE.

(*Continued from page 518.*)

LONDON COUNTY TRAMWAYS (NO. 2) BILL.

On July 19th the Earl of Camperdown's Select Committee of the House of Lords commenced consideration of the London County Tramways No. 2) bill.

Mr. FREEMAN, Q.C., said this was one to enable the London County Council to apply electrical working to those tramways which they already owned in the metropolis, or which they might from time to time acquire. At present there were actually laid in the metropolis about 115 miles of tramway, of which 72 had been already purchased by the Council; and by 1903 the Council would own nearly the whole of the lines. The Tramway Act of 1870 gave public authorities power to purchase but no power to work lines. The Council in 1896 obtained an Act giving them power to work. In the present session they were promoting two bills. The No. 1 bill took power to couple up the various tramlines in London into one complete system, and No. 2 bill sought authority to apply electric power. The overhead trolley system would obviously be quite unsuitable for the streets of London, as it was very disfiguring and required the use of a great deal of private property; and it had been agreed that it should not be used in the metropolis except with the consent of the local authorities. The conduit system, though it involved considerable interference with roads, once laid, worked smoothly and without inconvenience, and this system the Council proposed mainly to adopt. The surface contact system, where it had been tried, had proved a success, and it was proposed to adopt it in certain portions of London in order to ascertain whether it was better than the conduit system. Of petitions against the bill those of the Lambeth Vestry and Wandsworth District Board dealt with much the same matter, and he would therefore take the Lambeth one. Lambeth objected that their rights would be injuriously affected, and claimed really an absolute veto as to the system to be used. That, however, was a matter for the Board of Trade to decide. There were 40 local authorities, and this bill affected 33 of them, but all except the Lambeth and Wandsworth authorities had consented to the Board of Trade being the final arbitrators. The only other petitioners were the Lambeth Water and South Metropolitan Gas Companies, who raised two points. First, they were afraid of the action of electrolysis upon their mains. The answer to this was that an important committee sat on this question of electrolysis in 1893, and drew up certain standard clauses which they recommended should be inserted in all bills dealing with electricity. Those clauses had been inserted in this bill. Then these two companies asked that in all cases they might do the road work themselves. That was a clause point. The same remark applied to water and gas companies as applied to local authorities.

Mr. PEMBER, Q.C.: The Lambeth Company is taken as a test case.

Mr. FREEMAN: Then there was only one other point, and that was raised by the vestries. They said certain generating stations were going to be erected from which electricity would be conveyed by cables to the tramways. When those cables ran through the streets the work of refilling, digging the trenches, &c., must be done by somebody. The County Council proposed that it should be done under the Tramways Act;

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the local authorities said they would rather it were done under the Electric Lighting Acts. The County Council did not care so long as there was uniformity in the matter.

Sir ALEXANDER BINNIE, engineer to the London County Council, said it was very important that the tramways should be worked as a whole, with one mode of traction. If an isolated district such as Wandsworth or Battersea were to acquire control of the mode of traction in their particular district they might interfere very seriously with the general communications with other districts. South of the Thames the Council worked the trams they owned; North of the Thames the North Metropolitan Tramways Co. leased the trams which the Council owned. The Council had expended on the tramways, he believed, about £817,000 north of the Thames and about £887,000 south of the Thames. It is clearly in the public interest that the tramways should be in one hand and that there should be one system. He agreed that under the Tramways Act, as proposed in the bill, the Council, without any notice to the South Metropolitan Gas Co., would have power to interfere with roads. The practice, however, was to permit the companies to do the work. He did not see much objection to legalising the practice. There was a tramline through Wandsworth on which it was proposed to make some experiments, but he did not know that special protection other than that provided by the jurisdiction of the Board of Trade was needed. The clauses in the bill with regard to roads, &c., were the model clauses slightly modified to suit certain local authorities, but nothing was inserted to make them more restrictive of the powers of road authorities.

Mr. J. W. BENN, L.C.C., said as a result of a conference attended by 18 or 19 out of the 40 London local authorities, a code was embodied in bill regulating all the tramways; and it was the desire of the Council that there should be no exception made in favour of a particular district. The advantages which the County Council anticipated from the proposed change from horse to electrical traction were increased speed, increased profit, and lesser amount of room occupied by each tramcar. Each car holds 64 persons, and would occupy 5ft. less space than the present horse cars, which accommodated only 40 persons. The Council would not, under the bill, be able to introduce a new system without the approval of the Board of Trade. The surface contact system, to which Lambeth objected, had been tried with success. As a matter of policy he did not agree that there was no objection to legalising the present practice as to the method of dealing with mains. The Council thought the existing law and the model clauses already afforded the companies sufficient protection for their mains. At present the Wandsworth Board had a right of veto regarding the system of traction to be adopted in their district; but he did not think that should continue because they might interfere with the whole scheme.

Prof. A. B. W. KENNEDY said he had reported to the Council as to the advisability of adapting the tramway system of London to electric traction, and subsequently he prepared plans. He advised the Council not to bind themselves to any one system, but to leave the matter to the Board of Trade. Whichever of the two systems (the conduit or surface contact) was adopted, it would in no way interfere with the traffic passing over the roads. The contention with regard to electrolysis was amply met by the insertion of the model clauses drawn up by the Joint Committee of the two Houses of Parliament in 1893.

The CHAIRMAN: The clause says electrical powers shall be used only in accordance with the Board of Trade regulations. Therefore the Board of Trade will satisfy itself as to whether these pipes and things are going to be injured.

Mr. POPE, Q.C.: And shall make such provision as shall secure their safety if they are injured.

The CHAIRMAN: Quite so. That duty is thrown on the Board of Trade, not on us, and we are incapable of undertaking it.

Further examined, WITNESS said he knew of no injury done to gas or water mains by electrolysis since the Board of Trade issued the regulations.

The CHAIRMAN: Even if that had happened it would have happened under the regulation of the Board of Trade, and here is sub-section 7, which deals with such a case.

Mr. PEMBER said: Whatever injury might result from the insufficiency of the Board of Trade regulations, the water companies would get no compensation at all. He asked that if accident did occur under these regulations compensation should be given to the companies.

Mr. PEMBER asked Prof. Kennedy whether he thought the Board of Trade regulations were perfect, and would absolutely stop electrolysis.—He could not say they were perfect, but he thought they would practically prevent danger. They had been in use for a good many years, but he had not heard of any case of accident with the pipes.

Are you prepared to say that electrolysis may not be going on now, and not discovered; it would not be discovered till it had got to a serious point?—It is not discovered at once; but a good many years have elapsed. Until the escape of water became very serious the water companies would not discover the damage, and when discovered it would be a very expensive matter to set right if the pipes were seriously damaged. In most cases it would be clear to what cause the damage was attributable. In America a great deal of damage to pipes had been done by electrolysis; but the electrical arrangements in America were not subject to any body like the Board of Trade. Electric tramways were laid without any control at all so that what happened in America was no test of what would happen in England under Board of Trade regulations. Electrolytic action was caused by an escape of electricity meeting water and an iron pipe, in which case the water would decompose and the oxygen attack the iron. He agreed that the Board of Trade might sanction a system in which there would be uninsulated returns; but he was almost sure that would not produce electrolysis. The regulations of the Board of Trade of 1894 gave sufficient protection. He was aware those regulations were under review in 1898, but I believe the Board have not thought fit to alter their regulations.

Mr. CASTLE, Q.C. (for the South Metropolitan Gas Co.): That is the whole ground of our grievance.

Further examined: WITNESS agreed that a certain amount of leakage of electricity was allowed under the regulations, but not sufficient to produce electrolysis.

Seeing that you are asking for powers which may produce electrolytic action on our pipes, and seeing that you are working under regulations which you say are not absolutely perfect, do you see any reason why you should not give us compensation if you do us injury?—I have considered the question. The point is that we, as engineers to the work, have to construct our system according to the particular rules and regulations devised by skilled persons, officers of the Board of Trade, and we think if we carry out these things which are prescribed to us, honestly, and are looked after in carrying them out, we should not be held liable for further consequences.

The CHAIRMAN: You think that having done what the Board of Trade ask you to do, you ought to be free from further consequences, even although the result of the operations may be that these pipes are injured?—That is my view, because the Board of Trade have power at any time to strengthen their regulations.

Mr. CASTLE: I think you are going too far. You are bound to lay these tramways under the existing Board of Trade regulations; they have no future power over you.

Mr. WHEELER was proceeding to cross-examine with regard to the merits of the surface-contact system, which he said should not be left to the discretion of the Board of Trade to allow to be used, when the CHAIRMAN said the matter of a system of traction had nothing to do, in the judgment of the Committee, with the principle of the bill. The subject should be raised in clauses.

Cross-examined by Mr. Vesey Knox: The surface-contact system to be tried in Wandsworth would not be tried elsewhere until it had been found to be successful. He did not think precisely the same system of surface contact as was proposed to be tried in Wandsworth had been tried elsewhere.

This closed the case for the bill.

Mr. PEMBER addressed the Committee for the Lambeth Water Company, his contention being that it was not right to adhere to the particular part of the clauses of 1893. He asked for an amendment, making the tramways liable for damage so caused.

Mr. CASTLE said his clients were asking for protection from damage which might accrue to them under peculiar circumstances. This was the first bill in which Parliament had been asked to delegate its powers to a Department of the Government without retaining any sort of control on the part of the Imperial authority. The suggestion in clause 3 was that in future the County Council should act in connection with the system of electric traction to be used on these tramways with the consent of the Board of Trade. The matter of tramways was very similar to that of light railways, which in turn were similar to the question of the construction of railways. If anyone had had the audacity to come before Parliament and ask to make a railway, say, from London to York, on such and such a system, and according to such a method as the Board of Trade, apart from Parliament, might consent to, Parliament would have made short work of such a request, and yet it was what was being asked in this bill. Even when the Board of Trade permitted a scheme to be carried out under provisional order, it was always the rule that such an order should be confirmed by an Act of Parliament. But here they were asked in a most extraordinary way to deal not with what the Board of Trade had already done as in the case of a provisional order, but to sanction what the Board of Trade might do in the future.

The CHAIRMAN: Your contention is that the ordinary practice is at present for the Board of Trade to sanction an electric system, and for that system subsequently to come before Parliament for confirmation.

Mr. CASTLE: Yes, that was the arrangement he wished the Committee to make in this bill. If the Board of Trade authorised a system the opponents should be able to come to Parliament and say that the Board of Trade had erred, and the matter should be reconsidered by Parliament. The County Council came there and asked that what the Board of Trade might sanction in the future should have all the authority of an Act of Parliament. That would not be allowed in the case of any railway company making its own lines. For that reason he asked for protection in the shape of a compensation clause similar to that asked for and obtained by Mr. Pember. There were strong reasons why the County Council in these matters should not be allowed to shelter themselves behind the Board of Trade. If the compensation clause was not inserted he asked that the bill should be thrown out. His point was that this was an exceptional bill framed in an exceptional form, and he asked that it might not be passed without a compensation clause.

The CHAIRMAN: You do not offer evidence?

Mr. CASTLE said he might have to call witnesses as to the Council doing their own work if the bill were allowed to proceed.

Mr. WHEELER, Q.C., for the Lambeth Vestry, said his points against the bill were two, or possibly three. The first was as to whether they would not exclude the surface contact system; and the second—and this was a part of the bill which had hardly attracted any attention, although in many senses the most important part—who should have control over the Lambeth roads. Were the functions of the Vestry to be taken away from them and vested in the Board of Trade or someone else? The present bill entirely repealed the general law of the land, and he asked the Committee to say that in a private bill of this character that should not be allowed. The streets were within the jurisdiction of and governed and controlled by the various public authorities. That had been the law since 1855 under the Metropolis Management Act, and he maintained it was inconsistent with the general practice of Parliament that public acts should be repealed by private measures. The acts it

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was sought to repeal were the 18 and 19 and 25 and 26 Victoria The second part of the bill was for applying electricity to the tramways, and counsel for the promoters suggested that they should deal with the bill as a whole and include Lambeth with the other districts. But if he (Mr. Wheeler) was right in his first point as to repeal, if they looked at clause 5, as amended, they would find that the Board of Trade was prayed in that matter—the road authority was saved, but was coupled with the Board of Trade, and he objected altogether to the interference of the Board of Trade. And he protested against the proposal—which would really be the effect of this part of the bill—that the Lambeth Vestry should be subjected to no fewer than nine kinds of arbitration. He would ask the Committee to lay down that that which had been common law for centuries, and which was crystallised by the Acts 18th and 19th, and 25th and 26th Victoria, should be carried out. It was true that there were 28 or 30 local authorities, but it was not correct, as alleged, that of that number only Wandsworth and Lambeth were objecting. In the first place, the vestries would cease to exist this year; in the next place, some of the local authorities were not affected; and, finally, the covenants of some districts had been obtained as a matter of barter—Clerkenwell, for instance. That district had originally opposed the bill, but it had withdrawn its objection. Why? Well, the County Council had consented to spend an enormous amount of money in widening the roads.

The CHAIRMAN: We have nothing to do with the motives of the local authorities. If the local authorities went against the view of the public the public had their remedy in being able to turn out the authority at the next election.

Mr. WHEELER said he should now call evidence.

The CHAIRMAN: As to what?

Mr. WHEELER: The unsuitability of the surface contact system.

The CHAIRMAN: We are not experts.

Mr. HENRY EDWARDS, surveyor of Lambeth parish, said the Vestry should not have their existing powers in the matter of breaking-up and repairing roads interfered with. There were practical difficulties in the way of having two authorities responsible for dealing with the roadway for some distance outside the tramway lines.

This was all the evidence for Lambeth.

Mr. HILL, clerk to the Wandsworth local authority, said that that authority last year had given their consent to the London County Council to make experiments in connection with both the conduit and surface contact system of electric traction. They had given a licence for 12 months, the idea being that it should not be renewed if it were found that the system of traction was dangerous or detrimental to the interests of the public. They had had powers of this kind in connection with the cable traction. The cable had been in use 10 years, which showed that the local authority were reasonable in the exercise of their powers. Such having been their attitude it would be unreasonable to interfere with the control of the roads by the local authority. The Wandsworth Board of Works thought they should have the ordinary control over the road operations in roads and streets along which trenches were made for carrying connecting electric cables. The local authority should have at least the electric lighting clauses applied to these trenches. The cost of carrying out the proposed electric traction experiment would be from £10,000 to £15,000 a year.

By Mr. FREEMAN: What objection have you to vesting the power of veto with the Board of Trade?—Because this is a matter affecting the surface of the road and the pavement. The surveyor to the Board of Trade is an electrical engineer, and he will be anxious to see this particular science of electricity advanced. He would be likely to attach more importance to science than to the convenience of the public.

In reply to other questions, witness said that if local authorities did not petition against a bill they were usually taken as agreeing to it. In this case he believed that some local authorities refrained from petitioning on the score of expense. He had not got an agreement with other local authorities in favour of the adoption of the road powers contained in the Metropolis Management Act, or in favour of the electric lighting clauses. He had communicated with 42 of those authorities, and the 14 who had replied had favoured the adoption of those powers.

Mr. MARTEN, surveyor to the Wandsworth Board of Works, gave similar evidence in opposition to the proposals of the bill. He thought the local authority should say what materials the roadway by the side of tramway lines should be paved with. He did not think that such questions should be settled by arbitration. There was no objection to going to the Board of Trade on the question of electricity, but he should object to going to them on the question of the surface of the roads. If any point were brought before them touching the surface of the roads, he should fear that they would attach too much importance to electrical questions in giving their decision.

Mr. VESEY KNOX, for Wandsworth, contended that is was not desirable that powers which a progressive body like the Wandsworth Board of Works had enjoyed for so long a period should be taken away. Wandsworth had been reasonable in connection with the cable experiment, which had only been tried in two London districts. They might be trusted to show equal reasonableness in connection with the proposed electric surface contact system. That system was not to be tried all over London, but only in two districts—Wandsworth and Lambeth. It was a system only known in Tours, in France, and Monte Carlo, and as it was an experiment he submitted that it was only fair that the Board of Works should preserve their existing powers. It might be found that the new line would be slippery for horses or otherwise inconvenient, and clearly it was only right that the Board of Works should have some check on the County Council. He only asked for power to check the progress of the County Council works for two years. He insisted further, that the Board of Works should be able to say what the material outside the tramway lines should be, and his third point was as to the laying of electric mains, as to which no one up to now had had very much experience. As a rule these mains were not necessary except along the tramway road itself and the same street as the tramway. But in the south of London there was a proposal to have a generating station some distance from the tramway, and communication mains would have to be laid going through other streets through which the tramways were not themselves to run. That was a state of things not contemplated by the model clauses and his clients contended that in these streets the promoters should be subject to the Metropolis Management Act or to the Electric Lighting clauses, under which they would have power at the expense of the County Council to fill in the mains. He thought it was only a reasonable proposition to make to the Committee that these powers should be allowed.

This concluded the case for the opponents.

After deliberation the CHAIRMAN (without calling on counsel for the promoters) said: The committee have decided that the bill may proceed.

On clause 3 an amendment was accepted, providing that where an electric system was proposed to be used for experimental purposes the Board of Trade should have power to prescribe the length of time for which the experiment should last.

On clause 4, which provides that the Council shall take all reasonable precautions in constructing, placing, and maintaining their electric lines, and so conduct their undertaking as not to injuriously interfere by electrolytic action with any gas or water pipes, Mr. PEMBER submitted as an addition:

"And the Council shall make full compensation to any company or person suffering loss or damage by reason of any such fusion or electrolytic action as aforesaid."

Council said his point was that the Council were the aggressors, that the gas and water companies were in the roads first, that their business was quite as important as, if not more important, than that of the County Council in regard to the trams from the public point of view, and that those who caused the damage should suffer, and not those who bore the damage.

Mr. BALFOUR BROWNE said he understood the decision of the committee in this bill would regulate the committee's decision on the following bill, in which the same point was raised.

The CHAIRMAN said that that must not be taken for granted.

Mr. BALFOUR BROWNE said he appeared for the Great Northern Railway Co., and he entirely concurred in Mr. Pember's statement. What the railway company feared was that these wires of the Council might be blown or otherwise caused to fall upon the signalling wires of the railway company. If they did surely the Council ought to pay for the damage.

Mr. CASTLE agreed with what Mr. Pember had said.

Mr. POPE (for the County Council) said this was a much more important point than it at first appeared. It was an attempt for the benefit of one water, one gas, and one railway company to alter the laws which regulated all such undertakings. The law was that if Parliament chose to give statutory power for the exercise of certain powers, so long as those powers were exercised without negligence, no liability for damage in regard to the exercise of those powers could be brought against the company at all. The Committee had already decided that statutory power should be given for the creation of electrical traction subject to the regulations of the Board of Trade, those regulations being incorporated as part of the conditions of the statute; and if anybody obtained those powers at the hands of Parliament and exercised them in conformity with the regulations of the Board of Trade and was not guilty of negligence in carrying them out, no claim for damages could arise, and there ought not to be inserted any provision for damages for the benefit of one gas and one water company.

Mr. BAGGALLAY said that was an error because the Lambeth case was a test case.

Mr. POPE said he would put the proposition in another way—viz., that for the benefit of the gas and water companies of London the Committee were to alter the general law in regard to the power of an undertaker who used his statutory power without negligence. The clause would make the County Council, if they used the powers the Committee proposed to give them, without negligence, liable in any event to pay for any damage done. The evidence was that there was no imminent danger of the kind, and that the Board of Trade regulations were sufficient to cover it.

The CHAIRMAN took exception to the last words. It had not been proved that the regulations were sufficient. It had been admitted that the regulations might be imperfect.

Mr. POPE said the whole question was threshed out before Lord Cross's Committee with the assistance of all the water and all the gas companies, and the result was that Lord Cross's Committee made a report in which they said that with proper regulations made by the Board of Trade the whole danger might be a negligeable quantity. Lord Cross's Committee, after hearing all parties, recommended that the clause should contain a compliance with the regulations of the Board of Trade, which should free the undertakers from any charge of negligence. The amendment now sought really meant that where undertakers were simply using statutory powers without negligence, they should, contrary to the general principles of law, be held liable for exercise of those powers. That would be a total reversal of all legal principles and of all Lord Cross said.

Mr. BAGGALLAY said Mr. Pope had been referring to the report of the Committee of 1893; but before Lord Cross's Committee of 1898 Sir Wm. Preece gave evidence and as a result that Committee directed attention to the observations he made as regarded the difficulty arising from the working of tramways by trolley wire, his suggestion being that a strong control clause should be carefully considered. Nothing, however, had since been done. His (counsel's) sole point was that if the Board of Trade made efficient regulations and they were obeyed the amendment would not hurt the London County Council. If the provisions made by the Board of Trade were effectual for the prevention of electrolysis and fusion the County Council would incur no liability. It was only in the event of those regulations proving ineffectual and damage resulting to his clients that they would be liable. In that case he contented that as between two

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parties, one being wholly innocent and the other, however unintentionally, the cause of the mischief, the latter should pay.

Mr. CASTLE, Q.C. said if power were given to a Corporation by an Act, and no conditions were attached, it was very clear negligence must be proved before the Corporation became liable.

After consultation, the CHAIRMAN said the Committee had decided to admit the principle of the clause.

The parties proceeded to discuss the clause in detail, but eventually the matter was adjourned to enable the parties to bring up a substantive and separate clause.

On Wednesday, Mr. PEMBER brought up the following clause :—

"The Council shall make full compensation to any gas or water company suffering loss or damage by reason of any fusion of or electrolytic action on their mains, pipes, or apparatus which may in any way be caused by the Council in exercise of any of the powers conferred upon them by this act."

A long discussion followed.

Mr. POPE said the effect of the clause would be to make the London County Council insurers of the gas and water pipes of the Metropolis from any electrolytic action arising from any cause whatever. Though possibly this matter was not one of very great pecuniary consequence to the London County Council, because they did not propose to use a system which could result in electrolytic action, as a matter of principle the question involved was very important, being to what extent the Committee would alter the general law in this particular case.

The CHAIRMAN said the intention of the Committee was not, by giving the Council statutory power, to exempt them from anything in regard to what they would have been liable if this bill had not been passed.

Mr. POPE said he would suggest a clause which would meet the justice of the case. This clause was submitted, but

Mr. PEMBER submitted that the clause read by Mr. Pope did not give him the protection the Committee said he should have.

Mr. POPE, after further argument, suggested a modification of the clause which he had brought up, which would now read as follows :—

"If it be proved that any injury or damage to any gas or water pipes, or other metallic pipes, structures, or substances of any gas or water company shall have resulted from fusion or electrolytic action caused by any currents generated or used by the Council for the purpose of electric traction under this act, and nothing in this act shall relieve the Council from any liability to make compensation for such injury or damage which would have existed but for the passing of this act."

He wanted to make it clear that the injury for which they were to pay was caused by the Council, because, he pointed out, electrolysis arose in part from moisture which might be due to carelessness on the part of the companies in allowing their mains to be leaky.

The CHAIRMAN : Certainly.

The clause was accepted by the Committee, who proceeded to consider ther clauses of the bill.

On Clause 14, Mr. CASTLE, Q.C., proposed, for the protection of the South Metropolitan Gas and Lambeth Waterworks Companies, the following :—

"If, within seven days after a notice under the preceding section of this act shall have been served upon any gas or water company, that company shall elect to themselves execute all such alterations to their mains and pipes, the reasonable costs of executing such alterations shall be repaid by the Council to the company, provided always that such alterations shall be carried out in accordance with the directions and to the reasonable satisfaction of the chief engineer of the Council."

Under the bill the work was not to be done by the companies, but under their superintendence. That, however, was not sufficient, as was shown by a recent explosion at Manchester, in which an engineer lost his life owing to the incautious way in which a main had been handled.

The CHAIRMAN accepted the clause, and the bill, as amended, was ordered to be reported.

ROCHDALE CORPORATION BILL.

On July 19 the Select Committee of the House of Lords, of which the Earl of Camperdown is chairman, considered this bill.

Mr. R. W. HARPER, for the promoters, said Rochdale Corporation would next year and the year following have the right to purchase the existing tramways of a company within their borough. They propose to exercise that right, but the gauge being inconvenient, and one which prevented the trams from being worked with surrounding systems, with which an interchange of traffic was desirable, power was sought to alter the gauge, to make one or two extensions, and to electrically equip the lines. Some of the extensions proposed were outside the borough. The Lancashire and Yorkshire Railway sought protection for their property in the middle of the town, which they said was highly rated, and if they did not oppose the granting of the powers asked for they thought they should have some consideration in regard to rating in the event of the extensions outside the borough resulting in loss to them. The Corporation thought that request perfectly fair, although not thinking there would be loss. A clause was accordingly inserted in the bill, but had been cut out by the Police and Sanitary Committee, of which Lord E. Fitzmaurice was chairman, chiefly at the instance of the Local Government Board. In the Halifax Bill, which came before another section of the same committee, an identically similar clause was allowed, and the Halifax Bill had passed both Houses. In the Huddersfield Bill there was also a similar clause, and that bill had passed the Commons and would come before Lord Morley in the House of Lords as an unopposed measure. It seemed, therefore, that there was some difference of opinion.

The preamble of the bill was formally proved, and passed by the Committee.

Mr. POPE, Q.C., then submitted the following clause : —

"As regards all rates to be levied under the powers of this act relating to tramways owned, leased, or worked by the Corporation outside the borough, if at any time such tramways are worked at a loss the occupiers of any land used as a railway constructed under the powers of any act of Parliament for public conveyance shall be assessed to such rates in respect of the same in the proportion of one-fourth part only of the net annual value thereof."

The CHAIRMAN said that the Committee could not accept the clause. They would not, however, throw out the bill, but would further consider the matter in the light of two or three acts to which his attention had been directed.

On Monday, the CHAIRMAN said since the last proceedings he had obtained the proceedings in the Dundee and Aberdeen cases, and the Committee were going to consider the clauses in the acts relating to these places. The only difference in the two cases he could see was that in the Dundee case the depreciation on plant and machinery should be reckoned at not less than 3 per cent. In the Aberdeen case it was to be 3 per cent.

Mr. COATES, Parliamentary agent to the promoters, said he understood the difference between the two cases to be that in Dundee the undertaking was to be so arranged that there should never be any loss, whereas in the Aberdeen case it was to be so arranged that it should exactly produce the amount of money required, with neither loss nor profit.

The CHAIRMAN said the whole principle apparently of the Committee in the Dundee case was that if a municipality competed with certain of its own ratepayers if it made no profit it must not be allowed to make a loss. That was a principle which the present Committee thought worthy of wide consideration. It was one of the complaints against the whole system of municipal trading that a corporation might make a gain in one part and thus cover a loss in another. *Prima facie* the Committee thought there was very good reason for inserting this clause or something like it in the bill. They would like to hear argument against inserting such a clause.

Mr. HARPER said that would only relate, he supposed, to trams outside the borough ; if it applied to trams inside the borough it would alter the general law.

The CHAIRMAN said the Corporation were proposing to become traders and to take a portion of their undertaking outside their own limits, which was trading pure and simple. What reason was there why the Corporation should be forbidden to make a loss upon their tramways as a whole !

Mr. HARPER said it was matter of common knowledge that in every case, unless there was some very special circumstance, the cost to a borough of its tramways was levied upon the borough fund, in regard to which the railway companies paid in full. The railway company only asked for an exemption outside to the extent of one-fourth.

The CHAIRMAN said that was what the railways asked for, but that the Committee would not give them. It was not now the railways who were making a demand ; it was now the Committee who were making a proposal and asking what reason there was why the Committee should not insert in the bill a clause saying that the municipality should not make a loss upon their tramways, especially as they proposed to go outside the borough.

Mr. HARPER said as regards the particular circumstances in this case the extension outside was only for about a couple of miles ; and he suggested that in so small an extension so large a departure should not be made.

Further discussion followed, in which several counsel expressed the opinion that in no borough in England where a municipality worked tramways only within its own limits was there a provision that they were in no case to make a loss.

The CHAIRMAN eventually said : The Committee are of opinion that in a case such as this, where a municipality takes over tramways, including tramways which are beyond its own area, it is right that, if possible, they should be prevented from making a loss, so as to prevent, at all events to that extent, competition with private traders. As a means of giving expression to that opinion I now propound the clause in either the Dundee or Aberdeen case.

The clause in the Dundee Act was gone through line by line, and on Tuesday adopted in the following form :—

"The Corporation shall once in each year after the first two years' working cause the treasurer to the borough to lay before them a statement and balance-sheet of the tramway accounts, including the reserve and suspense accounts for the preceding year, and the estimate of the revenue to be derived for the ensuing year from the working and use of the Corporation tramways and carriages and trucks thereon, and also an estimate of the sums required to meet every such year's expenses of working, management and maintenance of lines, works, machinery, and rolling stock, repairs, renewals, materials, rents, wages, taxes, and other outgoings and charges, and including loans, and also the interest on all money borrowed under the powers of this act on the security of the tramway revenue and borough fund and borough rate, and the payment of the sums required to be annually made to the sinking fund for the repayment of such moneys as provided for by this act, and the Corporation shall thereupon fix annually the tolls, fares, and charges to be levied by them for the use of the Corporation tramways and all the carriages and trucks used or propelled thereon for the said year then ensuing not exceeding the tolls, fares, and charges specified in this act, so that the revenue shall meet the expenditure as before specified for each year.

"Provided that if in any year the revenue exceeds such an expenditure the Corporation shall carry such excesses to the reserve account to be used in providing for the advances and contingencies, and that should there be a deficiency in any year it shall be provided for in the estimate for the following year, or by drawing from the reserve account, or varying the tolls, fares and charges, or reducing working expenses, or

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by carrying to the suspense account, and reducing gradually over a period of years not exceeding five.

"Provided also that in making the estimates aforesaid and balancing accounts at the end of such year the depreciation on machinery and plant shall be at the rate of not less than 3 per centum on the first cost thereof.

"Nothing in this section shall be construed to injure or affect the security for any moneys borrowed by the Corporation under the provisions of sub-sections *a*, *b*, *c* and *d* of the section of this act the marginal note whereof is 'Power to borrow on the security of the tramway revenue and borough fund and borough rate.'"

The other clauses having been adjusted, the bill was then ordered to be reported.

WESTON-SUPER-MARE TRAMWAYS BILL.

The Select Committee of the House of Lords, of which Lord Brassey is chairman, on Tuesday considered the bill confirming a provisional order of the Board of Trade authorising the construction of tramways in the district of Weston-super-Mare. The proceedings before the House of Commons Committee were fully reported in *The Electrician* for June 29 and July 6.

Mr. WORSLEY TAYLOR, Q.C., for the promoters, said the order was for a tramway, 3½ miles long, to be worked by electricity. There was no real question as to the preamble, the question being as to a clause for the benefit of the Commercial Cable Co., who had a cable which landed at Weston. The company paid a shilling a year for this right, and were in the position of any ordinary landowner. The Cable Company contended that as they used electricity at very low pressure, and the promoters used a high pressure the working of the submarine cable would be seriously affected, if proper precautions were not taken. But, he urged, the Cable Company went to Weston with a full knowledge of the possibility of electric tramways being introduced, and they must take the risk that this course involved. The Cable Company asked for a clause giving them power to do such work as might be necessary to prevent their being injuriously affected, and that the tramway promoters should reimburse them for the expense of this, and compensate them for any loss or damage caused to them. This, the promoters urged, was an attempt on the part of the Cable Company to reverse the whole course of legislation on this question. The matter was of some importance because this was the first case of a tramway company seeking powers to work their system electrically where a submarine telegraph cable was already laid. But the principle was not a new one. He remembered when electric tramways were first proposed they were supposed to be dangerous to the rights of the Telephone Company, who used the current at an even less pressure than the Cable Company. It was proposed that the Tramway Company should be compelled to use an insulated return; but it was held that, whereas in the public interest the Tramway Company should be bound to take all reasonable precautions, the cost of such precautions should not be so great as to retard or prevent the development of tramways. He urged that the Board of Trade had made special provisions for the use of electricity which was for the protection of the public as well as of the Post Office. The whole question was thrashed out by the Telephone Company, with the result that to-day the company had to protect its own interests; and he submitted that what was good enough for the Telephone Company was good enough for the Cable Company.

At the conclusion of the promoters' case, Mr. PEMBER, Q.C., referred to the vast public importance of the submarine telegraph cable, and said that great injury would be caused to the Cable Company if this proposed tramway was worked under the ordinary Board of Trade regulations. He urged that the aggressors, rather than the aggrieved, should bear the expense of protecting the cables. He had proposed a clause to the effect that the provisional order should not interfere with any rights of the Cable Company at common law in connection with the use of their submarine cable.

Mr. JAMES SWINBURNE and Prof. W. E. AYRTON having given evidence in support of the petitions,

The Committee declared the preamble proved. They did not grant any protection clause to the Cable Company.

THE DURHAM ELECTRIC POWER BILL.

On Wednesday the bill of the County of Durham Electric Power Supply Co. came before the House of Lords Committee, presided over by the Duke of Argyle.

Mr. BALFOUR BROWNE, Q.C., for the promoters, said the bill was thoroughly considered by the Committee of the other House. [See *The Electrician* for May 25.] At the present time the difficulties in the way of supplying electricity cheap was that it was only used for the purpose of lighting, so that very expensive machinery was standing still for a great portion of the day. Eight hours out of a hundred only were used for generating electricity for lighting powers, and during the remaining time the capital and machinery were lying idle. The object of the Durham Company under the bill was to generate electricity for other as well as for lighting purposes, and thus to make greater use of the plant. They would then be able to supply current at a cheap rate and make a profit. The bill was in practically the same form as it was in the other House, but some additions had been made for the protection of local authorities. Clause 32 would prevent the company from paying an excessive dividend, and that was for the protection of the public; and at the end of ten years there was to be a revision of their charges, and if the Board of Trade found a reserve fund in their hands they would reduce the prices. Under clause 44, if within two years of the passing of the act, the company had not substantially commenced the work, or if within four years they had not erected a generating station or stations, and were not in a position to supply electric current, the Board of Trade might revoke the act. Their limits of supply extended over 100 square miles, and they were not opposed by anybody in that large area except the Councils of Felling and Hebburn.

Evidence having been taken in favour of the measure, and counsel heard in opposition,

The committee decided that the bill should be allowed to proceed, with an alteration in the clauses relating to Felling and Hebburn providing that wayleaves only be allowed.

Yesterday the bill was ordered to be reported.

SHANNON WATER AND ELECTRIC POWER BILL.

In the House of Lords on Monday, on the motion of Lord Lurgan, the second reading of this bill was, after a brief debate, agreed to.

EDINBURGH CORPORATION ACT.

This act, which now awaits Royal assent, authorises the Corporation *inter alia* to supply electricity in bulk to any local authority or person outside the city having statutory authority to supply electricity for either lighting or power purposes.

BROMPTON AND PICCADILLY CIRCUS RAILWAY BILL.

This bill is not to be further proceeded with this session.

MANCHESTER CORPORATION TRAMWAYS BILL.

The Select Committee of the House of Commons, presided over by Mr. Seale-Hayne, on Tuesday considered the bill promoted by the Corporation of Manchester, authorising considerable extensions of the tramways within and without the city, to be worked together with the present lines by electricity on the overhead trolley system. The bill has already passed the House of Lords. The estimated cost of the construction of the new lines and of the electrical equipment of the existing and new lines is £1,500,000.

Counsel for the promoters were Mr. Balfour Browne, Q.C., Mr. Lewis Coward and Mr. Rhodes; and the petitioners against the bill were represented—the British Electric Traction Co. by Mr. Worsley Taylor, Q.C., and Mr. Moon; and certain frontagers in Manchester by Mr. Forbes Lankester.

Mr. LEWIS COWARD said the bill not only sought to construct additional tramways in and near Manchester, but to confer powers on the Corporation and neighbouring authorities in respect to tramways beyond the city. Manchester Corporation were the owners of tramways within the city aggregating 58 miles of single track, which were at present under lease to the Manchester Carriage & Tramways Co., and worked by horse traction; this lease expires in April, 1901. A committee appointed by the Corporation had reported in favour of the Corporation working the tramways themselves, and of the adoption of electric traction. That recommendation was adopted by the City Council, and in 1897 the Corporation obtained from Parliament powers. The Carriage Company went to Parliament in 1898 with a bill to enable them to introduce electric traction on the lines and to continue the working of their system by arrangement with the various local authorities. That bill was opposed by the local authorities, who preferred that the Manchester Corporation should work the tramways, and was rejected by Parliament. Last year the Corporation obtained further powers in regard to their tramways, including powers to work and take leases of lines outside the city to Failsworth, Audenshaw, Denton and Heaton Norris, and agreements were about to be signed with the Councils of Stretford, Moss Side and Withington. By the present bill the Corporation would obtain general permissive powers to enter into agreements with other local authorities. The Tramways committee of the Corporation had recommended the present application for powers to construct a number of junction and extension lines—about 38 miles of single track. There was no doubt that these new lines were necessary to the provision of adequate tramway accommodation. It was the intention of the Corporation to adopt through routes, so that cars would pass right through the centre of the city. There were two petitions against the bill, one from frontagers, and the other from the British Electric Traction Co., who had powers to construct certain light railways in Middleton and neighbourhood, and who feared that the Corporations of Manchester and Middleton, if the powers of the bill were granted, would obtain a monopoly that would restrict the natural development of the company's light railways. In regard to the junctions to be made with the light railways, the Corporation could, under the bill, only act with the consent of the owners of those lines.

Mr. D. BOYLE, chairman of the Manchester Tramways committee, gave evidence bearing out the statements of counsel. He said the consideration to Middleton for the 21 years' lease arranged for was, that the interest and sinking fund on the capital involved in the construction of the lines would be met during the term of the lease by Manchester, and at the end of 21 years the tramway would become the property of Middleton. If Middleton desired to acquire the light railways of the British Electric Traction Co, they would have to buy them, whereas the tramways would pass to them at the end of 21 years without payment.

Mr. F. ENTWISTLE, clerk to the Middleton Council, said, with regard to the objections raised by the British Electric Traction Co., the routes of the proposed lines were not natural extensions of their light railways. The tramways need not be joined with the railways, and would not interfere with them. In regard to the suggestion made by the company that they were the proper people to become the lessees of the

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Middleton tramways, his Council repudiated the idea as unwarrantable. His corporation had prevented, as far as possible, connection between these tramways and the light railways because it would enhance the value of the light railways in case of purchase. Middleton would rather deal with Manchester. They thought that the company had no right to say to them what they should do in tramway matters. The company were not ratepayers in Middleton.

Mr. McELROY, general manager of the Tramways of the Manchester Corporation, said the Middleton agreement was on all fours with agreements under the Act of 1899, and was, he considered, only a fair one to the Manchester Corporation.

The promoters case being closed,

Mr. WORSLEY TAYLOR, Q.C., said the point raised here was important to tramway and light railway companies, and the case was one of extreme hardship to the British Electric Traction Co., who had relied on the grant of powers made to them under the Light Railways Act so long as they did their duty to the public. There could be no doubt as to the willingness and capacity of the company to carry out its engagements. The company had a large capital and was paying a good dividend on their undertakings in various parts of the country. They were now constructing the 8 miles of light railway running into Middleton, and were in a position to construct and work any necessary extensions. Manchester and Middleton, knowing where the company's light railways would end, had wilfully cut short their proposed tramways from the light railways by about the width of a street to prevent the value of the light railways being enhanced by a junction with the tramways, and so had conspired to defeat the interests of the public for 25 years in order that, at the end of that time, Middleton might not have to pay quite so much for the purchase of the company's light railways. The proposals of the bill would be of advantage, not to the public so much as to Manchester, as it would extend the Corporation's monopoly right out into the suburbs, and establish municipal trading on a large scale. He asked the Committee not to sanction this agreement between Manchester and Middleton, which would tie up this district by preventing these small links being made between the light railways of the company and the tramways for the next 21 years, irrespective of the necessities that might arise in that time.

On Wednesday the committee decided that the preamble of the bill was proved, but postponed the consideration of clauses.

RAILWAY COMPANIES AND ELECTRIC TRAMWAYS.

In the House of Commons on Tuesday Mr. T. M. HEALY asked the President of the Board of Trade whether the Great Northern Railway Co. (Ireland) disputed that the construction of their electric tramway from Sutton to Howth was illegal; and, if it was not in accordance with the act, had the Board of Trade ever previously sanctioned a line made contrary to statutory provisions?

Mr. RITCHIE said the first statement of the hon. member was correct. As to the second, the Board of Trade had no power either to sanction or not to sanction the line. They could not determine the legal questions at issue. All the Board had to do was to look after matters of safety. He further stated that it was not part of the functions of the Board of Trade, where the act of Parliament stated that the line should be laid on a level with the road, and when it was laid 1½ft. above that level, to state whether the line was legal or illegal. Their functions were confined to the question of safety.

Mr. HEALY stated that he would at another time ask the Attorney-General if he would consider whether an indictment should not be presented against the company in regard to the line.

IMPERIAL TELEGRAPHS.

In the House of Commons on Monday Sir E. SASSOON asked the Secretary to the Treasury if he would state the composition of the departmental committee on the system of cable telegraphs of the Empire, and the scope and terms of its reference.

Mr. HANBURY replied that the terms of reference were—

"To inquire into the present system of telegraphic communication between different parts of the Empire, and to consider in what respects it requires to be supplemented, to investigate the relations between private cable companies and the Imperial and Colonial Governments (including the Government of India), the amount of control at present exercised by these Governments, and the policy which should be pursued by them in future, especially when new concessions are sought; to examine existing rates; to report how far they are fair and reasonable, and if not, how any reduction can be effected."

The Committee would consist of Lord Balfour of Burleigh, the Postmaster-General, the Secretary of the Treasury, the Under-Secretaries for India and the Colonies and two members from the Intelligence branches of the Admiralty and War Office.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

Proceedings of the Forty-Eighth Meeting of the American Association for the Advancement of Science, held at Columbus, Ohio, August, 1899. (Easton, Pa.: The Permanent Secretary.)

"Mesure des Grandeurs Electriques dans les Circuits à Courants Alternatifs." By O. de Bast. (Liège: L. de Thier.)

"Traité de Magnétisme Terrestre." By E. Mascart. (Paris: Gauthier-Villars). 15fr.

"The Official Gazette of the United States Patent Office." Nos. 1 and 2, Vol. XCII. (Washington: Government Printing Office.)

LEGAL INTELLIGENCE.

Brockie-Pell Arc Lamp (Ltd.) v. Johnson & Phillips.

Yesterday, before Mr. Justice Kekewich, in the Chancery Division, a motion was heard to commit defendants for alleged breach of part of an order made by his lordship on April 22, 1899, in the following terms:—

"It is ordered that the defendant, Walter Claude Johnson (trading as and sued as Johnson and Phillips), his servants, agents and workmen, be restrained during the continuance of letters patent No. 4,248 (1892), No. 15,510 (1893), No. 12,932 (1894), and No. 23,825 (1894), or any of them, or during any extension of the respective terms thereof, from manufacturing, selling, or exposing for sale Victoria lamps, one of which is now in the custody of the plaintiffs, and is marked A. M. C. & Company & G. W., and from in any other manner infringing the said letters patent; but this order is not to apply to any Victoria lamps manufactured or sold by the defendant and bearing serial numbers" (the numbers of 200 of these lamps follow).

Mr. Warrington, Q.C., and Mr. J. C. Graham appeared for plaintiffs, and Mr. Fletcher Moulton, Q.C., and Mr. A. J. Walters for defendants.

Mr. WARRINGTON said the notice of motion asked that the Court be moved to commit defendants for breach of that order by selling certain lamps known by the name of "Victoria" lamps. The action in which the order in question was made was one for infringement of certain patents, and restrained defendants during the continuance of plaintiffs' letters patent from manufacturing, selling, or exposing for sale Victoria lamps, and defendants were not in any other manner to infringe the said letters patent. But the order was not to apply to any Victoria lamp manufactured or sold by defendants which bore the serial numbers mentioned in the order. The order then went on to state that all further proceedings be stayed except for carrying the order into effect. His lordship, said counsel, would see that the order was in two parts. It first restrained defendants from manufacturing or selling or exposing for sale Victoria lamps; and, secondly, it restrained defendants from infringing the plaintiffs' letters patent. The present motion was not founded upon the second branch of that order but on the first, and if he (counsel) failed to satisfy his lordship that the lamps the defendants had been selling were within the true meaning of the order "Victoria" lamps, then except to two of the lamps, which were admittedly Victoria lamps, the motion would fail. On the present notice of motion he asked his lordship for relief and to say that certain lamps which it was admitted had been sold by defendants were Victoria lamps. The notice referred to lamps of certain numbers. The first two of those were admittedly Victoria lamps, and they were not included amongst the serial numbers mentioned in the order and excepted in the injunction. The consequence was that on those two lamps the plaintiffs were clearly entitled to have an order to commit defendants who had committed a breach of that order. The only answer on that part of the case was that defendants had sold those two particular lamps to certain third parties before the date of the order, and had re-purchased them and sold them again. He (counsel) submitted that that was no answer as defendants were restrained from selling any Victoria lamps except those mentioned in the order. The defendants had no right to sell these lamps again. Plaintiffs could not prevent third parties from selling the lamps, but they could prevent defendants from selling them. The order restraining defendants from selling these lamps was absolute. Amongst the numbers mentioned in the notice of motion were Nos. 16,337, 16,354 and 16,338. That referred to lamps to which defendants had applied the same serial numbers that were mentioned in the order, and had sold them. Plaintiffs' case was that the defendants had made certain slight and immaterial changes in those lamps for the purpose of being in a position to say they were not Victoria lamps. The changes which had been made were immaterial and trifling, which left the lamps substantially what they were before. The only lamp which his lordship would be troubled with was that numbered 16,338, which hung on a frame in the court, and it had been agreed between the parties that all the other lamps except the first two were identical with the lamp No. 16,338. No. 16,371 also bore one of the serial numbers mentioned in the order, but those were in the same position as those he had mentioned, and were sold after the 200 lamps mentioned in the order had been sold. With regard to the others, Nos. 16,839 and 16,863 were sold to a Mr. Hawkins.

Mr. MOULTON: We admit the sale of all these.

Mr. WARRINGTON: Well, all your lordship will be troubled with is to say whether No. 16,338 was a Victoria lamp or not. He would first point out in what way 16,338 was said to differ from the Victoria lamp. The construction of the Victoria lamp was as follows: It was only necessary for present purposes to state that it started off with a brass plate, and from that there was a central column of brass, which was fastened on to a thing which was sometimes called a U-shaped plate. On to the two straight uprights was fastened the top plate. Two vertical bars were fastened on to the top plate. The object of the U plate was to support that which regulated the rising and falling of the lever which controlled the two rods which lifted and depressed the upper part. The object of the lamp was to keep the upper and lower carbons, so as to let the electric current pass and keep the sparks steady. At the bottom there was a little guide lever, but the lamp would work just as well without it. It was of no importance as to the action of the lamp. The only other thing he need mention with regard to the construction of the lamp was in reference to the two rods which supported the globe. The globe was attached by a button on the rim and to one of the rods by a kind of hinge. When it was desired to get at the carbons the rim was unhooked from the bottom and the globe dropping on one rod could be made to swing outwards so as to be quite free of the two carbons. That was the Victoria lamp. Now, he would take his lordship to the other lamp which was said to differ from it. That started exactly in the same way with the plate and

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with the central column. Then they had the same horizontal bars and the same upright bars up to within an inch of the plate. What defendants had down was this: Instead of carrying the uprights to the top they had substituted for them a column and fastened it on to the horizontal plate. It did not make the least difference mechanically which rod it was supported by. They had done the same thing on the other side and connected the two rods. That did not affect the construction in the least. If the two rods were away the action would be the same as if they were there. There was another difference which defendants had made in this part of the lamp and that was the omission of the little guide lever. Defendants had made other slight variations in the construction of their lamp which were merely colourable variations in order that they might say they were not selling Victoria lamps.

Counsel then read affidavits in support of his case.

Mr. DUGALD CLERK, in his affidavit, stated that he had carefully examined and compared the electric arc lamp No. 16,338, which was typical of all defendants' lamps, with the Victoria arc lamp. In his opinion, the lamps were substantially the same. There were some trifling differences in the structure of the two lamps; but they were so trifling that they could not be said to make No. 16,338 a different lamp from the Victoria lamp.

Mr. BROCKIE stated that in his opinion the lamps were in all respects substantially identical.

Mr. WALTER then read defendants' affidavits.

Mr. W. CLAUDE JOHNSON said he was in a large way of business in the manufacture of electric arc lamps and other electrical appliances. For several years past he had employed a competent manager in his arc lamp department, who was an engineer of great experience. Upon the order of April, 1899, being made he gave this gentleman instructions to carry out the order. Personally he had never designed, made or sold any lamp in breach of that order. To his knowledge there had been no evasion of the order of the Court.

Mr. W. B. ESSON, defendants' engineer, deposed that the order of April, 1899, had been carried out; 200 lamps had since been sold, but none of them were Victoria lamps or infringed plaintiffs' patent, and were not constructed in breach of the injunction. When the order was made he at once made it his business to reconstruct the arc lamps of defendants so as not to include the structural features alleged by plaintiffs to comprise their claim, and did not infringe plaintiffs' patent. None of the features described and specifically claimed by the plaintiffs were included in these lamps. The points of difference were such as to place the lamps wholly outside the scope of plaintiffs' specification. The mere repetition of certain of the numbers mentioned in the order could not injuriously affect the plaintiffs. The Victoria lamps referred to were originally sold by defendants in September, 1897 and 1898. In respect of these lamps royalty had been paid to plaintiffs under the agreement of 1899. The said lamps had been returned to the defendants and re-issued in the ordinary course of business.

Prof. S. P. THOMPSON, in his affidavit, said he had been familiar for some time with the lamps manufactured by plaintiff company and by defendants. He had examined the Victoria lamp and the No. 16,338 and found two substantial and complete differences between them. Plaintiffs claimed infringement by defendants in the employment of a regulator and the focussing mechanism, and in the use of a brake wheel controlled by a loaded band. He had carefully examined the lamps with regard to these points. In the lamp 16,338 there was no use of a spring brake, supplementing the main brake, which there was in the Victoria lamp. There was a substantial difference between the mechanism of this lamp and that of the plaintiffs'. The defendants had returned to the old use of two guide-tubes. The particular use of a single tube was that it allowed the globe when lowered to swing open on one side. That advantage was not possessed when the two tubes were used. There was no loaded band in No. 16,338, but, instead, a different brake. Having examined the Brockie-Pell arc lamp, he came to the conclusion that defendants' lamp did not contain any of the combinations or detailed mechanism which the plaintiffs claimed to be covered by their patents. In those respects in which 16,338 differed from the Victoria lamp, it differed from the admission of features of old and well-known matters of construction. In respect of the features which the lamps had in common, defendants were using nothing that was not common to all the world, and well known prior to 1892.

Evidence was then called.

Mr. BROCKIE, cross-examined by Mr. Fletcher Moulton, said that his affidavit of February, 1898, was in an action for infringement of letters patent. He had applied for an interim injunction. In paragraph 4 the invention claimed the combination of a spring brake supplementing the main brake on the regulating wheel. That was one of the points in which he alleged that the Victoria lamp made by defendants infringed his patent. As a matter of fact, the lamp he complained of had no spring brake supplementing the main brake. The letters patent 12,982 of 1894 were granted in respect of an invention of an arc lamp in which the crown plate was fixed to the top U-shaped piece, within which the brake and focussing wheels were placed, In that patent for the first time he showed this U-shaped piece attached to the top piece and holding the wheels. That he considered novel at the time. The globe gear was supported by a single tube attached at its upper end to the base plate. It also acted as a guide to the carbon rods. This last was not to be found in the lamp complained of. The U-shaped frame was practically the same in both lamps. The whole of the lamp was quite free to the public, except the point he had mentioned. In the letters patent 23,825 of 1894 the claim was for controlling the great wheel or wheels by means of a loaded band in combination with levers. In the lamp he complained of the band was loaded by means of a heavy weight attached to it. Band brakes were common for years. The releasing of the brake was the main thing in the patent.

Mr SHRIMPTON said he had negotiated the settlement of the action referred to. In making the settlement he intended to clear up all the past disputes. The payment of £1,675 was in respect of the lamps previously made by defendants. He had never made any attempt to interfere with the user by the public of lamps included in the settlement.

Mr. MOULTON said it was claimed that defendants' lamps did not differ from plaintiffs, or if they did it was in matters perfectly immaterial. He admitted that if defendants were repeating that which had been complained of he could not go back on the question of whether it was an infringement of the Victoria lamp. If it could be said that defendants' lamp was identical with plaintiffs', it would support plaintiffs' case. But the moment he left identity his case disappeared. There was no such thing as substantial identity in the abstract. You had to consider what were the material points by which you were to judge or not judge of the identity. For instance, it might be said that defendants were not to sell lamps of a particular size or strength. Then if you could show that they were selling lamps of the size or strength the case would be proved. But here the action was for infringement. Under these circumstances identity was destroyed if once you showed that any points which were taken as material were points in which the lamps differed. There were differences between the two lamps, and he submitted the plaintiffs had not made out a case to justify the granting of a committal order.

His LORDSHIP said that in his opinion there was substantial identity between the two lamps—the Victoria lamp and the lamp No. 16,338. The endeavour to distinguish them had been slight. Certain differences had been pointed out, but it was clear that these differences were mere differences in detail, and did not interfere with the real identity of the lamps. He had no doubt that they were adopted in order to enable defendants to put on the market Victoria lamps substantially like those mentioned in the order. It seemed to him that plaintiffs had proved their case. It was useless to go through the differences in detail, because to his mind the evidence was overwhelming that the differences were only differences in detail. What he had before him in No. 16,338 was substantially the Victoria lamp. He had no doubt that the defendants had been attempting to evade the order of the Court if possible. They had not succeeded. There would be an order for committal, and defendants must pay the costs.

Mr. MOULTON asked for a stay of the order pending an appeal.

His LORDSHIP said the order must be drawn up, but a stay would be granted if an immediate application were made to the Court of Appeal.

Mr. MOULTON said he would apply at once.

Attorney-General v. The National Telephone Co. (Ltd.)

In the Queen's Bench Division on Tuesday this case came before Justices Darling and Kennedy. The Attorney-General, on the relation of the London County Council, filed an injunction against the National Telephone Co. for opening and breaking up streets within the administrative county of London without the consent of the County Council and the licence of the Postmaster-General. The company contended that in what they had done they had been acting within their legal rights. The action was fixed to come on for argument, but after a brief consultation between counsel a settlement was arrived at.

The Attorney-General, the Solicitor-General, and Mr. F. T. Daldy appeared for the Crown; and the defendant company were represented by Mr. Joseph Walton, Q.C., and Mr. Roskell.

The ATTORNEY-GENERAL said Mr. Walton had communicated with the Solicitor-General and himself, and they had arranged the terms of settlement if their lordships would allow the information to be disposed of in that manner. The terms were (1) a declaration (in the terms of paragraph 1 of the information) that the defendants were not entited to lay any pipes, wires, cables, or apparatus for telephonic purposes under any of the streets in the county of London unless by licence of the Postmaster-General under the Telegraph Acts, and with the consents required by those acts, (2) an injunction restraining the defendant company, their officers, servants, and agents, from opening or breaking up any street or public road within the meaning of the Telegraph Acts, 1863 to 1899, within the adminstrative county of London, or any part of such street or public road for the purpose of extending the company's present system of underground pipes and wires, &c., without the authority of the Postmaster-General and the consent of the London County Council for such purposes described by the Telegraph Act of 1892, and (3) the defendant company to pay the taxed costs.

Mr. WALTON, Q.C, said he assented to these terms, by which they put an end to a long controversy on the subject, in the interest both of the telephone company and of the Crown.

The Court sanctioned the agreement.

Crystal Palace District Electric Supply Co.

In the Chancery Division on Saturday, Mr. Justice Kekewich heard a petition by shareholders for a reduction of the capital.

Mr. WARRINGTON said the company had a fully-paid up share capital of £28,586. It was proposed to reduce that to £2,858, a loss of 18s. per share. There was a loss in working of £14,885. 16s. 5d., and in depreciation of assets of £11,000, making £25,885. In addition there was £1,600 appearing in the accounts of last year as "preliminary expenses and losses on working" which had been struck out in the last accounts. The affidavits filed in support of the motion set forth that it was almost impossible under existing circumstances for the shareholders to receive interest for many years to come. For three years the undertaking had been carried on by money provided for working capital. The proposed reduction could be no hardship.

Mr. RENSHAW, Q.C., said the reduction would operate unfairly on the shareholders. There was no sufficient evidence as to the loss in carrying on the concern which would justify the reduction of capital. The affidavits dealt entirely with generalities, and there was no detailed statement whatever as to the loss.

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His LORDSHIP said some companies spent enormous sums in connection with the floating of their undertaking. Here it had been satisfactorily proved that what was put in as preliminary expenses were not those at all. Now that a valuation had been made they knew that depreciation and actual loss of capital between them made up the full amount to which it was proposed to reduce the capital of the company, which had been valued as a going concern. Mr. Chapman, the only dissentient shareholder before the Court, held 40 shares. It was said that this interest was so small that it ought to be disregarded. He was not prepared to take that view. But in this instance there was no doubt the proposed reduction of capital would get rid of the burden on the company, and might be the means of making it a success. He sanctioned the resolution, and Mr. Chapman's costs must be borne by himself and not by the company.

Simon v. Conze.

Mr. Justice Mathew and a special jury heard a case on Monday in which plaintiff sought to recover damages for an alleged breach of an agreement by defendant not to canvass plaintiff's customers. Defendant denied the breach, said he was entitled to act as he had done, and counterclaimed for £50. Plaintiff, an electrical engineer, carried on business as Simon & Berry, in Upper Thames-street. Defendant was formerly his partner, but was now partner in another firm. The partnership between plaintiff and defendant existed from 1894 to 1896. About the beginning of September, 1896, defendant, it was alleged, went to Germany, unknown to his partner, and when he came back told his plans to the plaintiff, and a dissolution of partnership was agreed on. A dissolution agreement was duly entered into, reciting that £200 of defendant's share in the business was to remain on loan. Defendant was not, within the City of London or within 2 miles thereof, for five years, to carry on a business of a like or similar character to that hitherto carried on between the parties, and was not to directly or indirectly canvass or endeavour to obtain customers from among the customers of the old firm of Conze & Simon, or who might hereafter be the customers of Simon. About six months afterwards, Simon took Berry into partnership, and the business was developed. Friction occurred between Simon, Berry & Co. and defendant over an agency for a German firm (Messrs. Busch & Co.) which was then held by Simon, Berry and Co. This agency was terminated in July, 1899, and a Mr. Eich appointed. Messrs. Busch, in September, 1899, sent out a circular to plaintiff's customers announcing the transfer, and a second circular was sent out by Eich. Both these circulars, it was contended by plaintiff, were in contravention of the arrangement under which the partnership between Conze and Simon was dissolved. The effect of their publication was of a damaging character to plaintiff's business. After hearing the correspondence,

His LORDSHIP suggested an arrangement should be come to.

Mr. NEVILLE, for defendant, said other actions were pending before the Official Referee.

Ultimately the case was settled on terms not stated, and the jury discharged.

Mercier's Patents (Ltd.) v. St. Helens Cable Co.

At Manchester County Court on Monday plaintiffs sought to recover £50 damages from defendants for breach of contract and non-delivery of certain electric cables.

Mr. SPENCER HOGG, for the plaintiffs, said that in November, 1899, defendants agreed to supply plaintiffs with two lengths of vulcanised rubber cable. A portion of the cable was delivered in December, but defendants then declined, as plaintiffs alleged, to deliver the remainder on the original terms, but only on condition that payment was made for the first portion of the cable, and that the second portion was paid for in advance. In consequence, plaintiffs alleged they were unable to execute a contract for the electric lighting of Winstanley Colliery, Wigan.

After plaintiffs' case had been closed, Mr. RHODES, for defendants submitted that though there had been a breach of contract the damages sustained were very slight.

The JUDGE said he did not understand why the action was contested, and gave judgment for plaintiffs for £21 and costs.

Re Westminster Automatic Telephone Syndicate.

On Wednesday a petition for the winding up of this company was dismissed, the petitioner being ordered to pay the taxed costs.

The Belle Isle Cable.—A correspondent of the *Financial News*, writing from St. John's, Newfoundland, as to the decision of the Canadian Government to lay a cable to Belle Isle, at the Strait of Belle Isle entrance to the Gulf of St. Lawrence, points out that such a line will inevitably be broken by icebergs in winter, and probably could not in that case be repaired until the following June. As a station could be established on the mainland within 10 miles of the island, the correspondent very reasonably asks why a wireless telegraph service should not be established, and urges the necessity, in the interests of shipping, for the land telegraph system to be extended on both sides of the Strait, so that prompt communication in case of shipwreck should be available. The wreck of the "Scotsman" last October, and of many other vessels in the neighbourhood, shows the great need for such telegraphic connection.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Barnstaple.—The Council is about to discuss the question of carrying out the terms of their provisional order.

Birmingham.—The Council have confirmed the purchase of the old general hospital for the use of the electrical department for £23,000.

Bradford.—An inquiry was held here on Friday into the application of the Council to borrow £56,000 for extension to the electricity works. The town clerk (Mr. F. Stevens) appeared in support of the application, and said that since 1888 £230,880 had been borrowed for electricity supply. Of the present loan £5,100 was for extension of the buildings, and the remainder for machinery, including four water-tube boilers, with mechanical stokers, &c. (£8,560), 2,600 H.P. steam dynamo (£9,500), cooling towers, fans, pumps, and piping (£6,000), battery (£3,000), mains (£15,000), and meters (£4,500). The city electrical engineer (Mr. R. A. Chattock) gave technical details. There was no opposition.

British Guiana.—There are 560 subscribers to the telephone system in Georgetown. The subscription is £5 per annum for business premises and £2 for private houses. A telephone exchange is also established at New Amsterdam.

Buenos Ayres.—A concession has recently been granted for a line of underground electric tramways between two railway stations in this city situated at the extreme points. The company which has secured this concession has also obtained powers to construct other electric lines in and about the city area. There are 39 miles of electric tramways already working. The concession above referred to is, it is stated, being exploited in Europe and a company is being formed to work it.

Croydon.—The Council recently advertised for tenders for the reconstruction of the present tramway track and the construction of new tramways, and the paving of the roads. The Council have decided not to accept any of the tenders received, but will carry out the work by direct labour.

Dudley—Sedgley Electric Tramway.—Trial trips have taken taken place on this line, and the Board of Trade inspection will shortly take place,

Electric Light Notices.—Notices to local authorities of intention to apply for provisional electric lighting orders have been given as under :—

For *Alnwick*, Northern Counties Electricity Supply Co. and North British Electricity Supply Co. Both companies are to attend at the next Council meeting to explain their proposals.

For *Blackwell* (Notts), Shirebrook Colliery Co.

The *Beaumaris, Berkhampstead, Bishop Stortford, Blairgowrie Brighouse, Cannock, Carnoustie, Chichester, Crieff, Cumnock* (N.B.), *Dorchester, Helensburgh, Kirriemuir, Largs, Matlock Bath, Newburgh, Newport* (Dundee), *Pontefract, Richmond* (Yorks.), *St. Andrews* (N.B.), *Stranraer, Tewkesbury*, and *Worsboro'* local authorities have received notice from the North British Electricity Supply Co.

South Lancashire Tramways Co. are anxious to obtain powers for supplying electric current for lighting, and they have intimated to the *Ashton* Town Council that they intend to apply for a provisional order.

Blackburn Parliamentary committee have served notices upon the local authorities of *Livesey, Pleasington, Rishton, Wilpshire*, and *Witton* (*Lancs.*)

Middlesex & Hertford Electric Lighting & Power Co. have given notice to the *Cheshunt* District Council.

The Wycombe (Borough) Electric Light & Power Co. has served notice on the *Chesham* Council.

The United Electric Light & Traction Co. have applied for powers for *Cirencester, Esher, Spalding* and *Yeovil*.

The Urban District Councils of *Clayton-le-Moors, Harwood* and *Rishton* are jointly considering an application for consent to a provisional order.

Messrs. Crompton & Co. propose to apply for an order for *Dulkeith*.

Dorchester Town Council have received notices from the North British Electricity Supply Co., the Urban Electric Supply Co., Edmundson's Electricity Corporation, and the Bournemouth & Poole Electricity Supply Co., but all are to be opposed by the Council, who have resolved to retain electric lighting powers in their own hands.

Mr. E. H. Shaw has given notice in regard to *St. Margaret's* (Dover).

For *Dunfermline*, Urban Electric Supply Co.

Enfield District Council have received various notices of intention to apply for electric lighting powers, but the Council have resolved to themselves apply for an order.

Esher and Ditton District Council have received notices from the Twickenham and Teddington Electric Supply Co. and the United Electric Light & Traction Co.

A proposal by the Northern Counties Electricity Supply Co. to obtain a provisional order for *Filey* (Yorks.) is to be opposed by the Council.

Although the *Friern Barnet* Council has resolved to apply for a provisional order, the North Metropolitan Electrical Power Distribution Co have also intimated their intention to apply for electric lighting powers.

The *Foots Cray* (Kent) Parish Council have resolved to apply for a provisional order.

The Midland Corporation for Power Distribution (Ltd.) have notified the Walsall Rural Council of intention to apply for electric lighting powers in *Great Barr*. The Company has also served notice on the *Tettenhall* Council,

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Finchley District Council will oppose a threatened application by a company for a provisional order.

The North British Electricity Supply Co. and the United Electric Light & Traction Co. have served notices on the *Gainsborough* Council.

The Northern Counties Electricity Supply Co. have notified the *Guisborough* District Council of their intention to apply for electric lighting powers.

Ham District Council have referred notices from Edmundson's Electricity Corporation and the Richmond Electric Light & Power Co. to the Highways committee.

Messrs. J. W. Manley & Co. will apply for a provisional order for *Herne Bay*.

Johnstone (N.B.) Town Council have received notice from the British Schuckert Electric Co.

The Electric Lighting committee of the *Kingstown* (Dublin) District Council is considering a notice to apply for a provisional order.

Notice has been given by the North Counties Electricity Supply Co. to the *Loftus* District Council.

For *Lyndhurst* (Hants) Lyndhurst Electric Lighting & Traction Co.

Although *Malvern* District Council obtained a provisional order in 1890 nothing has yet been done to comply with its provisions, and the United Electric Light & Traction Co. have now notified that they intend to apply for an order. The matter has been referred to the Gas committee—the committee which has hitherto had charge of electric lighting matters.

The *Molesey* (Surrey) District Council have received notice from the Twickenham & Teddington Electricity Supply Co.

Pudsey District Council intend to apply for electric lighting powers and to oppose the threatened application by the Northern Counties Electricity Supply Co.

The Northwood Electric Light & Power Co.'s application for *Rickmansworth* is to be opposed by the District Council.

Rye Town Council will oppose a proposed application for a provisional order.

The Northern Counties Electricity Supply Co. have intimated to the *Shildon* (Durham) Council that they intend to apply for a provisional order, and the matter is under consideration by the Electric Lighting committee.

Owing to the receipt of a notice the *Skipton* District Council have resolved to themselves apply for electric lighting powers.

Stourport Council have conditionally approved the proposed application of the Kidderminster & Stourport Electric Tramway Co. for a provisional order.

The *Stratford-on-Avon* Town Council have appointed a committee to report on a notice from a company which proposes to apply for a provisional order.

Swanage District Council have referred communications from the North British Electricity Supply Co. and the Bournemouth & Poole Electricity Supply Co. to the Works committee for consideration and report.

The County Electricity Co. has served notices on the *Wanstead*, *Woodford*, and *Buckhurst Hill* (Essex) District Councils.

The British Electric Traction Co. will apply for electric lighting powers for *Warwick*.

The General Purposes committee of the *Worsley* (Yorks.) Council are considering a notice of intention to apply for a provisional order.

Electric Light and Traction in Victoria.—The Ballarat Corporation have sanctioned the proposal of the British Insulated Wire Co. to form a local company to acquire the tramways and establish electricity works for supplying current for lighting, traction and power purposes. The new company will be styled the Electric Supply Co. of Victoria. It is stated that similar proposals have been approved by the Bendigo and Eaglehawk local authorities.

Exeter.—The Council has approved an important report from the Electric Lighting committee in favour of the erection of new electricity works in accordance with the recommendation of the borough electrical engineer (Mr. H. D. Munro). The scheme, estimated to cost £41,500, was submitted to Mr. T. P. Wilmshurst, of Derby, who reported favourably upon it. Particulars of the cost of the new station are as follows:—

For a building to receive plant of 3,000 H.P. capacity, and including the supply and erection of plant of 1,500 H.P. ...	£33,500
Site, say	2 000
Altering existing plant for frequency of 50	2,500
Moving existing machinery to new site	500
Main feeders	3,050

A lengthy report was also presented by Mr. Munro on the proposal to adopt a scheme of assisted wiring of consumers' premises, a proposal which the Council were recommended to endorse. The period for repayment of the instalments of capital cost by the consumer was fixed at three years. The chairman of the Electric Lighting committee (Ald. Domville) said that when the electricity works were taken over from the old Exeter company in 1896, they were 150 consumers, representing the equivalent of 7,300 8 c p. lamps. In 1898 the numbers were 300 and 14,000; in 1899 there were 353 and 18,000, and at present there were 400 consumers using 19,800 lamps. Those figures showed that it was absolutely necessary to provide a station adequate to supply the increasing demands. The demand for motive power was increasing as confidence in their methods was assured. The Council had also practically decided to take over the tramways, and they would probably extend the service and consider the adoption of electric traction. The proposed site was a convenient one, and the electrical engineer and the surveyor were of opinion that it was adequate for their requirements. With regard to assisted wiring, it was found that a profitable income was to be made from domestic lighting, and it was desirable that small householders should be induced to take electric current. The present proposal was that the occupier of the house should be empowered to submit three tenders for the wiring from tradesmen, one of which should be accepted by the Council, who would pay the tradesmen, and receive the amount again, with small interest, from the consumer, whose payments would be extended over three years. The committee's report and recommendations were adopted.

Glasgow.—The accounts of the electricity department for the year ended May 31 have been issued. The revenue was £59,762. 2s., of which £55,470. 17s. 2d. was from sale of current to private consumers, and £4,291. 4s. 1d. from public lighting. Last year the figures were £41,639. 6s. and £2,501. 18s. 7d., giving a total of £44,141. 4s. 7d., or an increase of £15,620. 17s. 5d. for the past year. The total expenditure was £38,181. 6s. 10d., leaving £21,580. 15s. 2d. to be carried to profit and loss. Last year the expenditure was £31,534. 2s. 3d., the amount set apart for depreciation £7,520. 18s., and to profit and loss £12,607. 2s. 4d. Borrowing powers amount to £700,000, and £628,500 has been borrowed at 3¼ per cent. Of this amount £11,500 has been repaid, leaving the department with borrowing powers to the extent of £60,000. The number of units generated last year was 3,401,731, against 2,619,019 in the previous year; the number supplied to private consumers was 2,566,016 units, against 1,885,902, an increase of 680,114, for public lamps 258,334, an increase of 30,200.

Hornsey (London).—Mr. Robert Hammond has been appointed consulting engineer to prepare and carry out an electric lighting scheme for this district.

Kiel (Germany).—The municipal authorities have entered into an agreement with the Siemens & Halske Actien Gesellschaft of Berlin for the erection of electricity works. The initial generating plant will consist of two 400 H.P. steam dynamos with a battery of accumulators.

King's Lynn.—The accounts of the electricity department for the year ended March 31 show a gross profit of £1,371. 14s. as the result of seven months' working, against which, however, must be set £1,366. 7s. 3d. for sinking fund and interest. Since the plant was opened in August last 126,496 units of current have been sold, producing an income of £2,536. 15s. 6d. Rental of meters has produced £31. 15s. 5d. and sale and repair of lamps £572. 9s. 7d. Of the income from the sale of current, £1,035. 12s. 9d. has been obtained from private consumers at 5½d. per unit and £1,501 2s. 9d. from public lighting. The demand for current is already far in excess of the capacity of the plant, but the Electric Light committee hope shortly to be able to satisfy all demands, and application has been made for sanction to borrow £10,000 additional for extensions.

Lancaster.—The Council on Tuesday decided to increase the price of electric current for private lighting in consequence of the increased price of coal. A report was presented by the Tramways committee recommending the Corporation to adopt the overhead trolley system on the local lines.

Light Railways.—An inquiry was held at Kingston-on-Thames on Monday into the application of the British Electric Traction Co. for an order to construct electric tramways in Kingston, Surbiton, Esher, and Thames Ditton. The local authorities interested, as well as the Surrey County Council, opposed the application, and the Commissioners refused to make an order.

The Board of Trade have approved the Southend-on-Sea and District Light Electric Railway order.

The promotors of the Warrington-Runcorn electric tramway have withdrawn their application for powers. The scheme will be presented in a modified form.

London County Council.—At Tuesday's meeting electricity loans were made to Battersea (£14,000) and Shoreditch (£30,000).

The Highways committee reported an offer by the British Westinghouse Company to sell to the Council for £900 the electric car shown in actual working at the recent Tramway Exhibition at the Agricultural Hall, London. Prof. A. B. W. Kennedy and the tramway manager (Mr. A. Baker) recommended that the offer be accepted, as the car, with some modification, would be available for use on the Council's lines when converted to electric traction, and would be useful when the specification for cars for the Council's electric lines was being prepared. A further offer was before the Council of the British Westinghouse Company to sell for £175 the permanent way, &c., used at the exhibition in demonstrating the facility and efficiency of the Westinghouse system. The committee recommended that both offers be accepted, and this was approved.

The Highways committee also reported on the subject of the further extension and doubling of track of the Council's tramways, the construction of new tramways of a total length of about 16¼ miles on the north side of the Thames, at an estimated cost of about £469,700, and for street widenings about £544,360; and on the south side of the Thames new lines about 12 mile

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in length at a cost of about £374,500, and about £449,400 for street widenings. It is proposed that those of the new lines which will be connected with the Council's (Northern) tramways (leased until Midsummer, 1910, to the North Metropolitan Tramways Co.), shall be constructed for horse traction, unless in the meantime effect shall have been given to the provisions in the company's lease relating to the conversion of the system to electric traction. The estimates provide, however, for rails of sufficient weight to permit of electric traction when that system is adopted on these tramways. An exception to this proposal is the tramway in the Archway-road, N., which will practically be an extension from the Council's tramway terminus in that road to the county boundary, and will probably be joined with the light railways which the Middlesex County Council is seeking powers to construct from that point to Finchley and beyond. As the Middlesex Council proposes to adopt electric traction for its light railways, the committee consider it expedient that the Council's new Archway-road line should be constructed for a similar system of traction. Those of the new lines which will be connected with the London County Council tramways undertaking, or which, being for the present detached from either undertaking, could be worked by the Council independently of any other system of tramways, it is proposed shall be constructed for electric traction. The committee's report gave the following estimates for the electric lines:—

Archway Tavern, £8,400 (current to be obtained either from the Islington Vestry's electricity station, or by arrangement with the Middlesex County Council). *Harlesden to Putney Bridge* (4 miles 7 fur.), £146,250. *Uxbridge-road to Shepherd's Bush-road* (3 fur.), £11,250. *Brook Green-road* (5 chains), £2,000. *Victoria Embankment* (Blackfriars to Battersea Bridge, 4 miles 3 fur.), £132,000. *Battersea Bridge to Putney Bridge*, £179,000. *Victoria Embankment* (Westminster Bridge to Westminster Bridge-road, 3 fur.), £11,250. *Chelsea Bridge to Lambeth Bridge* (1 mile 4 fur. 8 chains), £50,000. *York-road to Tooting* (2 miles 7 fur. 8 chains), £90,000. *St. John's Hill to Surrey Tavern* (1 mile 3 fur. 1 chain), £47,500. *Battersea Park-road* (4 fur. 8·8 chains), £18,500. *Camberwell Green to Forest Hill Station* (3 miles 4 fur. 6 chains), £107,000. *Goose Green to Peckham* (1 mile 4 chains), £31,500. *Southwark-street to Westminster Bridge* (1 mile 2 fur. 7·7 chains), £45,000. *Waterloo-road* (1 fur. 7·1 chains), £6,500.

It was recommended that the Council make application to Parliament next session for powers to construct the lines. Consideration of the report was adjourned for a week.

Manchester.—The Tramways committee have completed arrangements with all the local authorities outside Manchester, except Salford, for the running of electric cars through their districts. Negotiations are proceeding with Salford, and when these are completed there will thus be one uniform tramway system for Manchester and district. Manchester will provide the cars and supply electric current for all places except Salford and Stockport. The Corporation of the latter town provides the current only, and Salford will furnish its own cars and current. The committee have decided on the form of pole for Cheetham Hill-road. The pole selected has been designed by Mr. C. H. Wordingham, city electrical engineer, is of mild steel, and stands 25ft. above the ground. The poles will be 100ft. apart, and on every second pole an arc lamp will be placed. The committee have also selected for trial three types of seats for the cars.

The Watch committee have approved a report from the Fire Brigade sub-committee recommending that the Gamewell system of fire alarms be adopted in the city. It will be some time before the system is installed.

Mansfield.—Mr. Robert Hammond has been appointed consulting engineer in connection with the proposal to establish electricity supply and refuse destructor works.

Marylebone (London).—The question of the purchase of the Marylebone portion of the undertaking of the Metropolitan Electric Supply Co. was again under the consideration of the Vestry last week. The special Electric Lighting committee submitted the report of three delegates appointed to confer and instruct the Vestry's solicitor in opposing the Marylebone Electric Supply Co.'s provisional order, which was thrown out on second reading in the House of Commons. It was recommended that the Vestry empower the committee to conclude negotiations with the Metropolitan Company for the transfer of its undertaking under the West London (Marylebone) electric lighting order, it being a condition of the contract that the figures supplied by the Metropolitan Company be verified by a chartered accountant and expert electrical engineer to be employed by the Vestry. Mr. W. Sutherland, who moved the adoption of the report, stated that upon an estimated expenditure of £500,000 in 1901 there would be a net profit to the municipality of £12,500, or a 2d. rate saved, after allowing 5½ per cent. interest on the £500,000, and 1 per cent. sinking fund. These figures were based on the profits shown by the company for 1900, up to June 20. He contended that if they took over the concern they ought to work at a considerable profit at once. They had no plant to lay down, and what was still better, no streets to pull up. It was the most advisable thing to conclude the negotiations. They had got the company down to the lowest price. The purchase money would be £400,000, and this sum could be borrowed. Dr. Fletcher Little seconded the motion, and Mr. Stringer criticised the report at considerable length. He was in favour of purchase if it could be done at a reasonable price. The sum they proposed to pay was prohibitive, and he appealed to the Vestry to pause before entering into it. The price they were going to pay was £916,666, or close upon a million of money, after making allowance for stock, redemptions, &c. They would be buying two sets of plant, a new set and an old set, which would be very little good. The station in Marylebone would be of very little use, it was principally used by the company as a distributing station, a great deal of current being obtained from other sources. Mr. E. Manville, the electrical expert, had told the old committee that the Vestry could not work the concern with the present generating station, and that they would have to expend £250,000 for this purpose. Further consideration of the question was adjourned.

Mexico.—The city of Hermosillo, on the Sonora river, with a population of 28,000, has well-equipped electricity works and current is supplied for both private and public electric lighting. Electric tramways traverse the town and extend to the adjacent mining districts.

Guaymas, a port on the Gulf of California, with a population of about 20,000, is also well lighted electrically, and has a system of electric tramways. The town of Guaymas is a rapidly rising one, and the harbour is one of the safest and best on the Pacific coast.

Monmouth.—An inquiry was held here last week into the application of the Corporation to borrow £28,000 as a supplementary loan for the combined electric lighting and drainage scheme.

Newfoundland.—The St. John correspondent of *The Times* states that Mr. Reid has transferred his extensive electric power franchises to a company with a capital of $1,000,000.

Para Rubber.—It is generally agreed that the best indiarubber at present on the market comes from Para, on the Amazon, collected from the seringueira variety of tree. Owing, however, to the abnormal unhealthiness of the districts in which it grows (the rubber gatherers perish in a very short time from fever) planters of rubber trees are advised by the British Consul at Bahia to turn their attention to the culture of the mangabeira and manicoba varieties of rubber plants exported from Bahia. Mangabeira grows almost in any soil in this State, and flourishes in quantities in sandy districts, where absolutely nothing else can be produced. In certain zones of the interior, fertile in good rich, red soil, the tree yields more than four times the quantity of milk than when growing on sandy lands. But notwithstanding these advantages, the manicoba tree shows advantages over all others that go to make it a commercial success. It is easily planted either from seed or saplings, grows in six or eight months in any kind of soil to a height of 6ft., and will begin yielding a considerable quantity of milk in about three years, far more in proportion than any other rubber tree in existence. One planter at Bahia has planted over 100,000 manicoba rubber trees, to be ultimately increased to 1,000,000 trees, and he expresses the full conviction that this industry will in a few years show extraordinary developments.

Pembroke (Dublin).—The Council have consented to the Dublin Corporation laying electric lighting cables through their district from the proposed Pigeon House Fort generating station to the city boundary.

Stourbridge.—The Destructor and Electric Power committee unanimously recommend the Council to retain their electric lighting powers, and to take immediate steps to put their provisional order into force.

Telegraphy in Argentina.—In order to meet the deficit in the National Telegraph department's budget for 1901 it has been proposed to impose a tax of 1c. a word on all messages passing over private telegraph lines.

Telephone Directory.—The National Telephone Co.'s directory of subscribers for 1900-1901 is issued. The great increase in the number of subscribers has necessitated resorting to a different shape for the new volume which is now made up in double columns in a much larger page. Even with this change the book is very bulky. There are 176,000 subscribers to the company's system.

The Post Office and the District Messenger Service.—The District Messenger Co. complain bitterly of the action of the Post Office in threatening to deprive the company of their licence to carry letters, which was granted by the Post Office to expire in 1903. The company allege that an attempt is being made to crush them out of existence in order to support the new telephone policy of the Post Office.

Tourist Guide to the Continent.—This is the time when those who have not already been away for a holiday are on the look out for a suitable spot. Those who find it necessary to seek other lands than their own cannot do better than secure a copy of the authorised guide to the Continent issued by the Great Eastern Railway Co., full of illustrations and interesting matter relating to places on the

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Continent served by the Great Eastern Company's system and its Continental ramifications. The book is published at 6d.

Outing.—On Saturday a party of 70 of the Bolton Corporation Gas and Electric fitters, accompanied by the chairman and members of the electricity committee, Mr. Arthur Ellis, the borough electrical engineer, and Mr. R. Baker, gas and electric fittings superintendent, held their annual outing at Castleton.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Central Electric Supply Co. invite tenders for dry back marine boilers with mountings, feed and drain pipes, &c. (or, alternatively, water-tube boilers). Specifications may be obtained from the general manager (Mr. F. J. Walker), 19, Carnaby-street, Golden-square, London, W., and can also be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to Mr. Walker by 10 a.m. of Aug. 20. An advertisement contains additional particulars.

Blackburn Corporation invite tenders for the supply and delivery of a traction switchboard. Specifications may be obtained at the office of the consulting engineers (Messrs. Lacey, Clirehugh & Sillar), 2, Queen Anne's-gate, Westminster, after 27th inst., and tenders must be delivered to the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Aug. 6. An advertisement contains further information.

Bradford Guardians invite tenders for an electric lighting installation at their workhouse. Specification may be obtained at the offices of the clerk (Mr. Thos. Crowther), 22, Manor-row, Bradford, after 30th inst., and further particulars are given in an advertisement. Tenders must be delivered at Mr. Crowther's office before noon of Aug. 13.

Bradford Corporation invite tenders for steel girder and steel trough rails and fish-plates. Tenders to town clerk by 28th inst.

Halifax Corporation invite tenders for mechanical stokers suitable for Babcock boilers. Particulars may be obtained from the borough electrical engineer (Mr. H. F. Street), Foundry-street, Halifax. See advertisement.

Halifax Corporation also invite tenders for combined steam engine and alternator, alternators, static transformers, induction motors, rotary converters, and three-phase extra high-tension switchboards. Tenders to town clerk by noon Aug. 6.

The *Pacific Cable* committee invite tenders on behalf of Her Majesty's Government, the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland for the manufacture and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cable between Vancouver and Queensland. Forms of contract, &c., from and tenders to Messrs. Clark, Forde & Taylor, 4, Great Winchester-street, London, E.C., by noon 14th prox.

Barnes District Council invite terms from "free" wiring firms for wiring premises. Applications to clerk to Council, High-street, Mortlake, S.W., before 6th prox.

Tenders are invited for the electric lighting of the business premises of the *Ashington Industrial Co-operative Society*, at New Hirst. Particulars from secretary.

Grimsby Corporation invite tenders for wiring their electricity works. Specifications from town clerk, to whom tenders by Aug. 8.

Dorking District Council invite offers for leasing their provisional order. Tenders to clerk by Aug. 30.

Salford Corporation invite tenders for laying cables, tramway feeders, and street lighting. Tenders to town clerk by Aug. 13.

Rugby District Council invite tenders for leasing their provisional electric lighting order (1898). Applications to clerk by Aug. 1.

Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment. Tenders to clerk by Aug. 31.

Torquay Council require tenders for additional generating plant. Tenders by Aug. 6.

The municipal authorities of *Moguer* (Huelva), Spain, invite tenders until Aug. 10 for the concession for the electric lighting of the town for 20 years. Tenders to el Secretario del Ayuntamiento.

Particulars are published in the *Madrid Gazette* of 20th inst. of a royal order approving conditions for the establishment and working of a telephone system in the town of *Ciudad Real*, Spain; 35 days are allowed for the presentation of tenders. The maximum time allowed is 20 years, and the successful tender will be that which stipulates the minimum time at which the property of the telephone service passes to the State.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Bridgwater Town Council for the supply and erection of electricity generating plant. The tenders are accepted subject to the Local Government Board sanctioning the necessary loan.

Section A.—Boilers.

Babcock & Wilcox (*accepted*)	£2,350 1 6
Crompton & Co. (Babcock)	2,383 0 0
Stirling Boiler Co. (watertube)	2,744 0 0
Tinkers, Limited (Economic)	3,567 0 0

Section B.—Steam Dynamos.

C. A. Parsons & Co. (Parsons turbine) (*accepted*)	£3,092 0 0
Ditto (Willans)	3,098 0 0
Thames Electrical Engineering Co. (Allen)	3,113 0 0
Ditto (Reavell)	2,905 0 0
Ditto (Willans)	3,185 0 0
General Electric Co. (Reavell engine)	2,709 15 0
Ditto (Willans)	2,944 15 0
F. Suter & Co. (Helios Co.) (Alley & MacLellan)	2,959 10 0
Lancashire Dynamo Co. (Alley & MacLellan)	3,048 0 0
Ditto (Browett)	3,088 0 0
Ditto (Belliss)	3,308 0 0
Thomas Parker, Limited (Willans)	3,365 0 0
Brush Co. (Willans)	3,370 10 0
Electric Construction Co. (Reavell)	3,382 0 0
Ditto (Willans)	3,590 0 0
Ditto (Belliss)	3,682 0 0
Clayton & Co. (Clayton)	3,434 0 0
Crompton & Co. (Willans)	3,442 0 0
E. Scott & Mountain (Scott)	3,520 0 0
John Fowler & Co. (Reavell)	3,537 0 0
British Schuckert Co. (Browett)	3,580 0 0
Mather & Platt (Willans)	3,583 0 0
Ditto (Browett)	3,643 0 0
Ditto (Belliss)	3,833 0 0
W. H. Allen, Son & Co. (Allen)	3,674 0 0
Ashton, Frost & Co. (Willans)	3,801 0 0
Siemens Bros. & Co. (Willans)	3,835 0 0

Section C.—Switchboard.

Hodgson, Wright & Co. (*accepted*)	£538 0	Verity's Limited	620 0
Evered & Co.	458 0	John Fowler & Co.	£639 0
Williamson & Joseph	514 0	P. C. Middleton & Co.	674 3
Lea & Warren	542 0	Clayton & Co.	678 5
Brook, Hirst & Co.	561 0	Crompton & Co.	698 0
General Electric Co.	575 0	Vaughan & Brown	767 0
J. D. F. Andrews & Co.	575 0	Mechan & Son	840 0
		Siemens Bros. & Co.	940 0

Section D.—Mains.

Western Electric Co. (*accepted*)	£8,301 19 5	Siemens Bros. & Co.	£10,913 4 11½
St. Helens Cable Co.	9,379 5 8	Oliver & Co.	11,311 15 0
W. F. Dennis & Co.	9,507 2 2	W. T. Henley's Telegraph Works Co.	11,442 0 2
Callender's Co	9,951 18 0	British Insulated Wire Co.	11,564 0 0
J. D. F. Andrews & Co.	10,844 19 11		

Section F.—Accumulators.

Hart Accumulator Co. (*accepted*)	£ 986	E.P.S. Co.	£1,369
Marquand Accumulator Co.	1,156	Chloride Electrical Storage Syndicate	1,402
Tudor Accumulator Co.	1,265	D.P. Battery Co.	1,446

Section G.—Crane.

Chatteris Engineering Co. (*accepted*)	£143 10	Mather & Platt	£155 0
Carrick & Ritchie	149 0	Carrick & Co.	158 0
		James Spencer & Co.	160 0

The following tenders have been received by the London County Council for wiring and fittings for the Fulham Fire Station :—

Tamplin & Makovski (*accepted*)	£235 4 6	Barlow Bros. & Co.	£243 0 0
Concentric & General Contract Co.	243 0 0	F. A. Glover & Co.	260 0 0
		F. J. Coleby	273 5 0
		G. E. Taylor & Co.	298 0 0

Beckenham Council have received tenders from the following firms for the "free" wiring of premises in the district: L. Tate, Chas. Peacock & Co., Buchanan & Curwen, Concentric & General Contract Co., National Electric Wiring Co., and Electric & General Engineering Co. The tender of Roger Dawson for wiring the institute at £240. 13s. 5d., that of Tamplin & Makovski for wiring the baths at £277. 4s., and that of Foster Bros. for the erection of a transformer station have been accepted.

The London County Council has accepted the tender of Mr. T. Scott Anderson (£8,700) for wiring and supplying fittings, &c., for the electric lighting of Horton Asylum. The building work in connection with the Horton Asylum station for the supply of electricity and water is to beundertaken by the Works Department of the Council.

Five Belgian firms competed for the contract for the establishment and equipment of a municipal supply station at Jumet (Belgium). Tenders ranged from 223,650fr. to 518,000fr., the lowest being that of the Société Electricité et Hydraulique of Charleroi.

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Bradford Corporation have accepted the following tenders for the supply of additional plant for their electrical undertaking, subject to the Local Government Board sanctioning the necessary loan: Cole, Marchent & Morley (two steam engines); British Westinghouse Company (two 1,000kw. direct-current generators); S. Z. de Ferranti (Ltd.) (switchboard); E. Newell & Co. (coal and ash conveying apparatus); Babcock & Wilcox (steam and feed piping).

Liverpool Select Vestry have accepted the tender of Messrs. Campbell & Isherwood for an electric lighting installation (about 100 lights) at the parish offices, Brownlow-hill.

APPOINTMENTS VACANT AND FILLED.

Bolton Corporation invite applications for the post of electrical engineer to take charge of their electric lighting and tramway undertakings. Further particulars are set out in an advertisement, and applications must be delivered to the town clerk (Mr. R. G. Hinnell) not later than 30th inst. The Corporation are offering a salary of £500 per annum, with annual increments of £50 to a maximum of £700.

Manchester Tramways committee require an experienced traffic superintendent. Applications to chairman of committee, Town Hall, Manchester, before 28th inst.

An assistant is required in the engineering department of the Merchant Venturers' Technical College, Bristol. Applications to registrar by Aug. 13.

Mr. Thomas Rolls, of Leicester Corporation electricity works, has been appointed chief generating assistant at the Poplar (London) electricity works.

Mr. S. C. Gibson, second engineer, has been appointed to the position of chief assistant at the Wimbledon electricity works, and Mr. Russell Hudson has been appointed assistant engineer. There were 47 applications for the latter position.

Mr. L. M. Jones, B.Sc., A.R.C.Sc., science master at St. Dunstan's College, Catford, has been appointed headmaster of the day school of the Birmingham Municipal Technical School at a salary of £300 per annum.

Mr. F. G. Richardson, of Nottingham, has been appointed Superintendent of postal telegraphs at Grimsby.

Dr. R. S. Clay, late lecturer in physics at the Birkbeck Institution has been appointed principal of the Wandsworth Technical Institute.

BUSINESS NOTICES.

Increase of business has for some time past required large additions to the works of the Blackman Ventilating Co., at Holloway, and the company is now concentrating and removing its central offices to 443, Holloway-road, London, N. The Fore-street offices will be retained for the London district engineering representatives, but all correspondence is to be sent to Holloway.

Messrs. Geipel & Lange have been appointed sole British agents for the Ward Leonard Electric Co., Bronxville, N.Y., U.S.A., whose manufactures include motor switches, circuit breakers, theatre dimmers, &c., &c. A large assorted stock will be kept in London.

The Klein Engineering Co. has received an order through Messrs. Dick, Kerr & Co. for the supply of condensing plant for the power station of the Calcutta electric tramways. The plant is designed to condense exhaust steam from engines of about 2,000 H.P. and consists of surface condenser with Edward's air pumps and motor-driven circulating pumps.

BANKRUPTCIES, LIQUIDATIONS, &c.

Paris Singer (Ltd.) is to be wound up voluntarily, and Mr. S. H. Baldry, 52, Portsdown-road, London, W., is liquidator.

A first and final dividend of 15s. 5½d. is payable (any day except Saturday) at the official receiver's office, 33, Carey-street, London, W.C., in the liquidation of the Chitty Dynamo & Motor Co. (Ltd.)

The liquidator in the liquidation of the London Provincial Electrical Co. (Ltd.) has been released.

A petition has been presented to the Court of Session, Edinburgh, for an order to continue the voluntary winding up of P. C. Middleton & Co. (Ltd.), electrical engineers, Aberdeen.

Air Compressors and Hoists.—Messrs. Reavell & Co., Ipswich, have just issued a new catalogue of air compressors and hoists manufactured under the firm's patents. These machines are of the high-speed type specially designed to work quietly at a fairly high speed of revolution, and to give a continuous supply of air, so as to reduce the size of reservoirs at present used with pneumatic equipments. The compressors are designed for electric, belt, or steam driving. The list contains good illustrations of several electrically-driven machines.

Feed Water Filters.—A new list is to hand describing several types of patent feed water filters for land and marine boilers manufactured by the Rankine Patent Feed Water Filter Co., of Liverpool. The catalogue is fully illustrated, and contains a list of electrical plants which have been fitted with these filters.

"General Electric" Plant.—Two supplements are issued by the General Electric Co. to section A of their large catalogue, one dealing with enclosed and open type multipolar motors from 3 H.P. to 25 H.P., and the other describing reversible automatic lift controllers and motor-driven starters for presses, lathes, tools, &c. At a time when electric driving is being extensively applied to small machinery, lifts, &c. the particulars published will be found of service.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 18 to July 24, with the ports of destination:—

Africa—Alexandria, £32; Cape Town, £130; Durban, £261. *Argentina*—Buenos Ayres, £3,101 (including £1,332 telegraph material). *Australasia*—Adelaide, £104; Launceston, £191; Perth, £60; Sydney, £354 (including £174 telegraph material). *Belgium*—Ostend, £390. *Brazil*—Rio Janeiro, £1,512 (including £682 telegraph material). *Ceylon*—Colombo, £26. *Chili*—Boca, £197 (telegraph material). *China*—Shanghai, £180. *Colombia*—Santos, £252. *Denmark*—Copenhagen, £262 (telegraph wire). *France*—Calais, £45. *Germany*—Hamburg, £500 (telegraph material). *Holland*—Amsterdam, £75. *Hong Kong*, £75 (including £51 telegraph material). *India*—Bombay, £45; Calcutta, £1,093 (including £182 telegraph wire); Madras, £17. *Italy*—Genoa, £21. *Japan*—Yokohama, £475. *Norway*—Christiania, £39 (telegraph wire); Christiansand, £63 (telegraph cable). *Siam*—Bangkok, £148. *Straits Settlements*—Singapore, £2,006. *Sweden*—Stockholm, £59 (telegraph wire). Total £11,622, against £56,769 in the corresponding week last year (July 19 to 25).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

May 9, 1900.

8,531. J. T. Pearson. Burnley. Improvements in trolleys for electrically-driven tramcars, motors, and the like.

8,541. W. F. Jones. Hammersmith. Improvements in electromagnetic mechanism.

8,558. R. B. Roxby. London. Improvement in electric incandescent lamps.

8,575. F. Greening. London. The manufacture of an improved material for insulating electrical conductors, waterproofing fabrics, and for other purposes.

8,576. A. Hebblethwaite. London. Improvements in and connected with electric lamps for lighting billiard tables.

8,584. G. Tosi, M. Tullio, De Felice, and A. Parboni. Liverpool. An improved system of electric traction by surface contact.*

8,586. C. Martin. London. Improved galvanic battery.*

May 10, 1900.

8,610. H. Cheshire. Birmingham. Improvements in chains for electric light fittings.

8,611. W. F. Jones. London. Improvements in electrical apparatus.

8,642. H. W. Butler. London. Improvements in means for regulating pressure in electric mains.

8,656. W. A. Stevens and R. A. Barker. London. Improvements in connection with cut-in-and-out electric switches for accumulator systems.

8,668. The Interstate Electric Co. and J. Melzer. Strand. Improvements in electric arc lamps.

8,671. E. Schulz. London. Improved construction of electric switch.

8,678. A. U. Alcock. London. Improvements in or relating to electrical signalling apparatus.

8,682. R. W. Covant. London. Improvements in apparatus for measuring electrical resistances, and chiefly intended for testing the electrical resistance of rail joints in the tracks of electric railways. (Date applied for under Patents, &c., Act, 1883, sec. 103, Nov. 13, 1899, being date of application in United States.)*

May 11, 1900.

8,704. F. W. Carter. Birmingham. An apparatus for facilitating the photometry of arc lamps and like sources of light.*

8,719. F. W. Goldby. London. Improvements in electric circuit breakers. (A. Beyer and R. Schön-Felder, Germany.)

8,754. M. Forkas. London. Improvements in electric switches.

May 12, 1900.

8,779. J. Whitcher, A. H. Lea, and C. H. Warren. Kettering. Improvements in electric switches and fuses.

8,780. E. Eugene-Brown. Newcastle-on-Tyne. Improvements in dynamo-electric machines.

8,781. W. Snelgrove. London. Improvements relating to electric cash register tills.

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

7,284. DARDEAN. Telegraphic telephone and like systems and automatic switching apparatus therefor. (Date applied for under International Convention, October 10, 1898).

8,693. ABEL. (Soc. Anon. pour la transmission de la Force par L'electricité.) Converting transformers.

9,882. PRESTON and GILL. Electric lighting apparatus, especially applicable for railway and other vehicles.

10,029. DOUGLAS. Controlling of shop window illuminating electric lamps and the like.

10,241. IMRAY. (Oesterreichische Gasglühlicht and electricitäts-Gesellschaft.) Electrical incandescence lamps with osmium filaments.

11,166. MARINO. Electrolytes for deposit of metals.

11,747. BOWLEY. Telephones, phonographs and such like apparatus.

12,949. ANDREWS and GLASS. Connection of house-service or branch conductors to electric mains.

13,136. KINGSBURY (Western Electric Co.). Appliance for telephone pay stations.

13,194. TOMKINS. Method of winding coils for continuous-current dynamo and motor electric machines.

13,561. BARREAU. Means to be employed in electric traction.

13,939. MILNES. Electric railways and tramways on a sectional conductor system.

14,010. SWINBURNE and STEARN. Means for use in the production of radiation and light by electricity.

14,328. WISE (Actiengesellschaft Electricitätswerke vorm. O. L. Kummer & Co.). Insulators for the overhead conductors of electric tramways.

14,408. HARDINGHAM (firm of Felten & Guilleaume). Submarine cables.

COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Ltd.).

The forty-sixth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Tuesday, under the presidency of Mr. E. M. UNDERDOWN, Q.C.

The GENERAL MANAGER AND SECRETARY (Mr. T. Finnis) read the notice calling the meeting, and the minutes of the last meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, I have very few remarks to make to you to-day. A country is said to be happy when it has no history, and the same remark may be made with respect to our cables, we having been fortunate enough in the period under review not to have required any repairs. This is an extremely favourable incident to have to report. The revenue for the half-year under review, after deducting outpayments, amounted to £52,204, while the working and other expenses, including income-tax, absorbed £20,506, leaving a balance of £31,698 as net profit, making with £6,347 brought forward from the previous half-year, a total of £38,045, which has been appropriated as follows: interim dividend of 3s. per share to March 31, £9,106. 10s.; proposed final dividend of 3s. per share to June 30, together with a bonus of 2s. per share, £15,177. 10s.; transferred to reserve fund account £10,000; balance proposed to be carried forward, £3,761, making together the figure of £38,045. The revenue shows the small improvement of £253 as compared with that in the corresponding period of last year. The working expenses in London, the details of which will be found in abstract "A" of the accounts, show a reduction of £305, while those at the stations, as shown by abstract "B," are £88 higher, the result being a net saving of £217 in the ordinary working expenditure; but the item of income tax, as we are all aware, has absorbed a certain additional amount of our profits, and the outgoings, taken on the whole, including that, show an increase of £95. Practically, therefore, as you will see, the results of the working of the past half-year are the same as for the corresponding period of last year. We have had, as I have mentioned before, no interruption to the cables, and therefore we have not had to draw anything from the reserve fund. This fund has been increased by £10,000 from the revenue account, by £6,782 interest on the investments, and by £399 sundry profit and other items, bringing the fund up to a total of £418,875. The investments have been increased by £21,206, and they now amount to £401,807 at cost, their present market value being about £25,000 higher than their cost. No doubt, as you are all aware, although our securities have, as I think, been chosen with the greatest possible care, and have, as a whole, turned out to be very well selected and dealt with, as we have been able to deal with them, yet the profit upon them is not so large by a considerable sum as it was a few years ago. In point of fact, we know—it is a strange thing—that some of the largest differences in the prices of securities have been in those of the very best class. However, our investments still show a substantial profit, and when the present depressed state of things has passed over, I trust that they will show a more satisfactory increase over their cost price than they do at this moment. The result of the whole financial year's working is a revenue of £109,004. Deducting the expenses, £40,923, a surplus is shown of £68,081. That has been paid away, as far as dividends are concerned to the amount of £42,497; there has been placed to reserve £25,000, and there is an increased balance in hand of £584. As far as our service is concerned, it has been conducted with great regularity and success. Our relations with our allied companies have been exceedingly good, as is always the case; and all that we have to show is that we are holding our own, and endeavouring to hold our own, although the increase of cables across the Atlantic is an important matter, to which we cannot remain indifferent. As soon as the German cable is opened there will be 13 cables working across the Atlantic, and when the shorter section from Nova Scotia to the Azores is completed, there will be practically 14 cables across the Atlantic. All we can do is to conduct our business in the best manner we can, combined with our friends, and endeavour to keep our position, as we have succeeded in doing up to the present, as sure as possible. With respect to relations with Germany they remain much the same as when I last addressed you, because, although the contract between the Anglo Company and the German Government is, so to speak, at an end, yet messages are still being transmitted over the German cable connecting that country with the Atlantic cables of the Anglo Company at Valentia; but of course, we cannot expect that that arrangement will continue indefinitely. As I have informed you before, our attention has been very closely directed to this matter, and we have had many interviews in very influential quarters; and we trust that, as far as possible, the interests of the pooling companies will be protected. I now move that the report and accounts be adopted, and the dividends as set out in the report be approved.

Sir JAMES PENDER, Bart., M.P., seconded the resolution, which was carried unanimously without discussion.

Mr. Charles E. Gunther and Admiral of the Fleet the Hon. Sir Henry Keppel, G.C.B., D.C.L., were re-elected as directors, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. J. and J. Sawyer & Co., were re-appointed.

A vote of thanks to the chairman and directors terminated the proceedings.

National Telephone Co. (Ltd.)

The twenty-sixth ordinary general meeting was held at the City Terminus Hotel, Cannon-street, yesterday (Thursday) under the presidency of Mr. JAMES STAATS FORBES.

The SECRETARY (Mr. Albert Anns) having read the notice calling the meeting,

The CHAIRMAN said he had occasion at the last meeting to regret the very sparse attendance of shareholders, but he thought that the attendance on the present occasion was even more sparse. The interpretation which the directors put upon this fact was that the bulk of the proprietors were satisfied with the directors' action. He might say a great deal if it were desirable to enter into the future or to anticipate the unknown, but he proposed to be very reticent on everything connected with the unknown, and to deal simply with what they knew—the results of the half-year's working. He thought the figures spoke very intelligibly for themselves, and required very little elucidation. The income had increased, as had also the working expenses, in rather a larger proportion, this being attributable to the fact that they had had one of those casualities incident to their business—a snowstorm which involved an expenditure of about £25,000. The directors had thought it better at once to charge this to the half-year's revenue, a proceeding which would affect not what they would pay in dividend but what they would carry to reserve. The increase in the income was £97,500; the working expenses had been more by £77,000, including the £25,000 mentioned; and the result was an increase of about £11,000 in the net result of the half-year, which would have been £36,000 but for the exceptional item of £25,000. The board proposed to pay the dividends as usual upon the first, second, and third preference shares, and a dividend of 6 per cent. per annum (less tax) on the ordinary shares, and they would transfer £55,000 to reserve. This was a lower figure than they had added to this fund in any half-year for some time, but the amount must be remembered in connection with the £25,000 of extraordinary expenses. The Post Office royalties for the half-year amounted to the enormous sum of £68,357, being an increase of £9,472 compared with the amount paid in the June half of 1899. The net income had increased by £88,000, the working expenses by £77,000, and the net result for the half-year was £227,262, or £11,000 increase over June, 1899. The working expenses had gone up from 60·22 per cent. to 64·02 per cent., of course taking in the £25,000 of exceptional expenditure. This just about brought the percentage of working expenses to net income to the same average as before. The amount brought forward was about £2,000 less; the debenture and other interest had increased by £14,913, because in the interval the directors had raised debentures, the interest on them had been paid up to date, and the preference and ordinary dividend was larger by £5,000 because a portion of the ordinary stock sanctioned by the stockholders had been issued. The amount transferred to reserve was £55,000, or £5,000 less than they added in June 1899, and the amount carried forward was about £6,000 less. In order that the proprietors might receive their profits as early as possible the present half-year was treated as a provisional half-year—that was to say, the accounts were not made up and strictly audited for more than five months, and, with the sanction of the auditors, the results for the month of June were estimated. This enabled the directors to meet the proprietors very early, and to present them on the following morning, if they approved the proposed dividends, with cheques for the amount due to them. He thought it better to explain this, as the matter was referred to in the auditors' certificate. He had received certain correspondence from a few of the shareholders with reference to the deduction of the income tax, and he would therefore remind them that at their meeting last February he had referred to the matter. He need not say that no board of their character lightly departed from any course which they had previously followed; but they had made up their minds that they could no longer, consistently with their duty to the general body of shareholders, continue to pay income tax *plus* the dividend on the ordinary shares. When matters such as this came prominently before them, they had to consider their powers and obligations—and the directors were vested with large powers of discretion as to reserve funds. The directors had come to the

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conclusion, to get rid of the anomaly that had existed, that the ordinary shareholders should pay their own income tax. They had received nine letters from different shareholders enclosing their proxies, but attaching to the latter this instruction: "These proxies are not to be used if the board insist upon deducting the income tax." Of course, the directors would not use these proxies on any vote that might come before the meeting; but he might state that, on the other hand, they had received an enormous number of proxies from shareholders who expressed no dissent from the directors' intentions in this matter.

Probably the shareholders would like to know a little as to the future. The directors had had numerous communications with the postal authorities as to the future. They had been as reasonable as they could, and they had been as anxious as men could be to work in harmony and to work loyally with the Post Office on the principle of competition. There had been proposals and counter-proposals but up the present there was no result. The directors hoped, and they had reason to hope, that the competition would be conducted rationally and fairly, and they felt confidence in those pledges on which men of honour relied when given on authority by responsible politicians or officials. Mr. Hanbury was the Chairman of the Parliamentary Committee who sealed the company's fate—that was to say, who determined that there was to be competition, and that the company must put up with the brunt of it. Mr. Hanbury showed during the negotiations that he was a most admirable negotiator, who knew very well how to take care of the interests of the State, and who always showed a great disposition to act on the square; and Mr. Hanbury's public utterances must be taken to be Mr. Hanbury's intentions. These were specific. On June 21, 1899, in the debate on the second reading of the bill which sealed the company's fate, in the sense of their having to accept competition Mr. Hanbury "frankly recognised that the National Telephone Co. had done good work, and wherever it had got wayleaves and could give an efficient service, serving all alike, on equal terms, he should be sorry to see that system discontinued. What we wanted in this country was a general system that would extend itself over the whole country. . . . He would do the National Telephone Co. the justice to say that wherever they got the opportunity they gave an efficient serivce—that was to say, where they had underground wayleave and a double circuit system. . . . He was most anxious that they should treat the company with absolute fairness." Those were words which the directors relied upon. He had some colleagues on the board who were quite as eminent as Mr. Hanbury as public men, and they relied upon these utterances. Then, on the consideration of the bill—on July 24, 1899—Mr. Hanbury said: "The Committee and all those who had looked into the matter strongly recommended that wherever they introduced competition they should do their best to deal equally between the company and the new competitor. . . . We did not think the honourable and learned member would wish them to confiscate any of the rights of the National Telephone Co. . . . He had refused to be a party to anything in the nature of confiscation." Well, the board wanted fair treatment as between the competitors, whoever they were and wherever they were, and they of course would not desire to be treated other than as fairly as their competitors; they would shrink from conceiving it possible that any act of the Government would lead by any possibility to any want of recognition of what the company had done, of what they might have done had they not been hampered—and of what they were willing to do to co-operate cordially with the Government in making the service as efficient as possible; and they would be likely to resent anything like confiscation. He concluded by moving a resolution adopting the report and accounts and declaring the dividends recommended.

The Right Hon. Lord HARRIS, G.C.S.I., G.C.I.E. (vice-president), seconded the motion.

In reply to Mr. Lewis,

The CHAIRMAN stated that the item in the balance-sheet of "less amounts paid in advance for Post Office royalties, £68,727," was the company's payment for Post Office royalties for the half-year. If the shareholders looked at the abstract of the accounts they would see that the following payments had been made by the company to the Post Office for royalties:—For 1894, £67,000; 1895, £74,000; 1896, £79,000; 1897, £89,000; 1898, £104,000; 1899, £123,000; and as regarded the current year the amount would, of course, be much more on the basis of the first half-year's payment. This was a pretty heavy sum to pay for the privilege of being competed with by the people who received the money, but that was the bargain. They had already paid in royalties something over £600,000, and they would have to go on making similar payments. They were pitted against a competitor who took 21 per cent. of the profits clean out, without doing anything for it, and who competed with them at the same time.

The motion was carried unanimously, and the retiring directors and auditors were afterwards re-elected.

Mr. EDWARD CHAPMAN proposed a vote of thanks to the chairman, directors and staff generally for their able management of the company's business.

Mr. LEWIS, in seconding the motion, referred to the difficulties of conducting such a business, and remarked that it was fortunate that the company were served by one of the ablest boards of directors which could be found in the country.

The CHAIRMAN, in reply, said such votes were not only pleasant to the directors and the staff, but they also cast upon them a great responsibility. The officers of the company had very properly been included in the vote. He did not know how they would get on without their admirable general manager (Mr. W. E. L. Gaine); and they had an equally admirable secretary and an engineer of the greatest ability. The staff, including the ladies, certainly deserved the thanks of the proprietors and the considerate treatment of their customers.

The proceedings then terminated.

British Thomson-Houston Co. (Ltd.).

A meeting of this company was held on Monday, under the presidency of Mr. E. A. LAZARUS.

The ASSISTANT SECRETARY (Mr. Alfred Clements) having read the notice calling the meeting,

The CHAIRMAN said: The books of the company were very full of orders and he was pleased at the basis of those orders. Among the orders they had in hand might be mentioned the following: Birkenhead, Blackburn, Bristol City tramways, Croydon, Dublin City tramways, Glasgow, Huddersfield, Hull, Leeds, London United Tramways, Newcastle, Queenstown lighting, Sheffield, Tynemouth, Isle of Thanet, and several other orders of a smaller description. Satisfactory progress was being made with their works at Rugby. As they were beginning to pay for parts of these works, the directors had decided to make a call of £2. 10s. per share on Sept. 1, making £6 called up, and they would probably make a further call of £4 in two calls of £2 each at intervals of two months. There were two points which he would like to take that opportunity of expressing an opinion upon. The first was that consulting engineers would in most cases find it to the best interests of their clients to endeavour to obtain standard plant. Of course, he knew there were cases where special plant had to be used, but he thought that in the majority of cases it would be found very much more to the advantage of all concerned—to the manufacturer and to the buyer alike—if consulting engineers, instead of using any special type, were to adhere to the plant of some standard manufacturers, because in that way they would obtain cheaper and better plant. With reference to the second point, it was not without some misgivings that they noticed the tendency of municipalities to accept the lowest tender—a proceeding which was calculated to lead some of the less important firms in the trade to tender at prices and run risks out of proportion to the work to be done. This of course was to the advantage neither of the buyer nor of the seller. They could, of course, understand the difficulty that municipal bodies were in when called upon to vote money for highly technical matters like electrical plant; but, for all that, the system did not in reality make for their obtaining the best value for their money, because a smaller sum spent at the outset often meant a very much larger outlay in the long run, through the cheaper plant not being as efficient, and therefore costing more for maintenance and repair. As far as their company was concerned, they did not feel inclined to be too much alarmed at this state of affairs, although during the past year they had seen several important contracts go past them. The report and accounts were carried unanimously, and the following dividends for 12 months to March 31 last approved:—

On the £240,000 ordinary shares fully-paid of 10 per cent.; on the £160,000 ordinary shares (£16,000 paid up from Aug. 16, 1899) at the rate of 10 per cent.

The motion was seconded and carried.

The retiring directors and auditors were afterwards re-elected.

The directors report submitted at the above meeting stated that the Central London Railway, the whole electrical equipment for which was carried out by the company, was opened on June 27. The Cork Electric Tramways & Lighting Co., the complete equipment for which was also carried out by the company (payment being taken in shares and debentures) paid a dividend of 5 per cent. on the ordinary shares for its first year's working. The royal assent to the Chatham and District Light Railways Bill (promoted by this company) was given in August last. A suitable site for the power station has been acquired, and work is progressing satisfactorily. In pursuance of the policy adopted by the board, the directors have decided to open branch offices in Newcastle and Manchester. The report refers to the recent litigation in which the company was involved—viz., the Sprague motor suspension and Hookham meter patents, and states that notice of appeal has been given by the plaintiffs in the latter case.

A fresh issue of 16,000 £10 ordinary shares was taken up by existing shareholders in August last at a premium of £2. 10s. per share, and the premium (£40,000) has been placed to reserve. All matters in connection with the old company are wound up, the final losses upon or in respect of contracts taken over having been determined and entirely written off. The profits, after deducting general and technical expenses, discounts, and interest, amounted to £52,310. 10s. 1d.

Rand Central Electric Works (Ltd.).

The directors' report for the year ended Dec. 31, 1899, states that in consequence of the war business and mining work were brought to a standstill early in October, and as the company depends for its revenue upon these sources, it must be considered a favourable feature that it was at least able to pay its expenses during the last quarter of the year. The total revenue was £50,674. 9s. 1d., compared with £43,208. 14s. 6d. in 1898, and the working costs to £49,834. 11s., compared with £48,951. 3s. in 1893. The profit amounts to £839. 18s. 1d., of which £83. 19s. 9d. is carried to reserve, against a loss of £5,742. 7s. 6d. in 1898. The receipts for power supplied amount to £49,640. 7s. 7d. against £42,723. 3s. The installed power rose from 1,846 H.P. to 2,219½ H.P. On the basis of revenue actually earned, the amount of power per annum supplied works out at an average load of 1,103 H.P., which rose to 1,541 H.P. before the outbreak of hostilities, and after the outbreak fell away at one time to 524 H.P. As anticipated, a considerable improvement in the working of the main line has been brought about. A further expenditure of £1,375. 5s. 7d. was incurred to increase the water supply of the company.

Under the equipment contract Messrs. Siemens & Halske guaranteed that the profits of the company should be sufficiently large to provide dividends of 6 per cent., 8 per cent., and 10 per cent. per annum respec-

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tively for the years 1897, 1898, and 1899. The necessary amounts to provide the guaranteed dividends for 1897 and 1898 were duly paid, and the one now under consideration is due; but in regard to the profits for 1899, Messrs. Siemens & Halske claim a partial release on account of the hostilities in South Africa constituting a case of *force majeure*. Although the equipment contract makes no provision for a possible war, the directors are of opinion, after due consideration of all the vital points, that there is room for an amicable arrangement, which they advocate in the interest of the shareholders, and in this they are supported by the members of the local board, to whom the whole matter had been submitted. The board propose the following basis of adjustment in respect of the profits of 1899: The dividend guarantee to remain in force, subject to an allowance being made to Messrs. Siemens & Halske for the loss in receipts directly traceable to the war. In order to arrive at the amount of this loss it is proposed to assume that the working expenses and receipts for the last three months of the year would, but for the war, have been the same as those for the three months prior to the outbreak of hostilities—*i.e.*, July, August, and September. This would show the net loss for Oct.–Dec., 1899, to be £7,371. 13s. 7d., and the directors propose to relieve the contractors of the necessity for paying this amount, and ask for the shareholders' sanction. The liability of Messrs. Siemens & Halske for the year ending Dec., 1899, would thus be reduced to £21,872. 8s. 1d., and there would be £22,628. 6s. 5d. available for distribution amongst the shareholders. Subject to this recommendation being adopted the directors propose a dividend of 7½ per cent. be declared for the year 1899, payable when payment by Messrs. Siemens & Halske is made.

Mr. R. Charubin has resigned his seat on the board, and a further vacancy has occurred through the death of Mr. A. Barsdorf. Mr. G. von Chauvin has been elected a director to fill one of the vacancies, and the board proposes shortly to fill the other vacancy.

An interesting and exhaustive report from Mr. G. Gorrissen, the general manager at Johannesburg, follows. We extract the chief points:—

The amount of electric power distributed gradually rose, and in April we had the satisfaction of having to run a third engine during the night hours; while in August and September the maximum load rose at times to 85 per cent. of the total capacity of the plant. Negotiations for the extension of old and the connection of new installations, which would well nigh have exhausted the full capacity of the plant at its maximum load, were being carried on, when the war put a stop to all further business. The plant was kept running during the war in order to supply the wants of such of our customers as required power. Altogether the plant has worked very satisfactorily, the stoppages due to external influences only amounted to 68 hours 34 minutes for the year. In addition to the stoppages of 68 hours 34 minutes, the supply was also stopped for 85 hours 55 minutes to carry out alterations and improvements. The most important cause was the breakdown of insulation, which includes the effect of lighting.

The maximum output for any one day occurred on Sept. 28, and amounted to 30,815kw. hours. We have at present in the station four steam engines and dynamos of a normal capacity of 700kw. Of these, one engine and dynamo have to be considered entirely as reserve plant, so that the normal capacity of the station amounts to $3 \times 700 = 2{,}100$kw. The maximum load during August and September has been about 1,800kw., corresponding to 86 per cent. of the normal capacity of the plant. The largest demand was during September. The actual output amounted to 844,525kw. hours, or about 56 per cent. of the plant capacity.

Taking the equivalent horse-power value for the lighting plants 1,846 H.P. were connected in Dec., 1898, and 2,289·5 H.P. in Dec. 1899, of which, however, 70 H.P. represents a temporary installation, thus showing an actual increase of 373·5 H.P. during the year. The principal improvement at the installations connected to the system is the erection of a system of automatic regulators for the larger lighting plants. These regulators have worked very satisfactorily.

City & South London Railway Co.

The report of the directors for the half-year ended June 30 states the receipts from all sources for the past half-year amounted to £35,144. 18s. 2d., and the cost of working to £20,860. 12s. 8d., leaving a profit of £14,284. 5s. 6d. Inclusive of the balance forward the net revenue account shows a total of £18,366. 12s. 2d. After making provision for debenture stock interest, a balance remains of £13,215. 4s. 7d., and the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, and for four months on those of 1896 (the other two months being charged to capital as authorised), and that a dividend at the rate of 1½ per cent. per annum be paid upon the consolidated ordinary stock, leaving £788. 2s. 11d. to be carried forward. The number of passengers (exclusive of season ticket holders) carried during the half-year was 4,169,717 and the receipts (including season tickets were £33,608. 2s. 3d. For the two preceding half-years the figures were 3,442,942 and £26,749. 3s. and 3,540,098 and £26,197. 14s. 10d. respectively.

The diminution in the dividend is largely attributable to the increase in the debenture and preference charges before the recently-opened extensions have had time to develop their traffic. There has also been a considerable increase in the cost of coal, wages, and materials. The extensions to Moorgate-street and Clapham Common were opened for traffic on Feb. 26 and June 4 respectively. The receipts have already been considerably augmented, and are steadily improving. The extension to Islington is being rapidly proceeded with, and it is hoped will be ready for opening about March. The Central London Railway not having yet been opened for public traffic, the joint subway constructed for the exchange of traffic between the two companies at the Bank station has not been brought into use. The joint subway with the Brighton Company at London Bridge is in course of construction. The additions and alterations at the generating depôt are practically completed, and the further plant required for the Islington extension is in hand. In preparation for the opening of this portion of the line 10 additional locomotives have been ordered.

The bill promoted by the company in the present session has received the royal assent. The consent of the proprietors has been obtained to an arrangement between the company and the Baker-street and Waterloo Railway Co., who are obtaining powers to extend their line to the Elephant and Castle station, where it is proposed to have a subway communication between the two systems which will, it is hoped, result in a large exchange of traffic.

Resolutions are to be submitted to the shareholders varying the present agreement with the City and Brixton Company, with the view of facilitating the raising of the capital of the company. The offices of the company are to be removed to the new station buildings at Moorgate-street.

Crompton & Co. (Ltd.).

The report of the directors for the year ended March 31 states that the profit amounted to £31,326. 19s. 6d. After providing for debenture interest, payment of interim dividend, &c., there remains a balance of £24,636. 14s. 10d. It is proposed to set aside £2,500 as provision for doubtful debts, to place £12,000 to reserve, to pay a dividend at the rate of 9 per cent. per annum for the half-year, tax free, making (with the interim dividend paid in January last) 7½ per cent. for the year, and to carry the balance (£3,729. 18s. 11d.) forward. The reserve fund now stands at £25,046. 9s. 9d., and the directors propose to set aside from this account £5,000 as a special contingency fund, to provide for any possible shrinkage in value of investments, to write off £5,000 from goodwill account, £5,000 from the patents account, and £3,000, balance of the cost of establishing the electric cooking department, carrying the balance (£7,046. 9s. 9d.) forward. The whole of the 21,902 shares offered for subscription in July last year were taken up, and the premiums have been carried to reserve. The board have purchased an additional 10½ acres of freehold land adjoining the site of the new works. They have considerably extended the main shop at these works, which is now being equipped with the necessary machinery, and have also erected a detached pattern store. The report states that the business of the company continues to progress in a most satisfactory manner, and the order book is very full. The Chelmsford Electric Lighting Co. have hitherto been occupying a portion of the old works at Chelmsford for a generating station; a formal conveyance of the freehold, together with the plant and machinery therein, has now been made to the company. The administration of that company has been re-organised during the year, and it is believed that the results for the current year will show considerable improvement. This undertaking is earning a moderate but steadily increasing revenue, and the directors are of opinion that this improvement will continue.

Dublin United Tramways Co. (1896) Ltd.

The directors' report for the half-year ended June 30 states that after meeting debenture interest, &c., £36,039. 13s. 3d. is available for distribution, out of which dividends at the rate of 6 per cent. per annum have been declared on the preference, and 7 per cent. per annum (tax free) on the fully paid up ordinary shares (absorbing £35,253. 15s. 3d.), leaving £785. 18s. to be carried forward. The new line via Leeson-street was opened to Clonskea on March 12, the new line to Victoria Bridge, Ringsend-road, on May 1, and from Victoria Bridge to Sandymount on 4th inst. The through running of this line via Ringsend to Sandymount is delayed by the rebuilding of the bridge. The Southern Quay line is still closed owing to main drainage works. The new line from Capel-street to Ballybough Bridge is practically completed, but is not yet opened for traffic. The whole of the electrical construction and equipment of the old and new lines being now within measurable distance of completion, the directors consider that the best and cheapest way of raising the necessary additional capital is by increasing the borrowing powers of the company. It is estimated that £200,000 will be sufficient to pay off the company's liabilities, and to complete the works in hand, but it is deemed advisable to obtain powers to raise £300,000 to provide funds to meet future developments.

Globe Telegraph & Trust Co. (Ltd.).

The report of the directors for the year ended July 18 states that the net revenue, after deduction of expenses, amounts to £198,420. 4s. 1d. and makes, with £1,091. 2s. 9d. brought forward, £199,511. 6s. 10d. From this there has been distributed £132,321. 10s. 9d. in interim dividends, leaving £67,189. 16s. 1d. The directors recommend a final dividend for the year of 3s. per share on the preference and of 4s. 6d. per share on the ordinary shares, making a total dividend for the year of 6 per cent., less tax, upon the preference, and 5½ per cent. net upon the ordinary shares, leaving £982. 14s. 11d. to be carried forward.

During the year the Eastern Extension Telegraph Company and the Commercial Cable Company have both issued new share capital, which was offered to the shareholders of those companies *pro rata* to their holdings, the former at £13 per share and the latter at par. The full number of shares thus offered has, in each case, been taken up by the Globe Company the cost being met by the sale of other securities.

British Electric Transformer Manufacturing Co. (Ltd.).

The report of the directors for the year ended June 30 states that the business done by the company during the year has been very satisfactory. The accounts show that after paying all manufacturing costs and expenses of administration, and providing for repairs and depreciation, there remains £6,184. 8s. 9d., which, with the sum brought forward gives an available balance of £6,421. 17s. 10d. The directors recommend a dividend at the

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rate of 10 per cent. per annum (one-half was paid as an interim dividend in February) and a bonus of 2½ per cent. for the half-year, absorbing £2,119. 12s. 5d. £2,500 is put to reserve, and £1,802. 5s. 5d. carried forward. The lease of the present works expires next year, and the board will erect and equip new works near London, without increasing the present capital of the company. The business continues to show steady progress. The authorised capital of the Company is £50,000, with £40,000 fully subscribed.

Edison & Swan United Electric Light Co. (Ltd.).

The seventeenth annual report for the year ended June 30 states that the profit amounted to £43,388. 1s. 5d. After providing for debenture interest, there remains £29,208. 11s. 11d. available for distribution. An interim dividend at the rate of 6 per cent. per annum having already been paid in respect of the half-year ended December, 1899, a further payment, at the rate of 6 per cent. per annum, for the second half is recommended, making the dividend for the book year 6 per cent. per annum, the balance (£6,199. 18s. 5d.) being carried forward. The issue of the £100,000 5 per cent. Second Debenture stock was duly made and fully subscribed. A quotation has been granted by the Stock Exchange. The retiring directors (Mr. J. Staats Forbes and the Earl of Lichfield) offer themselves for re-election.

ALUMINIUM CO. (LTD.)—The directors' report for the nine months ended March 31, states that the profit for the period was £19,684. 1s. 2d. After deducting debenture interest and other charges, the net profit is £13,508. 1s. 3d., which, with £5,501. 10s. 11d. from last account, makes an available balance of £19,009. 12s. 2d. A dividend at the rate of 15 per cent. per annum for the period is recommended, and the balance (£11,697. 2s. 2d.) is to be carried forward. The directors state that they have carefully considered proposals for the amalgamation of the company with the Castner-Kellner Alkali Co., the purchasers of the Castner patents for the manufacture of caustic soda and bleaching powder by electrolysis, and a provisional agreement has been entered into for the sale of all the property of the company, excepting the shares of the Castner-Kellner Company held by the Aluminium Company. If this agreement is approved the holder of each Aluminium share will receive three shares of the Castner-Kellner Company with right to participate in the dividends of the latter company from March 31 last. Mr. G. H. Clarkson, who has resigned the office of secretary, which he had held since the formation of the company, has been elected a director in place of the late Mr. H. Y. Castner.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTROMOTION CORPORATION (LTD.)—This company was registered on July 19, with a capital of £50,000 in £1 shares, to acquire a concession for supplying electricity for light, power or other purposes, to Nova Friburgo, Rio de Janeiro, Brazil, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, &c.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 27⅞d. per oz. (July 26). Consols (2¾ per cent.) 97⅝—97⅞ for money, 97⅝—97⅞ for account; 2½ per cent. 97—97⅛ (July 26). Stock Exchange Settling Day: Consols, Aug. 2; Stocks and Shares Continuation Days, Aug. 13 and 28; Ticket Day, Aug. 14; Pay Days, July 27 and Aug. 15; Mining Share Carry-over Days, Aug. 11 and 27.

ALDERLEY AND WILMSLOW ELECTRIC SUPPLY (LTD.).—At the annual meeting, held last week, the chairman (Mr. F. E. Gripper) said the works were opened in October, 1899, and the capital expenditure had been £16,074. The number of lamps connected at that time was 438 8 c.p., and at the end of December 1,223. It was expected that by the end of 1900 3,000 lamps would be connected. The "free" wiring system had been adopted, and seemed likely to become general in the district. Penny-in-the-slot meters were supplied to the company's customers. Negotiations were proceeding with the Wilmslow Council for the supply of current for lighting that district.

BLACKHEATH & GREENWICH ELECTRIC LIGHT CO. (LTD.)—Applications have been invited during the week for an issue of £100,000 (part of an authorised issue of £120,000) 4½ per cent. first mortgage debenture stock.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—The directors have declared an interim dividend to June 30 at the rate of 7½ per cent. per annum (payable August 4) against 7 per cent. for the corresponding period last year. The total receipts for the half-year were £74,991, against £72,396. The number of passengers carried was 12,061,613, against 11,403,683.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At the general meeting, held on Wednesday, Mr. R. M. Horne-Payne said the company was in a prosperous condition. The net earnings, which were £33,238 for 1898-99, amounted to £40,512 for the last financial year. The growth of the business in the lighting department had been large, and the power supply department had been put into a better condition, and was being worked profitably. The proceeds of a recent issue of shares would be applied in providing a further unit of plant at Victoria, further boiler power in Vancouver, and to the purchase of additional rolling stock in both places in order to enable the company to meet the winter demand. A final dividend on the ordinary shares of 2 per cent., making 4 per cent. for the year, was approved.

BRITISH INSULATED WIRE CO. (LTD.)—The directors have declared an interim dividend at the rate of 10 per cent. per annum for the half-year ended June 30.

CHARING CROSS & STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—The directors have, after providing for debenture and other interest and dividend on preference shares, declared an interim dividend at the rate of 8½ per cent. per annum for the half-year ended June 30, and carry forward £10,508. The interim dividend for the corresponding period of 1899 was at the rate of 8 per cent. per annum, with a carry-forward of £8,300. The lamps connected during the past half-year have amounted to the equivalent of 24,242 8 c.p.

CONSOLIDATED TELEPHONE CONSTRUCTION & MANUFACTURING CO. (LTD.)—Col. G. Gouraud announces his intention of offering himself at the forthcoming meeting of shareholders for election as a member of the board. Col. Gouraud was a director of the company in the early days, representing Mr. Edison's interests.

COUNTY OF LONDON & BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—An interim dividend on the preference shares has been declared at the rate of 6 per cent. per annum, less tax, for the half-year ended June 30, and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum, less tax, both payable on Aug. 15. The company has just made an issue of £100,000 4½ per cent. debenture stock at £108. The transfer books and register of members will be closed from Aug. 6 to 15 inclusive, preparatory to the payment of an interim dividend on the preference and ordinary shares for the half-year ended June 30.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—Applications are invited until 4 p.m. this day (Friday) for a balance issue of 19,370 5 per cent. Cumulative preference shares of £5 each in this company at par. The issue is made by the Electric & General Investment Co. (Ltd.) on behalf of the British Electric Traction Co. (Ltd.), who guarantee the issue, and are themselves holders of 19,707 ordinary shares in the Dudley Company, which has a total authorised share capital of £200,000. The Dudley Company was formed in 1880, and owns tramways from Dudley to Stourbridge, 5½ miles in length, recently converted to electric traction on the overhead trolley system. In addition, the British Electric Traction Co. has agreed to transfer to the Dudley Company certain orders for new lines, which will bring the approximate length of the Dudley Company's tramways and light railways to 17 miles of the uniform gauge, 3ft. 6in., the whole to be worked by electricity, and to form a continuous service. The Dudley Company will further have running powers over the extensive system of the British Electric Traction Co. in the surrounding districts. The various tramways and light railways controlled by the Dudley Company are owned in perpetuity, subject to the rights of the local authorities to purchase the undertakings. The prospectus, which will be found set out on another page, gives further particulars of the properties and rights owned by the company, whose existing lines for the year 1899 yielded a net profit of £4,309. The adoption of electric traction has led to a large increase in the number of passengers carried and the receipts therefrom, and it is anticipated that the complete system of 17 miles will be working before the year 1901. A coloured map, showing the existing lines and their extensions, new lines, and the lines over which the company has running powers, accompanies the prospectus.

DUNDEE & DISTRICT TRAMWAY CO. (LTD.)—The company is applying to the Court of Session, Edinburgh, for sanction to alter their articles of association so as to employ electric traction on their lines.

ELECTRIC TRACTION IN AUSTRALIA.—It is announced that "a strong syndicate of financiers has been formed for the purpose of dealing with the Adelaide electric tramway concession lately obtained by Mr. W. Gentry Bingham from the Corporation of Adelaide. The necessary capital of over £1,000,000 is said to have been guaranteed."

ELMORE'S TRUST (LTD.)—A meeting of debenture holders will be held at the Cannon-street Hotel, London, E.C., on Aug. 3 to consider resolutions sanctioning and confirming a compromise of the rights of the holders of the debenture stock.

GREAT NORTHERN & CITY RAILWAY CO.—The report of the directors states that satisfactory progress has been made with the driving of the tunnels during the past half-year, and the speed of construction will soon be greatly accelerated by the erection of four additional shields, two of which will drive southward from Drayton Park, and two southward from Old-street.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show an available balance of £14,202, and the directors recommend payment of a dividend at the rate of 5 per cent. per annum on the preference and 3 per cent. (against 2½ per cent. for the corresponding period last year) on the ordinary shares. The balance forward is £4,452, against £4,320.

METROPOLITAN RAILWAY CO.—In the directors' report for the half-year ended June 30 it is stated that in view of the importance to the Metropolitan and District Railway companies of adopting electricity as a motive power, a committee consisting of three members from each of the boards of the companies has been appointed to consider the question of applying electric traction to the working of the Inner Circle, and it has been agreed between the companies to invite eminent electric traction firms to submit plans and specifications, with detailed estimates and tenders for the necessary installation.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—An extraordinary general meeting will be held at Winchester House, London, E.C., on Aug. 1 to consider resolutions authorising the increase of the capital of the company to £200,000.

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WATERLOO AND CITY RAILWAY CO.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year to June 30.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended June 30, 1900. The following statement, dated June 13, shows the condition of the company at the close of the quarter ended March 31, 1900:—

Surplus Jan. 1, 1900, as per last quarterly report ...		$8,430,753 61
Net revenues, quarter ended March 31, 1900		1,318,384 05
		$9,749,137 66
From which deducting for—		
Dividend of 1¼ per cent. paid April 15	$1,216,996 25	
Interest on bonded debt.....	224,120 15	
Sinking funds	9,797 00	
		1,450,913 40
Left a surplus April 1, 1900, of		$8,298,224 26
The net revenues of the quarter ending June 30, based upon nearly completed returns for April, partial returns for May, and estimating the business for June will be about		1,700,000 00
		$9,998,224 26
From which appropriating for—		
Interest on bonds		225,000 00
		$9,773,224 26
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,996 25
Deducting which leaves a surplus, after paying dividend, of		$8,556,228 01

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared payable on and after the 16th inst.

STOCK EXCHANGE NOTICES.—Aug. 1 has been appointed a special settling day in the further issue of 29,437 ordinary £5 (£2. 10s. paid) shares (Nos. 80,001 to 109,437) of the *Westminster Electric Supply Corporation (Ltd.)* These securities have also been ordered to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	July 21	4,711	+ 320	2	9,387	+ 439
Blackpool Corporation...	,, 19	1,321	+ 382	16	10,352	+ 2,354
Blackpool and Fleetwood	,, 21	1,491	+ 80	3	3,241	− 93
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	,, 22	535	+ 93	16	7,950	+ 1,625
Brisbane Trams	June 6	1,789	+ 431	22	40,745	+ 11,577
*Bristol Trams & Carriage	July 20	3,605	− 72	3	10,431	+ 21
*Buenos Ayres & Belgrano	June 24	2,163	+ 103	25	56,487	+ 4,415
City & South London Ry.	July 22	1,411	+ 547	3	4,292	+ 1,532
Cork Elec. Trams	,, 19	489	− 12	29	11,089	+ 1,194
Dover Corporation	,, 21	283	+ 31	16	3,423	+ 310
Dublin & Lucan Rly. ...	...	...	...	...	...	...
Dublin United	,, 20	3,971	+ 287	3	11,007	+ 1,345
Dublin Southern Dist....	,, 20	1,302	+ 106	3	3,294	+ 198
*Glasgow Corporation ...	,, 21	7,825	+ 47	...	...	...
Hull Corporation	,, 21	1,378	+ 524	3	4,047	+ 2,359
*Liverpool Corporation...	,, 14	8,624	+ 906	28	205,803	+ 24,989
Liverpool Overhead Rly.	,, 22	1,751	+ 141	3	5,193	+ 451
*Sheffield Tramways	,, 22	4,450	+ 1,088	29	60,510	+ 20,432
*South Staffs. Trams.....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 18.	Price Wednesday, July 25.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 25. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,000	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	... ...	... ...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£932,720	Stock	15/0	Anglo-American	59 62	59 62	5 19 9	Feb., May, Aug., Nov.	...	...
£3,068,640	Stock	20/0	Do. Preferred	113½ 114	112 113	5 8 1	,, ,,	113	111⅞
£3,068,640	Stock	27/0	Do. Deferred	11¾ 12¼	11¾ 12¼	11 0 5	,, ,,	12	11⅞
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	160	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	,, ,,	10 ¼	101½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	6 1 3	,, ,,	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	,, ,,	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	100⅞ 104⅞	100⅞ 104⅞	4 6 7	January and July.....	...	...
60,710	20	2/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	...	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	148 153	148 153	4 12 5	Jan., Apr., July, Oct.	151	150½
£1,626,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	96 99	96 99	3 10 8	,, ,,	98	96
£1,452,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	112½	...
250,000	10	2/6	Eastern Extension.....	14¾ 15½	14¾ 15	4 13 4	Jan., Apr., July, Oct.	15 1/16	14⅞
£230,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 117	113 117	3 9 2	February and August	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) ...	103⅞ 103⅞	103⅞ 103⅞	3 17 8	May and November ...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11½ 11¾	11½ 11¾	4 9 4	Jan., Apr., July, Oct.	11¼	...
180,042	10	2/0	Do. 6 per Cent. Preference	15 15½	15 15½	3 18 8	,, ,,	15⅝	15⅜
150,000	10	5/0	Great Northern of Copenhagen	32 34	31 33	3 15 9	January and July.....	3 5/8	...
£84,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99 101	99 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	52 56	52 56	4 9 3	May and November ...	...	...
£100,000	100	6%	London Platino-Brasilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	107	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 9	June and December ...	...	...
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October.....	7 7/16	7½
2,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	,, ,,	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	93 101	5 0 4	March and September	9 3/4	9 1/4
30,068	2½	...	West Coast of America.....	¼ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	93 102	3 14 7	January and July.....	...	...
89,321	10	1/0	West India and Panama	⅝ ¾	⅝ ¾	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	,, ,,	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference.....	6 7	6 7	8 11 5	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	... ...	... ...	4 15 3	June and December ...	...	...
207,930	10	2/0	Western Telegraph (late Brazilian Submarine)	14¾ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	...	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	... ...	... ...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¾ ¾	¾ ¾	5 0 0	November	...	...
96,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	,, ,,	...	...
490,000	5	3/0	National	4⅞ 5⅛	4⅞ 5⅛	5 17 1	February and August	5 1/8	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 15	13 15	4 5 9	,, ,,	...	..
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12 14	12 14	4 5 9	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5⅛	5 5⅛	4 15 3	,, ,,	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December ...	93½	97
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4⅞ 5⅛	4⅞ 5⅛	6 13 4	July	5 1/16	...
16,629	5	2/6	Do. 5% Cumulative Preference.....	5 5⅛	5 5⅛	4 10 11	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	,, ,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 18.		Price Wednesday, July 25.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 25.	
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)					...	...	...	...
£5,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅛	12⅛	11⅛	12⅛	3 11 3	...	...	...
£6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	10 3/16	10⅛
£12,000	5	3/6	Do. 7 per Cent. Preference	8⅛	9⅛	8⅛	9⅛	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6⅛	6⅜	6	6⅛	...	...	6 3/16	6 3/16
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9⅛	10⅛	9⅛	10⅛	4 5 9	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6⅛	3 18 3	,, ,,	5⅛	...
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	6	7	6⅛	7⅛	4 0 0	March	6⅛	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107	110	107	110	4 1 8	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8	9	8	9	4 8 11	February and August	...	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 12 4	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 11	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	8⅛	9⅛	8⅛	9⅛	4 4 3	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11⅛	12⅛	11⅛	12⅛	4 16 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107	110	108	111	4 1 3	...	109	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12⅛	13⅛	12⅛	13⅛	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6⅞	7⅛	6⅞	7⅛	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1	1⅛	1	1⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4	4⅛	4	4⅛	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98	100	98	100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	14⅛	15⅛	14	15	3 6 8	April and October	14⅛	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111	114	111	114	3 18 11	June and December	...	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96	98	96	98	3 11 6	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15⅛	16⅛	15⅛	16⅛	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6	6⅛	5⅛	6⅛	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	3/16	5/16	3/16	5/16	11 12 10	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75	85	75	85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165	185	165	185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	13⅛	14⅛	14	15	4 16 8	February and August	14 3/16	14⅛
20,000	5	3/6	Do. 7 per Cent. Preference	8⅛	9⅛	8⅛	9⅛	3 13 8	,, ,,	...	...
£12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2⅛	2	2⅛	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85	95	85	95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3⅛	4⅛	3⅜	4⅛	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	12	13	12⅛	13⅛	4 16 4	March and September	13⅛	12 7/8
			ELECTRIC MANUFACTURING &c. COMPANIES.								
70,000	1	1 1/16d.	Alliance Electrical Co. 5% Cum. Pref.	...		1	1⅛	4 0 0	...	...	...
140,000	1	7/16d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	3/16	5/16	3/16	5/16	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	3/16	5/16	3/16	5/16	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/8	1/4	1/8	1/4	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97	99	97	99	4 4 2	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11⅛	12⅛	4 0 0	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅞	6⅛	5⅞	6⅛	4 16 0	...	...	...
100,000	5	1/6⅛	British Westinghouse 6% Preference	4⅞	5⅛	4⅞	5⅛	...	...	...	...
90,060	2	1/2 3/8	Brush Electrical Engineering	1⅜	1⅝	1⅜	1⅝	4 5 4	September	1⅝	...
90,000	2	1/2 3/8	Do. 6 per Cent. Pref. Non-Cum.	2	2⅛	2	2⅛	5 6 8	,,	2 1/16	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109	114	109	114	3 19 10	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	103	101	103	4 7 5	June and December	...	...
33,000	5	10/0	Callender's Cable Construction Ord.	13	14	13	14	5 7 2	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	5⅜	5⅛	5⅜	4 6 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	114	110	114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1	1⅛	1	1⅛	6 8 0	...	1 1/16	...
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/9 3/16	Chadburn's Ship Telegraph Ordinary	3/16	1/4	3/16	1/4	7 0 0	March	...	...
60,000	1	0/7 5/16	Do. 6 per Cent. Cumulative Preference	1/4	1⅛	1/4	1⅛	5 6 8	...	...	...
32,098	3	1/9 3/16	Crompton and Co. (Nos. 1 to 32,098)	3⅞	4⅛	3⅞	4⅛	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	102	99	102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	3/16	1/4	3/16	1/4	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅛	4⅛	3⅛	4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91	93	91	93	4 6 0	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (50% pd)	48	52	48	52	...	...	...	...
26,100	5	6/0	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛	5	4⅛	5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
112,100	2	1/2 3/8	Electric Construction Co. (Limited)	2	2⅛	2	2⅛	5 6 8	January and July	2	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3	3⅛	3	3⅛	4 0 0	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102	105	102	105	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13	14	13	14	6 15 9	February and August	...	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5⅛	5⅜	5⅛	5⅜	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	103	101	104	3 17 10	March and September	103½	...
37,350	12	24/0	Telegraph Construction and Maintenance	35	39	35	39	4 12 4	March and July	37	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101	104	101	104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10	11	10	11	5 9 1	...	10½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	5⅞	4 6 11	...	5⅞	...
30,000	5	7/0	Willans and Robinson Ordinary	10⅛	11⅛	10⅛	11⅛	5 4 4	April and October	10⅝	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6⅛	7	6⅛	7	4 5 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	105	107	4 0 4	May and November	10 ⅛	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	10/0	Blackpool and Fleetwood Tramways	17⅛	18⅛	17⅛	18⅛	4 6 6	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103	105	103	105	4 17 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	23⅛	23⅛	23	23	3 3 10	February and August	23	22
25,000	10	4%	Do. Cumulative Preference (fully pd.)	10⅛	10⅜	17⅛	17⅜	3 13 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	120	118	120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10⅛	10⅜	10⅛	10⅜	4 13 0	May and November	...	...
80,000	10	11/0	British Elec. Trac Ord. (Nos. 1 to 80,000)	14	15	14	15	4 0 0	...	14 1/16	14⅛
15,000	10	8/7½	Do. (Nos. 60,001 to 75,000)	14	15	14	15	...	...	...	...
50,000	10	6/0	Do. 6% Cum. Pref.	13	13	13	13	4 12 4	February and August	13⅛	12⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	128	131	4 0 4	...	125	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	120	123	131	134	...	...	...	...
40,000	5	2/8 1/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5	5⅛	4⅝	5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4	4⅛	4	4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	100	103	103	105	4 17 1	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	96	99	96	99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	9	9⅛	9	9⅛	3 3 2	June and December	9 1/16	9
£955,000	Stock	1½%	City and South London Railway Con. Ordinary	60	64	57	60	3 3 3	February and August	60	57
37,503	10	1/3 1/16	Do. (Nos. 23,501 to 60,000)	6	7	6	7	3 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	132	137	132	137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	123	123	120	123	3 4 5	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22⅛	23⅛	22	23	3 6 8	March and September	23	21
10,000	10	6%	† Do. 6 per Cent. Preference	14⅛	15⅛	14⅛	15⅛	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	116	113	115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	1/16	3/16	1/16	3/16	43 0 0	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16	3/16	1/16	3/16	43 0 0	,, ,,	...	...
80,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10	10⅛	10	10⅛	4 17 6	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 1/16	9 3/16	9 1/16	9 3/16	3 19 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13⅛	13⅜	13⅛	13⅜	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103	105	103	105	3 16 2	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅛	3⅜	3⅛	3⅜	...	...	...	...
80,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4⅛	5⅛	4⅛	5⅛	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅛	10⅜	10⅛	10⅜	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£340,000	Stock	3%	Waterloo and City Ordinary	91	97	93	93	3 3 6	June and December	...	...

In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption

The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,159. [No. 15. Vol. XLV.] FRIDAY, AUGUST 3, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.

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NOTES.

THE Lancashire Electric Power Bill has passed through the committee stage in the House of Lords, but it has suffered considerably in the process. It will be remembered that, in order to meet the objections of the local authorities in the districts affected by the bill, the promoters only sought powers to supply wholesale and with the consent of the local authority, the only compulsory powers they asked for being that of laying mains subject to certain conditions to be imposed by these authorities as to the position the cables should occupy. Notwithstanding the modesty of the demand, and although the Commons Committee, after exhaustive examination, had decided in favour of the bill, the House of Lords Committee has decreed that the important areas of Liverpool, Bootle, Manchester, Salford and Stockport shall be excluded.

THE Corporations of these towns had no need to fear competition with their own electricity undertakings, as it could not be instituted without their own consent in their own areas, and they themselves have no power to supply outside these areas; yet they opposed the bill tooth and nail, their ostensible reason being that they objected to a company having power to open the streets within the Corporation boundaries. The exclusion of these areas will therefore have the effect of sending the mains round by a more circuitous route in many cases, but it should not have any determining influence on the success or failure of the scheme. It is surprising that the town of Southport should have opposed the bill so stoutly before the House of Commons Committee, as it is in a corner of the company's area and is not likely to be traversed by mains unless the Corporation itself were to invite the company to supply; but for the same reason this district might also have been excluded from the company's area without seriously affecting the company's own operations. Perhaps the Lords Committee thought that, as electrical energy was not so cheap at Southport as at Liverpool and Manchester, it would be well to look after the town in spite of the present Corporation, and give it a chance of possibly taking advantage of the company's system in the future. But this argument should also then have been applied to Salford, where the electricity supply works have, up to the present, not presented a marked financial success. Truly, the ways of a Lords Committee are inscrutable.

THE Shannon Water and Electric Power Bill was even less fortunate than the Lancashire Bill, for the House of Lords Committee threw it out altogether. The two grounds for opposition were, firstly, that the bill was not complete, as a further bill to permit the construction of an additional weir would have to follow; and, secondly, that the scheme would interfere with or totally destroy the salmon-fishing industry on the Shannon. The first reason being merely a question of procedure is unimportant; but the second is, of course, of moment from an economic point of view. The value of the salmon fisheries was given by Mr. BALFOUR BROWNE, who represented the Limerick Fishery District Conservators, as £40,000 a year, a figure which we think should be accepted with caution, and, moreover, the statement as to the destruction of the salmon fishery was disputed by more than one piscatorial expert witness. On the other hand, it has been recognised that the remedy for the extreme poverty in the south and west of Ireland is to introduce an industrial element into a country which is now purely agricultural. In the Shannon district, which includes some of the poorest parts of Ireland, a company desires to lay down works for the cheap distribution first of 8,000 H.P., and subsequently a possible 20,000 H.P., which could be employed for industrial purposes, and would tempt large factories to the district, as has already occurred in Lombardy, at Niagara, at Rheinfelden and other places. This would benefit the poorer population directly, to whom but a small fraction of the £40,000 from the salmon fisheries seems to find its way.

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The Tyneside Bill, it will be remembered, failed to secure the approbation of the House of Commons Committee, but the remaining three large power bills have now passed both the Commons and the Lords Committee. The North Metropolitan went through without opposition, an agreement having been arrived at with the opposing local authorities. In the South Wales Bill, a clause, not of vital importance, providing for compensation to two gas companies has been reinstated, it having been struck out by the Government draughtsmen and the Board of Trade after having been inserted by the Commons Committee; but the bill otherwise passed unaltered. The passage of the County of Durham Bill was recorded in our last issue; the alteration made in it by the Lords, excluding two villages from the scope of the bill except as regards wayleaves, upsets the wise recommendation of the House of Commons Committee that the power companies should have the right to supply in districts where no electrical energy was available from the local authorities. Hebburn and Felling, the two villages in question, are, however, worse off than before, for now they are obliged to allow the company's cables to pass through their district without being able to benefit by a cheap supply of electricity.

In a leading article recently (May 25, 1900) we criticised the dallying and half-hearted way in which the directors of the Metropolitan and District Railway Companies had approached the question of equipping their lines for electric traction. Their excuse for not starting work at once was that it was necessary to effect the modification in the method of working without in any way interfering with the present system, and, in fact, to construct an electric line which would enable the old permanent way, rolling stock, and signalling arrangements to be used as before. Consulting engineers and manufacturing engineers, they admitted, possessed sufficient knowledge and experience to construct an ordinary electric railway, but this task was more difficult and quite novel, and it was necessary to take special precautions and try new methods on an experimental line. The experimental line was designed by Sir John Wolfe Barry and Sir William Preece and successfully built, but the directors have again changed their policy. The idea, that the application of electric driving to their line is a novel problem which only their own consulting engineers could solve after previous experimental work, has given way to precisely the contrary opinion; for at the last meeting of the Metropolitan Railway Co. the chairman, speaking for the Board of Directors, "believed that the best and most practical knowledge of electric traction was centred in the leading electric traction firms, and what the Board proposed to do was to ask some of the most eminent firms to submit their views as to the best method or system to adopt for the working of the circle, and invite them to submit offers, with plans and specifications, for the installation." It is satisfactory that this course is to be adopted at last, but the implication in the previous sentence of Mr. Bell's speech, reported in our City Notes this week, that the leading electric traction firms were not three years ago as competent as they are now to equip the "Underground" for electric driving is manifestly unjust and unwarranted.

At the District Company's meeting yesterday Mr. J. Staats Forbes, the chairman of that company, also made a long statement as to electric traction. The trial line between High-street, Kensington, and Earl's Court is to be extended to Putney or some other outlying station in order that it might be "a fair test and not a philosophical one." Still more interesting is the definite information that a request would be sent to-day—Friday—to several firms (Mr. Forbes mentioned Westinghouse, Mather & Platt, Siemens, and "American companies") asking for their opinions and estimates with regard to an electric traction scheme.

Yorkshire College, Leeds.—The next session commences on Tuesday, Oct. 2.

Owen's College (Manchester).—The engineering drawing office and Whitworth engineering laboratory will open on October 2nd, and lectures will commence on October 3rd. Particulars can be obtained from the registrar, Mr. Sydney Chaffers.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

The Institution Meeting in Paris.—Permission has been granted for the Institution of Electrical Engineers to hold a reception in the British Royal Pavilion in the Paris Exhibition from 5 p.m. to 7 p.m. on Wednesday, August 22. Arrangements for the reception are being made accordingly.

Physical Congress at the Paris Exhibition.—We remind our readers that the International Physics Congress at the Paris Exhibition will open on Monday, August 6th, at 3:30 p.m., in the Palais des Congrès. An extract from the programme was given in our issue of June 1st. The Electrical Congress will be held from August 18th to 25th, as already announced.

Opening of the Dublin-Howth Tramway.—The new electric tramway line from Dublin to Howth was opened on Thursday last week. The system has been constructed and is worked by the Clontarf & Hill of Howth Tramroad Co., the Dublin United Tramways Co. supplying the power and only taking charge of the cars between Dublin and Dollymount, which is a section of the latter company's lines.

The Chinese Crisis.—The Great Northern Telegraph Co. is establishing cable communication between Chifu and Taku and will lay other cables in the Gulf of Pechili. A submarine line is also to be laid from Chifu to Shanghai, forming a connecting link between North China and the existing cable system, which will be very important and valuable to the European Powers and the United States.

The National Lecture Society.—We are asked to announce that with a view of increasing British trade and spreading a better knowledge of articles manufactured in this country, the National Lecture Society is arranging a series of illustrated addresses on British industries, to be given in all important commercial centres throughout the world. Those who are desirous of availing themselves of this movement are invited to write to the honorary secretary, Mr. Leslie Stewart, Imperial Institute, London, S.W.

The Hughes Medal of the Royal Society.—It will be remembered that the late Prof. D. E. Hughes bequeathed the sum of £4,000 to the Royal Society, as well as similar amounts to the Institution of Electrical Engineers and the Académie des Sciences. The Royal Society has decided to devote this legacy to the institution of a gold medal to bear the bust of Prof. Hughes, and to be awarded annually for original work in electricity and magnetism, or their applications. Discoveries

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to qualify for the medal must have been published not less than one year before the award of the medal. There is no restriction as to the sex or nationality of the candidates.

New Atlantic Cables.—The Commercial Cable Co.'s new cable from the Azores to New York *viâ* Nova Scotia has now been completed by Messrs. Siemens Bros. & Co. This line, which forms the Commercial Co's. fourth Atlantic cable, connects at Fayal with the system of the Europe and Azores Telegraph Co., and was opened for traffic on Wednesday last. Messages between North America and Germany will be carried by the German Atlantic Telegraph Co.'s cable from the Azores to Borkum.——The Telegraph Construction and Maintenance Co.'s steamer "Anglia" left for New York on Thursday last week to commence laying the remaining part of the German Atlantic Telegraph Co.'s cable from New York to Fayal.

Fire at the Lachine Rapids Works.—A serious fire occurred on June 24 at the sub-station of the Lachine Rapids Co., at Montreal. The fire, the precise cause of which was unknown, started on the low-pressure switchboard and spread to the 4,000-volt board, and immediately after the whole building was ablaze. The damage would have been more serious still had it not been for the presence of mind of the general superintendent, Mr. R. S. Kelsch, who rushed through the flames to the private telephone on an upper floor, in order to instruct the power house to switch off the current. The night watchman unfortunately was killed. Twenty hours after the accident the company succeeded in resuming the supply to all their customers.

Competition for the Invention of Insulating Gloves.—A prize of 1,000f. (£40) is being offered by the Association des Industriels de France contre les Accidents du Travail, 3, Rue de Lutèce, Paris, for the most efficacious insulating gloves for electrical workmen. They should be strong enough to resist not only the electric pressure, but also accidental perforations by copper wires, &c., and must, in addition, be easy to wear by hands of any size and allow the workmen's fingers sufficient freedom to execute their work. The competition is international, and competitors must send two pairs of gloves, accompanied by an explanatory note to the President of the Association before Dec. 31, 1900. The Association reserves to itself the right to publish descriptions of samples submitted to it, and inventors should therefore take the precaution of protecting their invention previously.

Thunderstorms.—A good deal of damage was caused by last Friday's thunderstorms in several parts of the country. The Post Office telegraphs and telephone testing station at Weedon, through which a large number of main-line wires from Ireland, Scotland, and England pass, was only saved from partial destruction by the arrival of 100 soldiers from the barracks with a fire engine. The communications were complete again by daybreak on Saturday, although to accomplish this the wires had to be joined up without running them through the testing station. In Berkshire, the Isle of Wight, Kilkenny, and Worcestershire men and animals were killed by lightning, whilst at Bulford Camp one volunteer was killed and a dozen or more injured. At Kingston-on-Thames the post office was struck, although without interrupting the telegraphic service, and in all parts of the country serious damage to property was done.

Central London Railway.—The Central London Railway was opened to the public on Monday last, and both from a technical and financial point of view the line promises to be eminently successful. Crowds of people made use of the new line all day, and general satisfaction is expressed with it by the travelling public. The run from the Bank station to Shepherd's Bush takes only 25 minutes, and the trains follow at five-minute intervals, stopping 30 seconds at each station. A slight hitch occurred for an hour at about seven o'clock in the evening owing to the brake of one of the 12 trains in use getting out of order as it was entering Tottenham Court-road station from the City side. The railway carried 85,400 passengers on Monday, and 90,000 on Tuesday. —— On Friday last a large number of the members of the Institution of Junior Engineers availed themselves of the opportunity afforded by Mr. Basil Mott for visiting the generating station and the line.

The Patent Office Library.—The Patent Office is issuing convenient "subject lists" as a guide to those who have occasion to use the Patent Office library. Each volume contains a general alphabetical list of subject-headings with descriptive entries in chronological order of the books arranged under these headings. In this way the operation of picking out works referring to any particular subject or part of a subject will be greatly facilitated. In preparing the lists, the contents of the work have been considered in preference to the language of the title page, which is often misleading. Searchers who desire to find a particular book by a given writer or with a given title can always find it by consulting the general library catalogue. The first volume of this series, including only "photography and the allied arts and sciences," has just been published, and its price is 6d. We trust that the volumes relating to electrical subjects will soon follow, for such a reference catalogue will prove most useful.

An Amusing Dispute.—The town of Dudley was entertained on Saturday and Sunday last by an amusing dispute between the Corporation and the British Electric Traction Co., with regard to the laying of feeder cable for the Dudley and Sedgeley tramway. It appears that the company decided to lay cable on the "draw-in" system, while the Corporation desired that they should employ the "solid" system, similar to that used on the Corporation lighting network. The Corporation maintain that in their agreement with the company the latter undertook to lay the cables to the Corporation's satisfaction, whereas the company say that the Corporation has only the right to indicate in which part of the roadway the cables are to be laid. This difference led to a passage of arms in the streets, which is graphically described as follows in the *Birmingham Daily Post*:—

> The laying of the cables within the borough commenced during the latter part of the past week, and on Thursday, the 26th, the Tramway committee of the Town Council received an intimation from the company of their intention of using the cast-iron pipes throughout, and, if necessary, of using force to carry out the work in that way. An offer by the Corporation to lend the company earthenware troughs for the purpose of doing the work according to the "solid" system was rejected; and in spite of the representations and protestations made by the representatives of the Corporation to the officials of the company the laying of the cable in cast-iron pipes was expeditiously proceeded with, the work on Saturday morning being completed for a distance of over half a mile. Finding that their wishes had been set at defiance, the Tramway committee resolved to take action, and sent a posse of police with a view of stopping the work, but the tramway officials and their men refused to desist. The Corporation officials, not to be beaten, were promptly on the scene with a staff of about 30 men, and for the ensuing four or five hours the extraordinary spectacle was presented of the company's men busily making excavations and the Corporation's employés as actively filling them up again. The futility of such proceedings was at last realised, and at about six o'clock in the evening a truce was declared between the rival workmen. Fearing a display of hostility, a detachment of police remained along the route of the cable throughout the night. At six o'clock on Sunday morning, on the company's men arriving to resume work, they found that the Corporation's traction engine had been placed across the road at the spot where the junction of the cable with the Stourbridge system had to be made. This formidable obstacle, however, failed to deter the persistent tramway men, who commenced to excavate underneath the traction engine, and it was stated that an effort was made to eject the men from the trench, one of whom had his clothes badly torn in the scuffle. Again a staff of the Corporation men were despatched to the spot to prevent the work proceeding. The company's officials, finding that the excavations made by their men were being filled up as fast as they were dug, hired about a dozen carts, and with these removed the refuse as it was thrown out of the trenches. The Corporation men, however, were equally determined not to be foiled, and promptly filled up the excavations with ashes and rubbish, and for a time the tramway employés were completely baffled. After this sort of thing had been going on for some time the company's men executed a counter move by surrounding the trenches with the carts, and in this way succeeded, despite the efforts of the rival workmen, in laying over 50 yards with pipes. Thousands of people flocked to the Wellington-road on Sunday morning to witness the proceedings, and the efforts of the rival workmen to frustrate each other were a continual source of amusement, the unsuccessful endeavours of either section occasioning outbursts of laughter. Eventually the company's foreman received instructions from head-quarters to suspend operations for the day.

It was stated that the Corporation would make an application in the Court of Chancery for an injunction against the company to prevent them from continuing their work, but on inquiry at the company's offices we hear that no notice of such an injunction has yet been given. The company are, in the meantime, continuing the work which, besides the laying of mains, includes the altering of the gauge from standard to 3ft. 6in.

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SOUTHPORT COMBINED LIGHTING AND TRACTION SYSTEM.

(*Concluded from page 512.*)

One only of the three continuous-current sets has been put down up to the present. They are Peebles dynamos, driven by Belliss engines (Fig. 6). The engines are the ordinary Belliss E.C. 12 size, rated at 375 B.H.P., with a steam pressure of 130lb. per square inch at the stop valve, with 100deg. of superheat, and running at 350 revs. per min. When running condensing, as at Southport, the steam consumption per kilowatt is guaranteed at 28lbs. The 200kw. compound-wound dynamo, generating current at a pressure of from 500 volts to 550 volts, is four-polar, with a drum armature and carbon brushes. Besides its compactness its chief feature is the pole pieces shown clearly in the sketch, Fig. 6. As is seen, the leading horn has a small cast steel projection bolted to it with the object of securing complete sparklessness of the brushes. The armatures are slot wound and fitted to spiders of rigid design and thoroughly ventilated. The efficiency of the combined set is stated to be 89 per cent. at full load. We are informed that Peebles dynamos have also been ordered for traction purposes at Aberdeen, Barrow-in-Furness, Carlisle, Dewsbury, Erith, Perth and Warrington.

The tramway switchboard, shown in Fig. 7, owing to exigencies of space, had to be built in an angle of the building, and this has proved a most convenient arrangement. Messrs. Dorman & Smith have supplied this part of the plant. It is built up of polished slate panels mounted on a skeleton frame of T-iron. On the right are three generator panels, each with an ammeter, a voltmeter, the hand wheel of the shunt rheostat, and three double-break switches—equaliser, + and − respectively. The next two panels are for the insulated rail feeders, both of which come from the same point of the tramway system. On these panels are four ammeters (two of which are spare), two voltmeters with plugs for connecting them to any circuit, and two recording wattmeters, one for the energy leaving the 'bus bars, the other to record the energy used for lighting the works. The two centre panels are for the Board of Trade instruments, with the exception of the upper half of the left-hand of the two, which it is seen has two smaller switches and an ammeter, and controls the works lighting circuits. The Board of Trade panels are at present being altered, as according to their present arrangement allowance has not been made for the rail feeders. On the right are the four circuit panels, each fitted with an ammeter, a Wurtz lightning arrester (with its choking coil behind) a circuit-breaker, a two-way switch (allowance being made for the possible employment of boosters subsequently, when the top contacts will include the booster in the circuit and the bottom contacts will connect the dynamo straight to the 'bus bars) and a Thomson recording wattmeter. Messrs. Dorman & Smith's circuit-breakers are

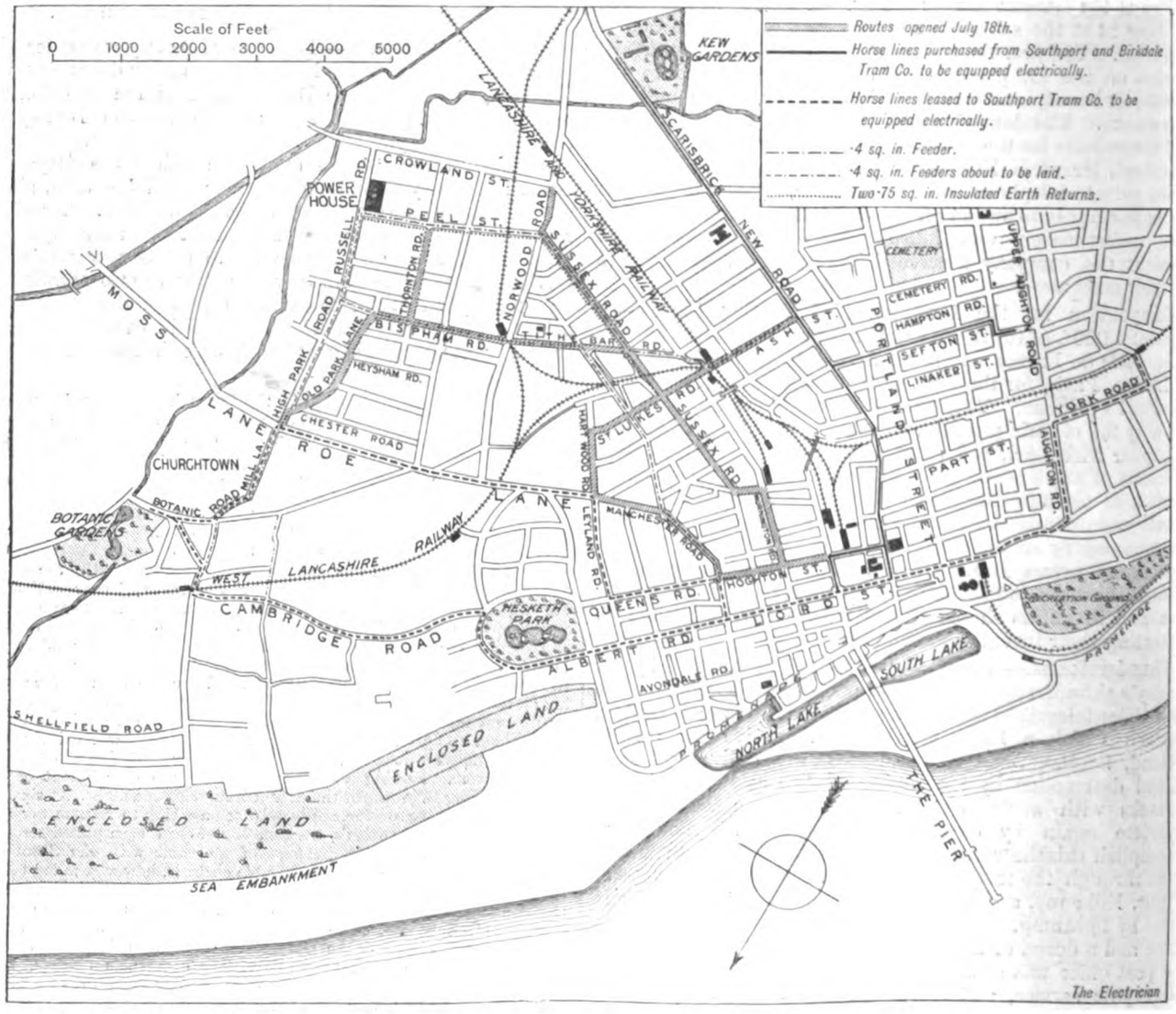

FIG. 5.—MAP OF SOUTHPORT SHOWING TRAMWAYS AND TRAMWAY FEEDERS.

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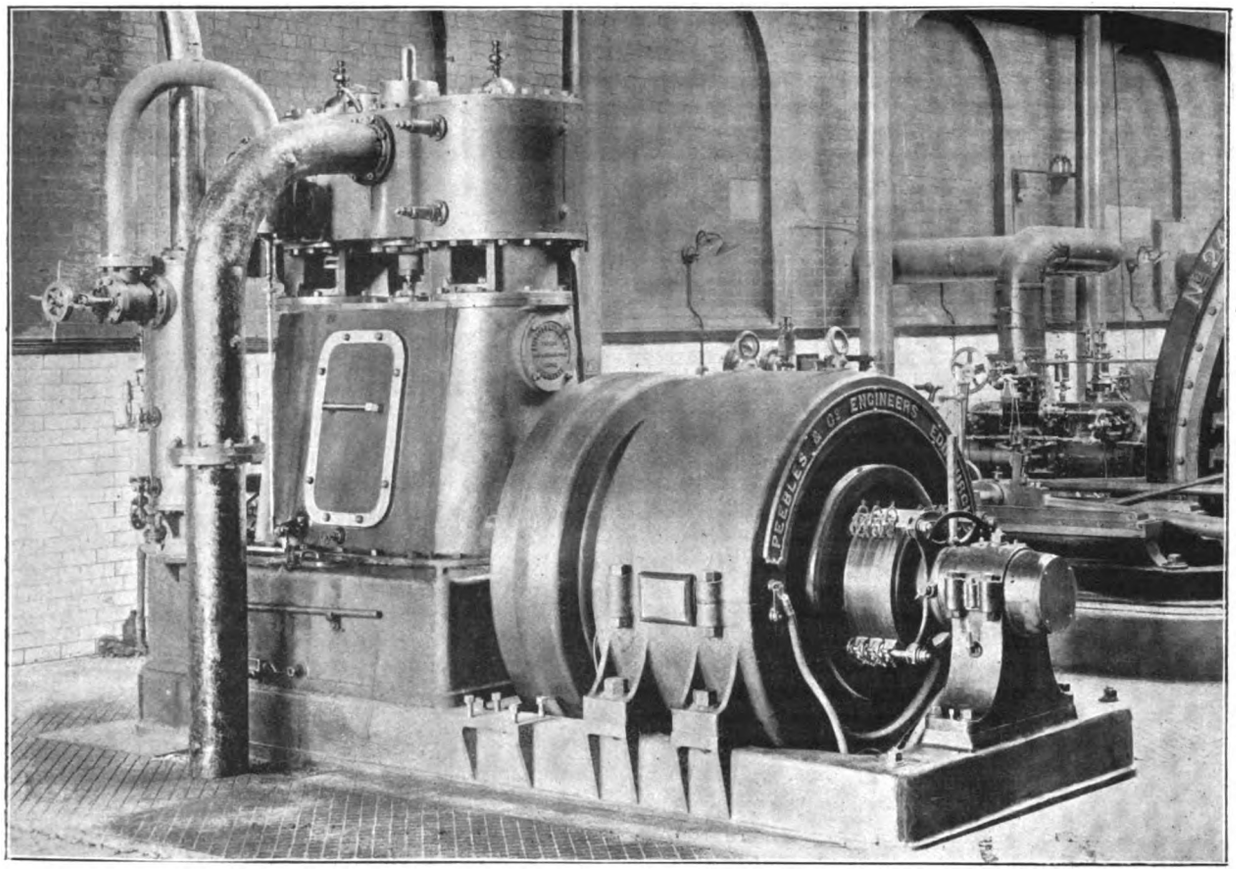

FIG. 6.—200KW. BELLISS-PEEBLES TRACTION SET.

FIG. 7.—TRAMWAY SWITCHBOARD.

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of a particularly neat design, shown in Fig. 8 in front and side elevation, the right-hand drawing showing a side elevation of the right-hand part of the device only. A tongue holds the laminated brush in position in its contacts against the force of a spring so long as the handle on the right is in its upright position and its roller is pressing against the intermediate brass piece. The main current, however, passes through the bare copper coil on the extreme right at the lower corner, and when this gets too strong it attracts the small piece of iron over it and pulls over the lever to its unstable position, from which it falls, allowing the other two parts also to fall back and break contact. The *modus operandi* is difficult to describe, but

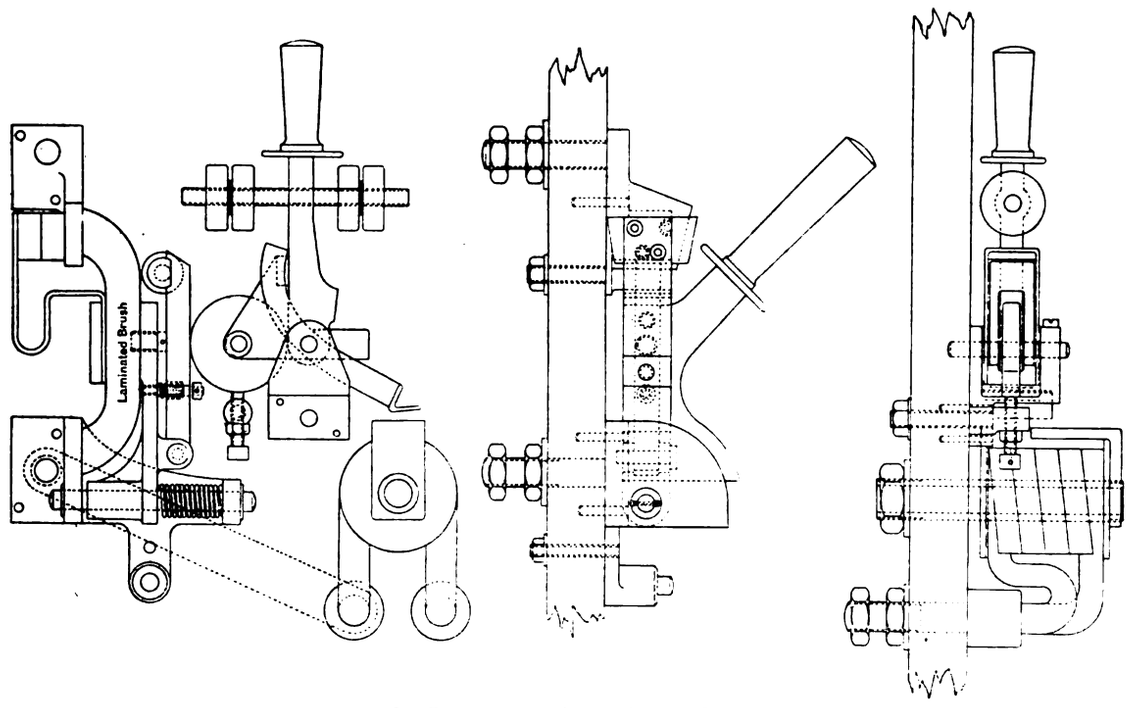

FIG. 8.—DORMAN AND SMITH CIRCUIT-BREAKER.

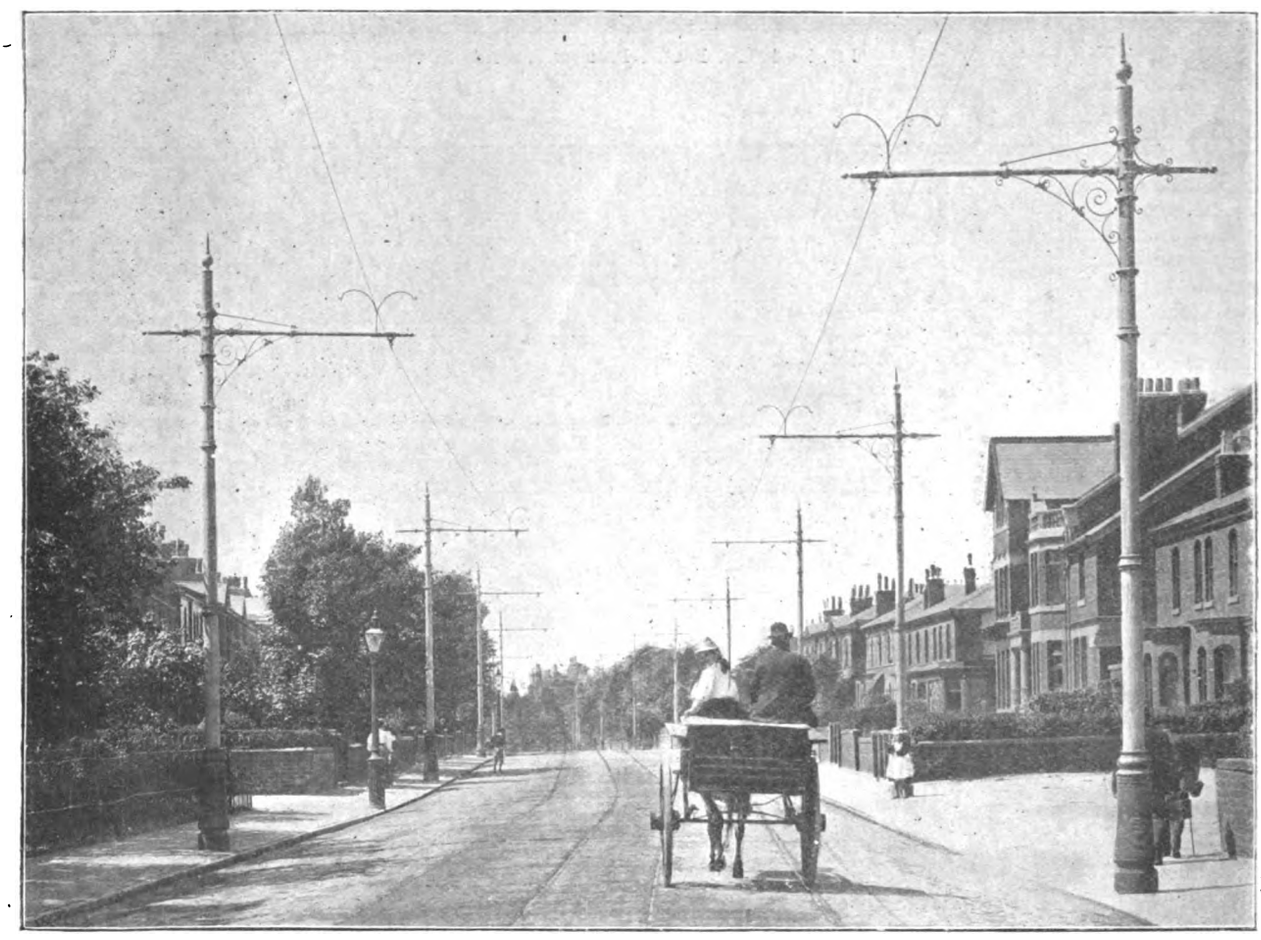

FIG. 9.—DOUBLE POLE LINE IN MANCHESTER ROAD.

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can be made out from the drawing. The dial voltmeters and ammeters are of the Weston make, and the recording ammeters of Messrs. Elliott Bros. standard pattern.

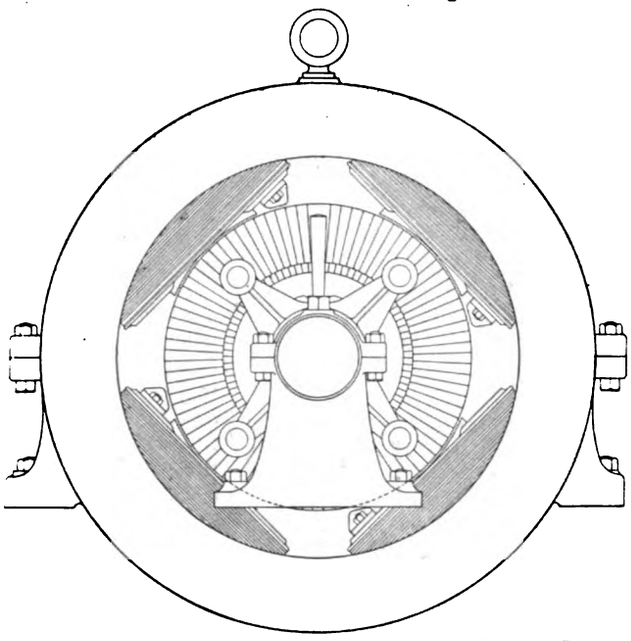

FIG. 10.—SKETCH SHOWING SHAPE OF POLE-PIECES OF PEEBLES DYNAMO.

A large extension is being built to the engine room, big enough to contain plant for a light, power and traction system of greater dimensions than that ever likely to be attained at Southport. No doubt this extension may have something to do with the violent antipathy that some of the members of the Corporation have to the power bills, one of which was described in a speech of the chairman of the Tramways committee, on the opening day, as "that abominable bill"—any mention of the name or scope of the bill being deemed redundant. The existing engine room measures 120ft. by 60ft. by 18ft. high; and the new one, of which the walls and roof are already finished, is 20ft. wider and considerably higher, its dimensions being 94ft. by 80ft. by 25ft. high, the heights in the two cases being given as the distance between the under side of the traveller and the floor.

The boiler house has been extended a corresponding amount. Six boilers are in use at present, all of the Lancashire type, with the dimensions 28ft. by 7ft., and by various makers. They are hand-fired. In the new boiler house, Messrs. Musgrave & Sons are putting in three Lancashire boilers, 30ft. by 8ft. 6in., rated at 600 H.P. in aggregate, all fitted with Musgrave superheaters to give 120deg. of superheat. A 360-tube economiser, by Roberts Bros., is also to be added, the existing 288-tube one of the same make, having given satisfaction. The scrapers are driven by a Langdon-Davies motor. A railway siding has been put down next to the boiler houses, so that the coal can be discharged directly from the trucks into the coal bunkers, the boiler room floor being below ground level and the tops of the boilers on a level with the engine room floor. The original ring steam main has given place to a single range of pipes.

As already mentioned, the vertical Musgrave engine has its own jet condensers. In addition, there are Körting and Browett-Lindley condensers for the other sets. There is a large cooling pond in front behind the works and water is pumped from a brook in the vicinity.

Near to the generating station a spacious car shed is being built. The building will be of brick with timber ends, and will contain three bays, one of which will be walled off for a repairing shop. A whole army of workmen is employed in order to get the building ready, as at present the cars have no roof under which to shelter their weary motors and their chocolate and cream flanks. In fact, as is unfortunately frequently the case, it would have been well to have delayed the opening day a little, as several alterations were necessary in the overhead equipment, and it is also scarcely wise to run a line from a single generating set, the dynamo of which bore evidences of being erected in a hurry, while the reserve set is still in its packing cases. During the excavation for the foundations of the car shed a large quantity of peat has been dug up. It is not proposed to burn this as fuel in the boilers, although a German chemist is reported to have calculated recently that one acre of good peat turf 10ft. thick gives 1,000 tons of dry turf, equivalent to 480 tons of coke!

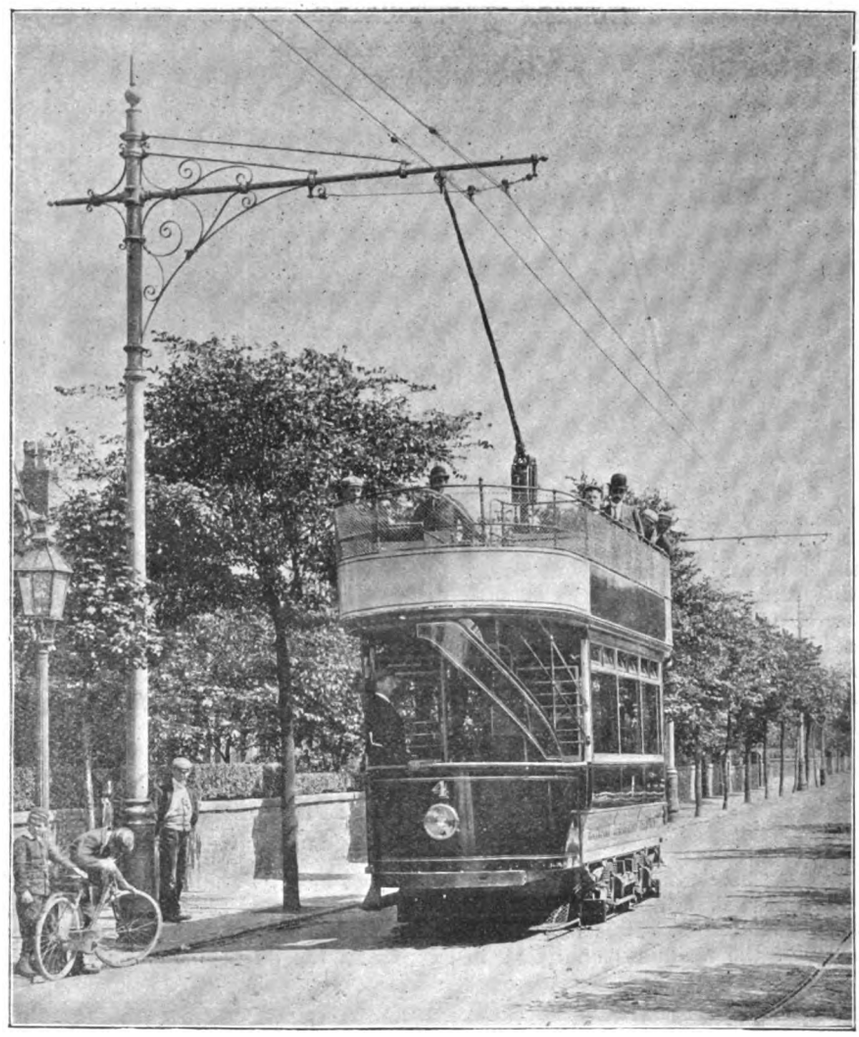

FIG. 11.—SINGLE BRACKET POLE WITH TWO LINES IN SUSSEX ROAD.

Fig. 5 is a map, drawn to scale, showing the extent of the lines now open, the position of the power-house, and the lines about to be equipped electrically. The position of the feeders and rail returns is also shown. At present there is only one feeder of 0·4 sq. in. section, but three more are to be laid. The two insulated rail feeders each of 0·75 sq. in. section for the centre of the system, will suffice for all the routes when completed. In addition, there are pilot wires measuring the fall of potential on the rails, and also wires for telephones, which will be placed in the section boxes. The feeders are laid on the Callender solid system in ∪-shaped stoneware troughs. The lengths of stoneware troughs have sockets, and, as the

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cross-section is larger than a semi-circle, the pipe-line is locked, and adjacent lengths of pipe cannot sink unevenly. After the cables have been drawn in, and the pipe filled with compound, the duct is covered with a stoneware brick. Compound is also used to fill the space in the sockets.

Single-bracket poles (Fig. 11) holding the two wires are chiefly employed in the overhead construction, but in one instance (Fig. 9) a double line of poles is employed, one line on each side of the road. The poles are of an elegant design, and even where there are guard wires, as seen in Fig. 9, they are not unsightly. Some details in the attachment of the guard wires and anchor wires are open to criticism, as, for instance, making-off the anchor wires on the trolley wire ears and the omission to secure the guard wires (which are also noticeably kinked in places) to the hooks. The latter is a serious defect, for in the case of a guard-wire breaking several hundred yards of it might come down. A method of flexible attachment adopted on one of the routes is shown in Fig. 11. The trolley wires are of 00 B. & S. gauge (0·364in. diameter), two wires are used throughout for the cars in the two directions, and the line is divided approximately into half-mile sections. At the feeding points vulcanised indiarubber wire is employed from the section boxes to the trolley line. Messrs. Macartney, McElroy & Co. were the contractors for the overhead equipment.

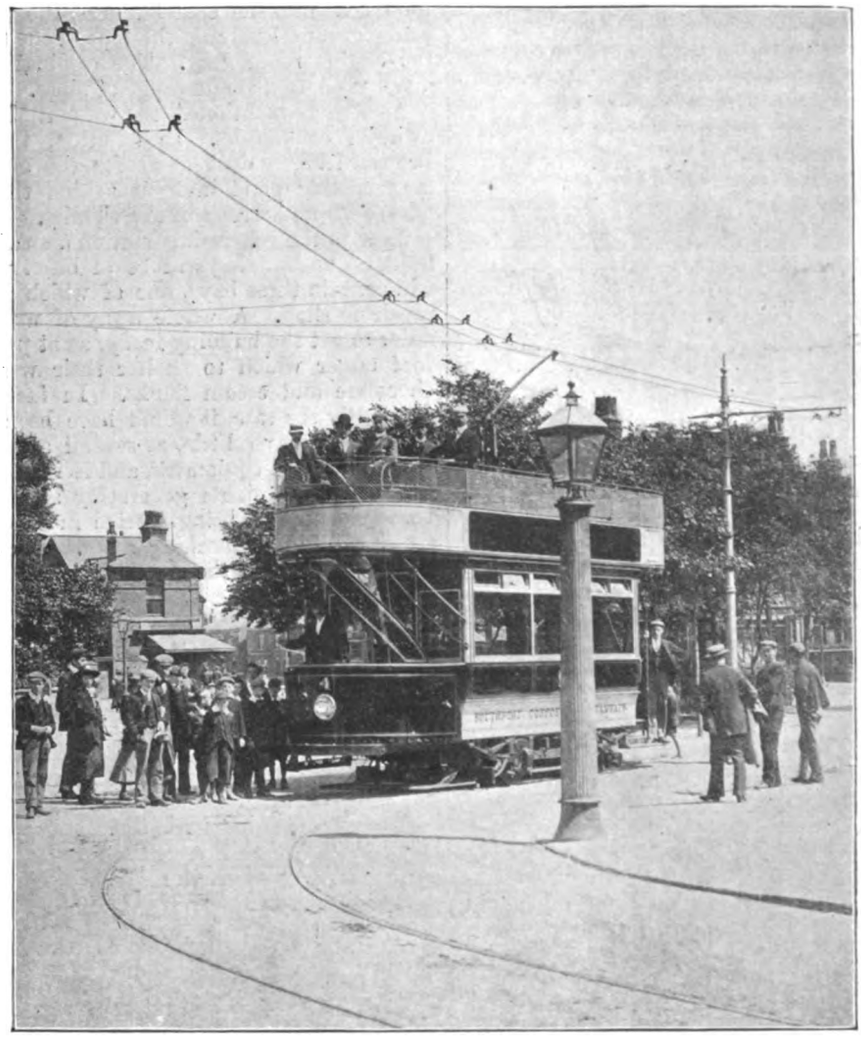

Fig. 12.—A Sharp Curve.

The contractors for the rails and permanent way were Messrs. Dick, Kerr & Co., and some 800 tons of steel girder rails of their No. 75 section have been employed. These rails weigh 87lb. to the yard, are made up in 40ft. lengths, and are jointed with the firm's "Dicker" joint and 0000 "Neptune" bonds. Cross-bonding is done every 120ft. The gauge is standard, 4ft. 8½in. The points and crossings were supplied by Messrs. Askham Bros. & Wilson. The points are 7ft. 6in. long and 6½in. deep.

The rolling stock for the present consists of nine double-decked cars, but there are also six single-decked cars on order, Messrs. Dick, Kerr & Co. supplying both types to the Corporation. The cars now running have been manufactured at the Electric Railway and Tramway Carriage Works at Preston, and, as seen in the illustrations, are of the reversed stairway type which, while affording complete protection to the passengers from the danger of falling when ascending and descending the stairways, also allows an increased seating capacity of something like 12 per cent. The cars are of handsome appearance. They are mounted on Brill 21 E. single trucks and are lighted electrically, having eight lamps in the interior and also headlights and platform lamps. The electrical equipments were designed by Prof. Short, and are of the same type as those supplied by the contractors to Liverpool, Bolton, Dover, Sunderland, and other corporations. The American motors are, however, only to be left on the cars temporarily, and will soon be replaced by motors of a new design of Prof. Short's, which will be manufactured at the new works of the English Manufacturing Co., recently described in *The Electrician*. Two 25 H.P. motors are fitted to each car and the controllers are of the solenoid blow-out pattern. Each car carries 22 passengers inside and 34 outside. The six single-deck cars on order are combination open and enclosed cars seating 16 passengers inside and 16 outside. As there are no grades of any importance on the routes, ordinary hand ratchet brakes have been fitted with a short-circuiting brake for emergencies.

THE PARIS EXHIBITION.—III.*

(BY OUR SPECIAL CORRESPONDENT.)

The 1,500kw. Willans-Siemens set desersves first mention among the three English machines generating current for the light and power supply of the exhibition. It is one of the largest, in point of capacity, of the machines exhibited in operation by any of the countries represented, yet in point of actual physical dimensions, especially as regards the floor space it occupies, it is almost one of the smallest. The engine (Fig. 8) is the largest Messrs. Willans & Robinson have yet built; but, in spite of its large size, a fast speed has been adopted (200 revs. per min.), and it has therefore been possible to retain the single-acting principle and to construct the engines with but little modification from the lines usually adopted by the firm, and admirably described in Mr. Mark Robinson's Paper read before the Institution of Electrical Engineers in 1895.† Briefly, therefore, the engine

* Preceding articles appeared in *The Electrician* of July 20 and 27.

† See *The Electrician*, Vol. XXXV., pp. 152, 93 and 117.

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is a central-valve, triple expansion, three-crank engine, and the following are the chief dimensions, &c.:—

Cylinder diameters: 49in. (1,250mm.), 30 1/8in. (770mm), and 18 7/8in. (480mm.).	
Stroke	23 5/8in. (600mm.).
Maximum power for continuous running:	2,400 H.P.
Ditto short periods	3,000 H.P.
Speed	200 revs. per min.
Weight	120 tons.
Floor space occupied	31ft. by 11ft. 1in.
Steam pressure	10 atmospheres.
Worthington jet condenser.	

Among the modifications necessitated by the larger size is that the bed-plate is divided longitudinally into two parts, down the centre-line of the crank shaft, and is bolted together to form the usual oil bath. Each piece weighs about 15 tons. The crank chamber upper-part is also divided; and the lower portion is in four pieces, so as to enable the crank shaft, connecting rods and crossheads to be withdrawn if necessary, without dismantling the engine. The exhaust chamber is in one piece. The governor is of Messrs. Willans' usual centrifugal pattern, but it is placed vertically, and driven by screw gearing on the crank shaft, in accordance with the practice the firm adopted in all its larger engines. The crank shaft, in spite of its size, is in one piece, with the eccentric forged upon the crank pins as usual. The diameter of the journal is 14·5in. (368mm.), and the total weight of the shaft is about 12 tons. Contrary to the practice of several of the German firms, which have adopted heavy flywheels in addition to heavy flywheel armatures, the armature of the dynamo is considered sufficient in this respect, and a coupling disc only is supplied upon the engine. The coupling disc serves also for the purpose of barring. The firm has two other machines of the same size on order for the Glasgow Corporation.

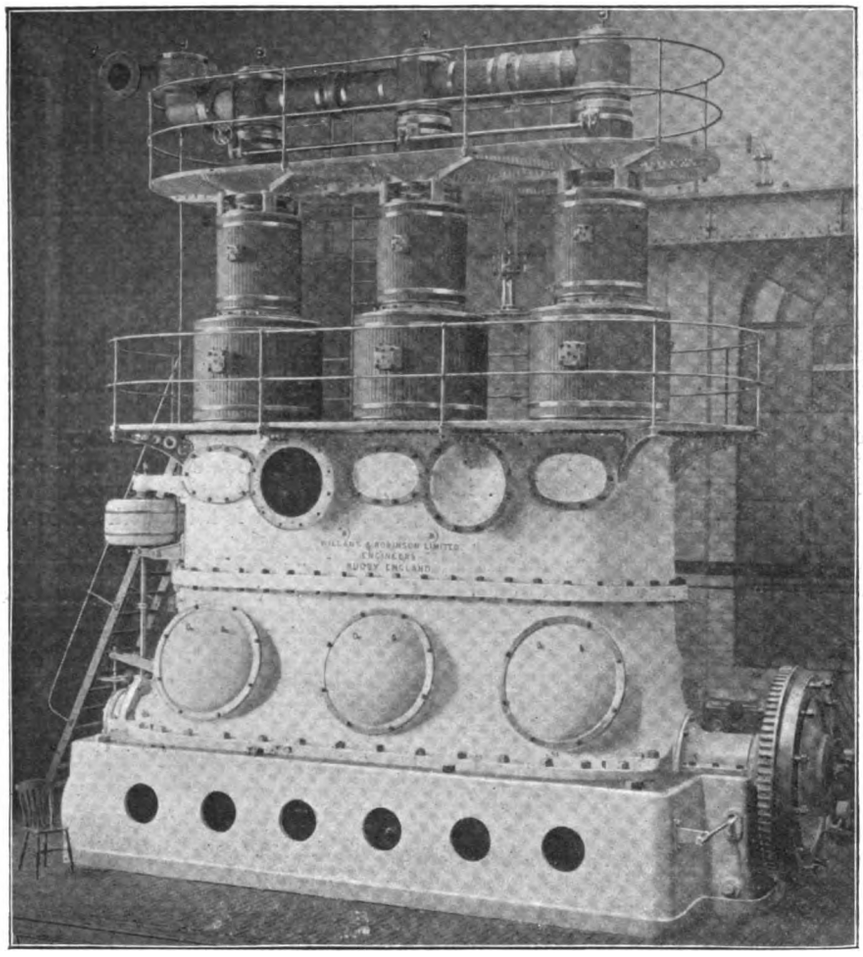

FIG. 8.—2,400 H.P. WILLANS ENGINE.

In the generator (Fig. 9) the field magnets consist of a circular ring of cast steel, 14ft. outside diameter, made in two halves which are bolted together. There are 16 inwardly projecting poles (forming part of the ring casting), each of which carries a bobbin wound with copper wire. The armature is of the usual slotted type, built up of a number of toothed segments of sheet iron supported by a cast steel spider, and bolted together by end castings. It is provided with ventilating ducts. Each slot contains four insulated solid copper bars, which are connected so as to form a multiple circuit singly-wound drum winding. The end connections are of the barrel type.

The commutator is 66in. in diameter, and has 616 segments of hard copper insulated by mica. It is so arranged as to permit of removal of sections without pulling the whole commutator apart, and is long enough to allow of axial adjustment of the brushes to equalise the wear. There are 19 carbon brushes to each spindle, carried by aluminium holders, and pressed against the commutator by means of steel springs. Flexible copper strips connect the brush holders with the gun-metal bar to which the cable connections are made. The brush arms are fixed by insulated bolts to horizontal projections from the cast-iron ring which can be rotated for adjustment of the brushes in the usual manner.

The sole-plate of the dynamo carries an outer bearing of ample proportions; it is provided with a stair and rails for inspection and for attending to the lubrication. The weight of the dynamo complete with sole-plate and bearing is 60 tons; of the armature including commutator and spindle, 29 tons.

The switchboard presents no special features except that the minimum cut-out and the switch are of extremely massive construction, in view of the large current that has to be carried. The fixed contacts of the minimum cut-out are made up of copper gauze brushes so arranged that the pressure of contact can be adjusted, and the single-pole main knife switch has a heavy laminated J-shaped contact-piece attached to the switch arm, and this breaks the circuit in four places, the switch being designed for a maximum current of 3,500 amperes.

Next to the Willans-Siemens set is another typical English steam dynamo—a Mather & Platt generator driven by a Galloways' vertical compound engine. The dynamo is shunt wound, and has an output of 220 to 250 volts and 1,400 amperes, at 105 revs. per min.; it is, however, capable of carrying a temporary overload up to 1,600 amperes. It is of the 12-pole type, the yoke ring and magnet cores being of cast steel, and arrangements are made so that the lower half of the ring can be lowered into the foundations, enabling any magnet winding to be taken off or to be easily inspected. The armature is central hung (as seen in Fig. 11), being mounted upon the crank shaft between the two engine bearings, so that the dynamo has no bearings of its own. This construction has recently been adopted by Messrs. Mather & Platt in their larger machines, *e.g.*, in those recently described in connection with the Bolton tramways. The armature is not keyed to the shaft but bolted directly to the heavy flywheel with which the engine is provided. The armature is of the slotted type, the bars being laid in insulating troughs, and entirely embedded in the iron of the core, and the commutator is of large diameter and width. The brush holders for the carbon brushes are fitted with a practical

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"hold-off" attachment, enabling a carbon to be replaced during running simply by lifting off the brush and without disturbing the adjustment of the pressure with which it bears on the commutator.

The efficiency of the generator is stated by the makers to be 94 per cent., which, with a stated engine efficiency of 91 per cent. gives a combined efficiency of 85·5 per cent.

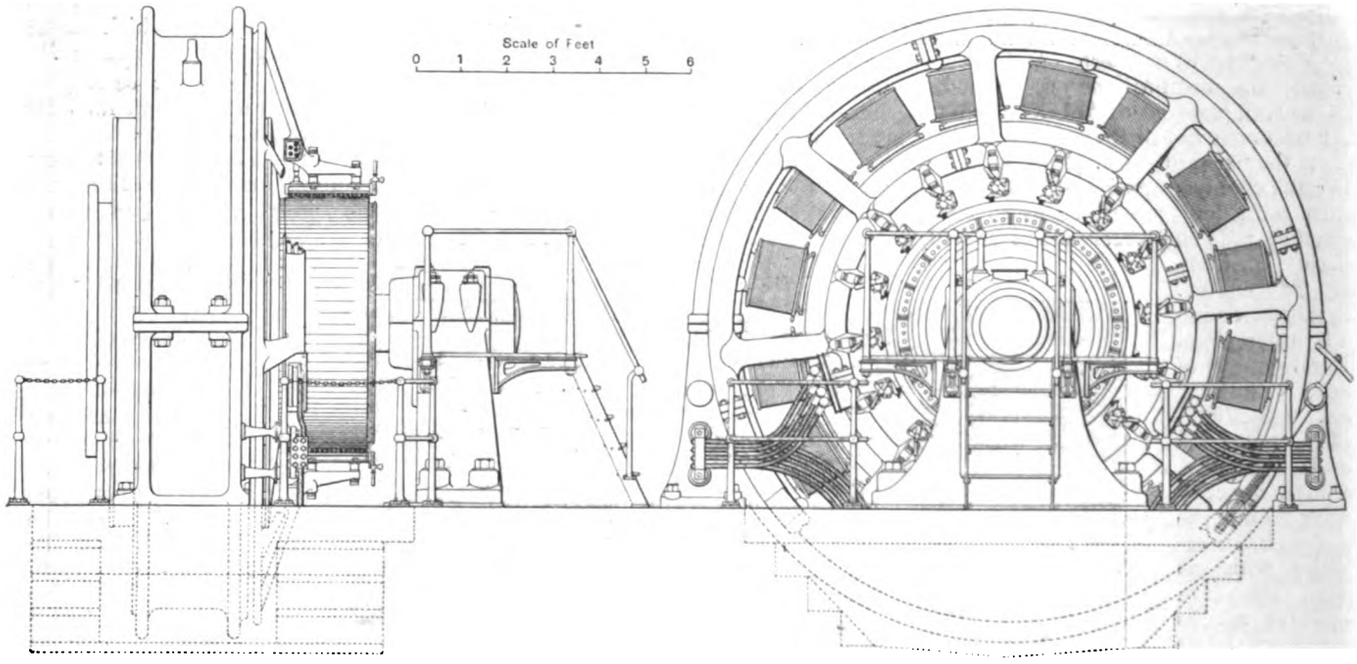

FIG. 9.—SIEMENS BROS. & CO.'S 1,500KW. MULTIPOLAR CONTINUOUS-CURRENT DYNAMO. (2,730 amperes at 550 volts; 200 revs. per min.)

The engine is capable of developing up to 680 I.H.P. when provided with steam at 10kg. per sq. cm. and running at 105 revs. per min. The high-pressure cylinder is 18in. in diameter, and the low-pressure 34in., both being arranged for a stroke of 3ft.; the cylinders are erected on standards of an enclosed type, the flywheel and dynamo being mounted between them as already explained. The distribution of steam to both high and low-pressure cylinders is effected by Corliss valves, having separate chests for steam and exhaust, both sets of valves deriving their motion from eccentrics fitted on the crank-shaft, driven from the end of the main crank pins. The steam is superheated between the high and low-pressure cylinders. The whole of the valve gear is arranged on the outer sides of the standards, and thus, owing to its accessibility, admits of ready adjustment at any time from the outside of the engine, and further, in conjunction with the enclosed design of the standards, avoids the risk of any oil, steam, or water being splashed upon the dynamo. The governor, which is of the high-speed, centre-weight type, is positively driven from the valve shaft, and acts on the high-pressure cylinder; provision is also made for the adjustment of speed by hand while the engine is running. A system of forced lubrication is adopted. The condenser is of the ejector type and is fitted with an independently-driven water pump.

Two other machines in the British section which, on account of their compactness, have attracted considerable attention from foreign engineers, are the Parsons steam turbines and dynamos. They are shown revolving at their full speed, but not under load, as they do not supply current for the service of the exhibition. The design of these machines is more or less familiar to British engineers, however, and need not be recapitulated here. Fig. 10 shows the larger of the two,

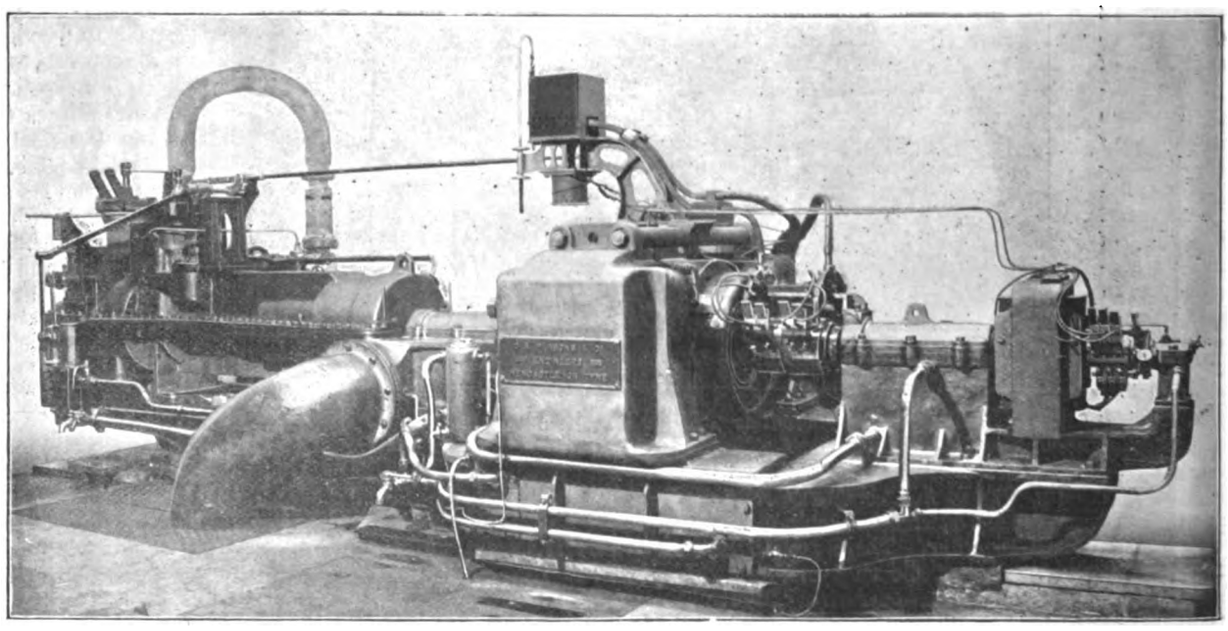

FIG. 10.—500KW. PARSONS TURBO-ALTERNATOR.

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a 500kw. alternator. The armature is directly coupled to the turbine shaft, its speed being 2,400, and, the magnets being four-polar, the periodicity is 80 ~ per sec. The voltage is 2,400. The exciter is also coupled directly to the main armature shaft. Two governors are provided, an electric one for constant voltage and a mechanical one for constant speed. The turbine runs condensing, and works with a boiler pressure of 130lb. per square inch. Its bearings are lubricated by oil delivered under a pressure of about 5lb. per sq. in. from a small pump driven off the turbine shaft. The steam consumption at full load of this set is said to be about 23·5lb. per kilowatt hour, and at half load 25·5lb., and the nominal load may be exceeded by 20 per cent. The set occupies a floor space of only 25ft. by 6ft. 4in., and its complete weight is only 18 tons.

The smaller Parsons machine is a 50kw. continuous-current one which makes use of its condenser as a bed-plate, a combination only possible with a turbine where there is a complete absence of reciprocating motion and vibration. This machine also drives its own air and circulating pumps from the main shaft by means of a worm and worm wheel. The steam consumption of this plant is stated to be 38lb. per kilowatt hour, including the power required to drive the pump. The speed is 3,500 revs. per min., and the boiler pressure is 120lb.

The third English set generating current for the light and power service of the exhibition is a Robey-Ernest Scott & Mountain combination. Its engine is a cross-compound condensing engine with tripvalve gear, the dynamo and flywheel being placed between the cylinders. Its chief dimensions are:—

Diameter of high-pressure cylinder	1ft. 8in.
Do. low-pressure do.	2ft. 11in.
Stroke	3ft. 6in.
Revs. per min.	90
Diameter of piston rod	3¾in.
Diameter of middle of crank shaft	1ft. 6in.
Diameter of engine bearing	1ft. 0in.
Length do. do.	2ft. 0in.
Distance between centres of connecting rods	9ft. 0in.
Diameter of flywheel	13ft. 0in.
Width do.	2ft. 0in

Both cylinders are jacketed. The valve seatings are of phosphor bronze. The governor is of the ball type, acting on the cut-off of the high-pressure cylinder. The valves are lifted and released by levers with a pawl attachment, the levers being driven by eccentrics, and the time the levers are in contact is varied by the governor in the usual manner. In addition, there is an electrical governor, consisting of a pair of solenoids, the plungers of which act on the cut-off in the same way as the mechanical regulator. The shunt solenoid varies the cut-off to keep the voltage constant, and the series solenoid is so arranged that should the current fail from any cause the admission valve is not opened, and in consequence steam is cut off from the engine. The power required for this governor is stated to be only 150 watts. A vertical jet condenser is employed, placed beneath the floor, and worked by a rocking lever from the low-pressure piston rod.

As already stated, the dynamo is direct-driven. It is 8-polar and drum-wound, its capacity being 1,440 amperes at 280 volts. Its main casting and pole pieces are of cast steel and the armature is tunnel-wound, and it does not present any extraordinary features or evidences of exceptional "finish."

Among the other engines and dynamos exhibited in the British section are some by Messrs. Ruston, Proctor & Co. and Messrs. Marshall, Sons & Co., both of these firms, however, having their more important exhibits in the agricultural machinery section. The former firm show a vertical compound engine driving a 80 kw. dynamo directly at 400 revs. per min., the most noticeable feature of the combination being, perhaps, that the engine is enclosed and single-acting; and also another vertical compound engine 9in. × 15½in. × 10in. stroke and simple single-cylinder Corliss engine and an oil engine. Messrs. Marshall's exhibit in this section is a coupled compound, non-condensing engine designed for steam at 150lb. pressure and a piston speed of 600ft. per min. The valves are double-beat drop valves actuated by the familiar "two-valve" releasing gear fitted by this firm, and the bed of the engine is of the Corliss pattern.

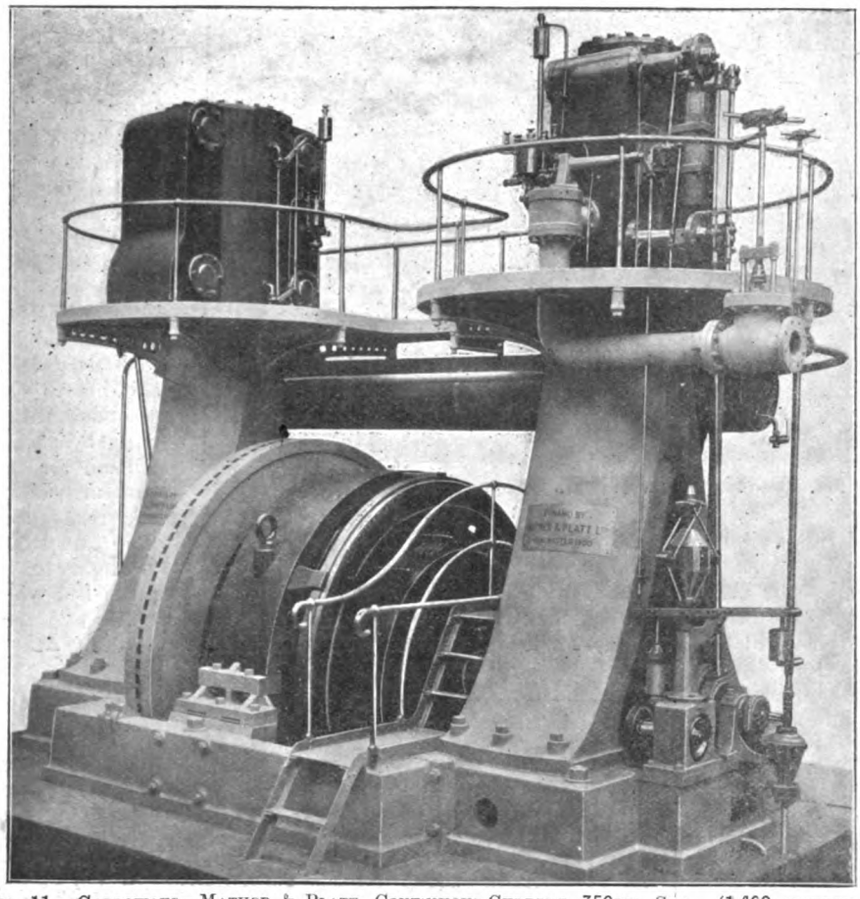

Fig. 11.—Galloways—Mather & Platt Continuous-Current 350kw. Set. (1 400 amperes at 220 to 250 volts; 105 revs. per min.)

Many representative British engine and dynamo builders have not exhibited. The only specimen of a Belliss engine I saw was a diminutive 2-crank one driving an auxiliary machine, hidden by a large French-American generating set, and bearing a French name plate. Messrs. Crompton are only exhibiting instruments, and no Brush, Ferranti, E. C. C., Johnson & Phillips, or Parker dynamos are to be found.

The next article will refer to some of the continuous-current sets of French manufacture.

[Correction.—By a printer's error the name of the chief of the electrical department at the Paris Exhibition, p. 508, second column, in the line immediately above the illustration, has been spelt Picon instead of Picou.]

Copper Mines in Natal.—The special correspondent of the *Standard* at Durban reports that an important discovery of copper has been made in the northern part of the colony, and that the lode is reported to be 4ft. wide.

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THE CENTRAL LONDON RAILWAY.

(*Continued from page 433.*)

The Power Station (concluded).—Fig. 30 shows the front of the main switchboard, and Fig. 31 shows the back, viewed from the same end. The arrangement of the instruments on the various panels of this switchboard are shown to scale in the front and back view given in Fig. 32, while Fig. 33 gives a complete diagram of the electrical connections of the switchboard to the main generators, the exciters, the lighting sets, the rotatory converter—which is not yet erected—and the feeders going out from the station to the railway. An enlarged view showing the front and section of a three-phase switch is shown in Fig. 34. Referring to Fig. 32 the four small panels at the left are devoted to the four 50 kw. exciter sets. These feed the exciter 'bus bars through double-pole 400-ampere switches, which possess the novel feature of being made interlocking with the field switch, thus excluding the possibility of opening the field switch of any exciter while the main switch is closed. The main and field switches are double-throw, and in their lower positions are available for supplying lighting circuits, but since at a later date it was decided to have entirely independent lighting sets, the switches will not be used in the lower position. In the main circuit of each exciter there is also a Siemens' minimum cutout. The six large panels to the right of the exciter panels contain the controlling and measuring apparatus for the three-phase main generators, and the two remaining large panels are devoted to the main feeder cables. At the top of each generator panel is mounted a Parshall three-phase double-break aluminum-bladed switch. The construction of this switch is shown in Fig. 34. All the measuring instruments are of the Hartmann and Braun hot-wire pattern. Of the three instruments in the upper row the middle one is a voltmeter connected across the secondaries of a 40:1 potential transformer. There is one such transformer for each generator, and a seventh for obtaining the line voltage. The outer instruments are of exactly the same type as the voltmeter (they all take about one-fourth of an ampere at full scale reading), but are employed as ammeters by being connected in the secondaries of 'bus bar transformers. These two instruments give the current in two of the three phases. The field current is also indicated by a 0·25-ampere hot-wire instrument, but in this case it is connected in shunt to a strip of patent resistance metal which carries the field current. The 10in. handwheel on the sub-base controls the field rheostat connection board, the field rheostat itself being located on iron brackets under the switchboard gallery. The two lower points of the field switch (see Fig. 33) go to the field circuit, the two upper to the exciting 'bus bars, and the two intermediate contacts to the discharge resistance. In this case the discharge resistance is built for 3 ohms, and suitable to carry 40 amperes for 15 seconds without harmful rise of temperature. This is a suitable proportion for taking up the discharge current from the generator field. The field resistance is 0·73 ohm.

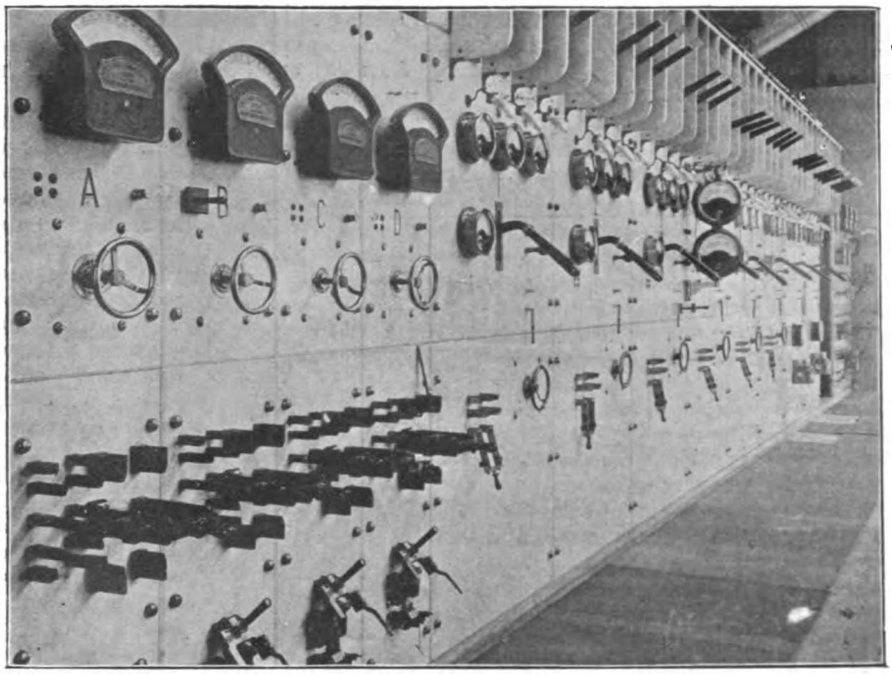

FIG. 30.—FRONT VIEW OF MAIN SWITCHBOARD.

The two large Hartmann and Braun illuminated dial hot-wire voltmeters upon the swinging bracket are used respectively, the upper for indicating the line voltage, and the lower for synchronising. There are also two synchronising lamps above the line voltmeter. On each panel there is a red lamp constantly alight whenever the corresponding generator is excited. Upon the feeder panels there is a 'bus bar transformer ammeter in each of the three phases. The sub bases of these feeder panels each contain a Holden integrating wattmeter, and a Thomson recording wattmeter. The Holden wattmeters are built on quite novel lines, in that

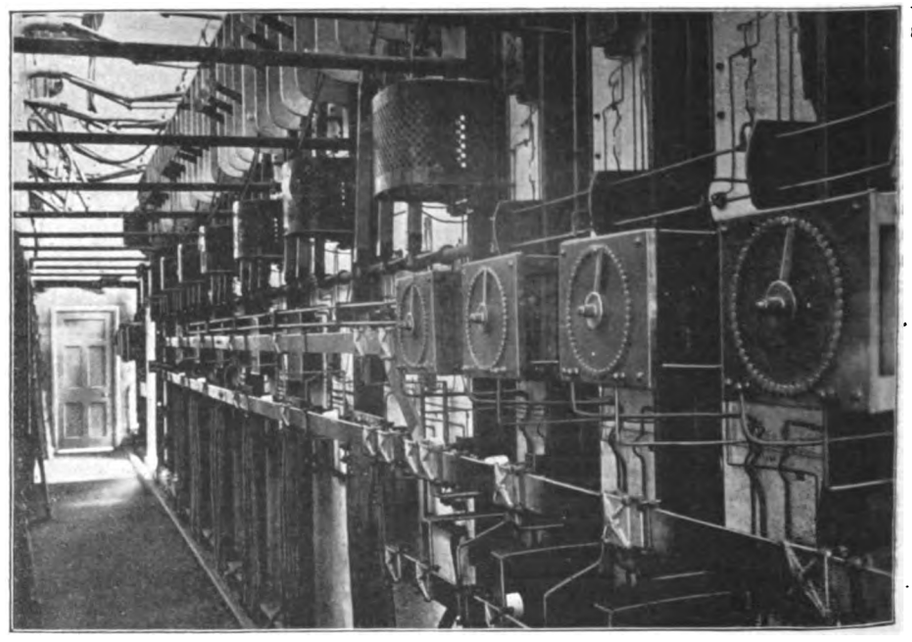

FIG. 31.—BACK VIEW OF MAIN SWITCHBOARD.

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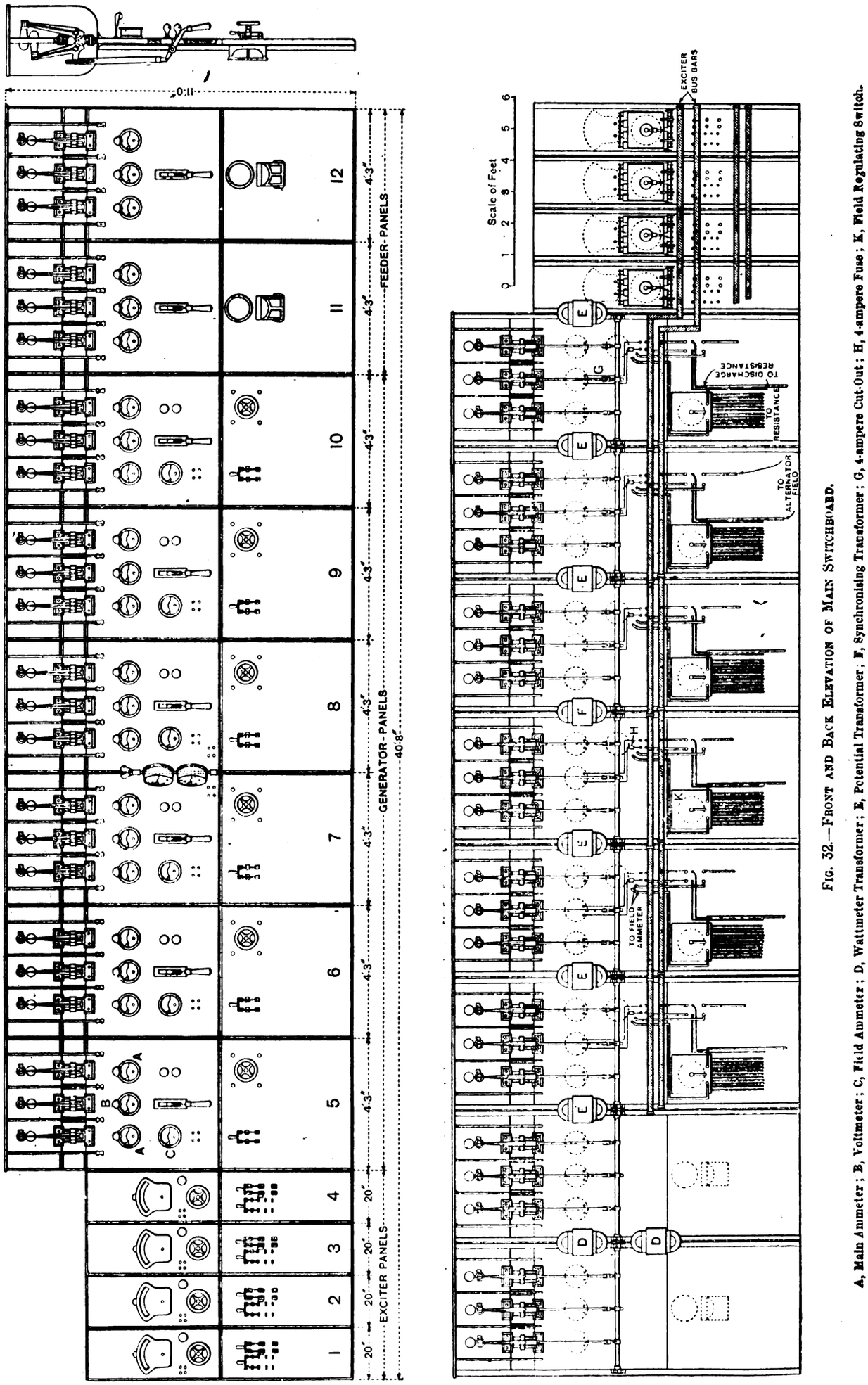

FIG. 32.—FRONT AND BACK ELEVATION OF MAIN SWITCHBOARD.

A, Main Ammeter; B, Voltmeter; C, Field Ammeter; D, Wattmeter Transformer; E, Potential Transformer; F, Synchronising Transformer; G, 4-ampere Cut-Out; H, 4-ampere Fuse; K, Field Regulating Switch.

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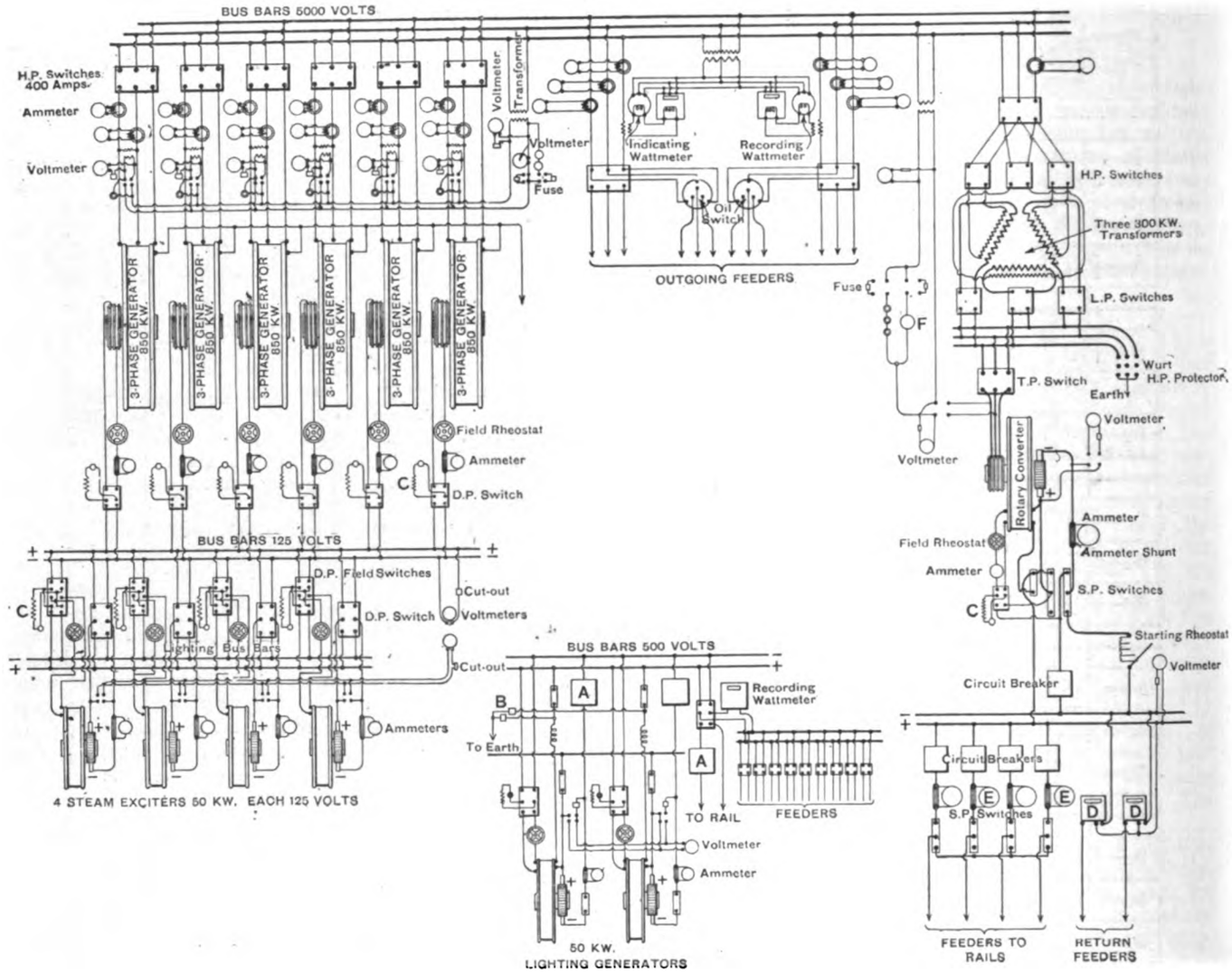

FIG. 33.—DIAGRAM OF ELECTRICAL CONNECTIONS OF MAIN SWITCHBOARD.

A, Circuit Breaker; B, Lightning Arresters; C, Discharge Resistance; D, Thomson Record Wattmeters; E, Ammeters, 1,800 Amps.; F, Synchronising Voltmeter.

the indicating pointer is not directly operated by the dynamometer coils, which here simply control the movements of a motor, which in turn moves the pointer. The watt dynamometer acts as a relay to close and open the secondary circuit of a small induction motor, so arranged that when the circuit is closed the motor moves the pointer in such a direction as to increase the reading of the instrument. As the reading increases there is a proportionate extension of a spring which is attached to a cylindrical drum on the pointer shaft. The tension of the spring acts on the movable coil of the dynamometer so as to tend to open the secondary circuit. Under these circumstances the motor will increase the reading until the spring force balances the electro-dynamic force of the coils, when further forward motion is impossible, as it would cause the secondary motor circuit to open. As the dynamometer coil has to move through an angle of 1deg. or less there is little trouble from flexible contacts to the movable coil. The induction motor consists of a copper disc mounted on the pointer shaft and a pair of laminated magnets whose poles are brought together so as to leave a slit big enough to allow free motion of the disc. One of the magnets has a coil of very fine wire wound on its pole, and forms the circuit opened and closed by the relay. Each magnet has a magnetising coil, the alternating current for which is obtained from any convenient source of supply. The scale of the instrument covers 300deg., and is uniformly divided throughout.

From the switchboard diagram it also will be seen that, of the four outgoing main cables, two are connected to Parshall overhead type switches, and two to oil-break switches, which will be located below the gallery. These oil-break switches are of very liberal proportions. Next to the feeder panels, an additional panel will soon be installed, leading down to the power-house rotary converter. The other panels for this additional installation will be located in another gallery on a

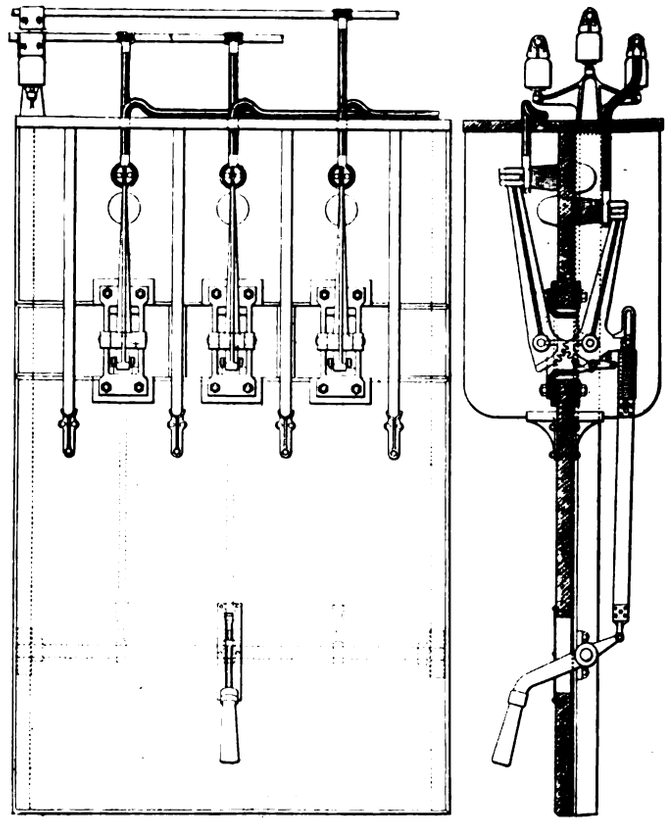

FIG. 34.—GENERAL ARRANGEMENT OF HIGH-PRESSURE, DOUBLE-BREAK THREE-PHASE PARSHALL SWITCH.

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lower level than the main switchboard gallery, at the east side of the building. The remaining four small panels at the extreme right-hand end of the main switchboard gallery are devoted to the two lighting generators and the feeders for the lighting circuits. They possess no features of especial interest. All the apparatus on these power-house switchboards have a uniform copper finish, which, against the marble panels, present a very satisfactory appearance. It will have been noted that on the front of the panel nothing below the high-tension switch blades is connected to the high-potential circuits. The panels stand 5ft. 2in. forward from the back wall, giving ample room for working behind the switchboard.

(To be continued.)

[Erratum.—We are asked to state that the curve, Fig. 21, in our last article on the Central London Railway, published in our issue of July 13th, is incorrect, and was given us in error.]

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Effect of Mast Wires in Space Telegraphy.—A. Lindemann has completed a systematic study of the precise influence of the mast wire upon the intensity and the wave-length of the system of waves emitted by a Righi oscillator. He used a horizontal arrangement for the latter, and was thus enabled to attach auxiliary wires on both sides. He found that such an oscillator emits two superimposed wave trains, one of which has the same wave-length as that emitted by the oscillator without the wires, while the other has a greater wave-length, determined by the period of the whole oscillating system consisting of the balls of the oscillator and the wires joined by air sparks. The effect of the wires upon the original wave train of the oscillator is to strengthen it, since waves of the same length, but less damped, are emitted by the wires. The advantage of the wires is the greater the shorter the air-gap separating them from the oscillator. As the air-gap increases the amplitude of oscillation of the whole system decreases in comparison with the amplitude of the original oscillation, and the damping factor increases. When one of the "feelers" was put to earth, and the other left in position, thus approximating to the arrangement used by Marconi, the second wave system could no longer be proved to exist. At least, its wave-length could no longer be determined. Otherwise the phenomena were the same.

[A. Lindemann, *Ann. der Physik*, No. 6, 1900.]

Kinetic Theory of Metallic Conduction.—The laws of metallic conduction will probably soon be brought completely under the theory of electrons, which has lately succeeded in establishing some important fundamental relations between the phenomena of heat, of resistance, and of electrolysis. The ratio of the two conductivities of a metal may be approximately calculated by Drude's electron theory, which involves the number of gas molecules per gramme and Thomson's value of the elementary electric charge. M. Reinganum points out that these two numbers, both somewhat roughly determined, are not really necessary at all, and that the much better known values of the electro-chemical equivalent and the velocity of hydrogen atoms in a gas may be substituted for them. This substitution gives for the ratio of thermal to electric conductivity the number $0{\cdot}7099 \times 10^{-10}$, which is in remarkably close agreement with the experimental values found by Jäger and Diesselhorst, such as $0{\cdot}706 \times 10^{-10}$ for aluminium. In this agreement the author sees a proof that in metals also, as in liquids, electricity moves in separate quantities of the value of the quantities transported by electrolytic ions, and that the principles of the kinetic theory of gases apply to both. If that is the case, our knowledge of the material convection of electricity is about to become as complete as our acquaintance with the ether stresses causing or attending it has already become.

[M. Reinganum, *Ann. der Physick*, No. 6, 1900].

Theory of the Coherer.—From a series of measurements of the difference of potential between the terminals of a coherer observed when different E.M.F.s are applied and different currents sent through, K. E. Guthe and A. Trowbridge have arrived at the conclusion that the high original resistance of the coherer is due to a film on the surface of the metallic particles, and that the reduction of resistance by electromagnetic waves is due to some kind of electrolytic transfer of ions across this film, resulting eventually in a deposit which bridges over the gap, and attaches the particles to each other. As the current through the coherer increases, the resistance falls, and the difference of potential at the terminals of the coherer tends asymptotically towards a limit P. This P is the potential difference over a molecular layer of ions in which there flows through each ion the maximum current it can carry. The authors point out a remarkable relation between the P of any element and its gramme-equivalent. The product of both is constant, and its value is about 6. For steel P is 0·23 volts, for copper 0·173 volts, and for lead 0·127 volts. The asymptotic limit of P may have some connection with the peculiar apparent resistance of the arc. The authors make PbO_2 and CuS agree in their behaviour with this modification of Lodge's theory by supposing that they are broken up into two components, one of which conducts well, while the other conducts poorly.

[Guthe and Trowbridge, *Phys. Review.*, July, 1900.]

Electric Effects of Light upon Green Leaves.—Under certain favourable conditions, which are not as yet completely determined, green leaves show a true electrical response to light, consisting in the establishment of a potential difference between the illuminated and the non-illuminated half of a leaf which may amount to 0·02 volts. This effect shows a remarkable similarity with the effect of electric excitation upon nerve and muscle. In the human nerve substance, electric excitation causes a current from the resting to the active tissue, followed after a few seconds by a smaller current in the opposite direction. In Iris leaves, the current flows from the illuminated to the shaded half of the leaf during illumination, and in the opposite direction for about five minutes after the illumination has ceased. The response takes about four seconds to set in, and it is only the young and growing leaves that show any response. When the stimulus is repeated, a certain amount of fatigue is shown, as in all organic structures and even in some inorganic substances. But no fatigue is shown when the leaf is given an hour to recover between each stimulus. The tobacco plant acts like Iris, but in Tropæolum and other plants the currents are in the opposite direction. That chlorophyll is essential to this photo-electric reaction is shown by the fact that the petals of flowers do not show it.

[A. D. Waller, *Commun. to Royal Society*, read June 14, 1900.]

Vacuum Phenomena of Nitrogen.—The effects presented by an electric discharge through nitrogen are of a particularly complex character. Very minute quantities of a foreign substance are capable of altering the aspect of the discharge considerably. This is particularly the case with the fluorescence of the walls of the tube, which P. Lewis has recently studied. He found that when nitrogen prepared from ammonium nitrate and sulphate and purified over hot copper was pumped through an H-shaped vacuum tube, the whole wall of the tube showed a brilliant temporary fluorescence, which extended for about 1 metre into the supply and exhaust tubes. This temporary luminosity, which the author terms B-fluorescence, was confined to the wall, as could be shown by heating a small portion of it. At that portion the luminosity disappeared, but reappeared on cooling. The whole phenomenon lasted only a few seconds, but could be made permanent by keeping the pump at work and thus supplying a continuous stream of fresh nitrogen. Spectroscopic examination showed that the fluorescence was dependent upon the presence of a number of bands in the extreme ultra-violet, which are due to a combination of nitrogen with oxygen. It is therefore likely that very minute quantities of oxygen are the cause of the phenomenon, though larger quantities stop it altogether.

[P. Lewis, *Ann. der Physik*, No. 7, 1900.]

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LIGHT-LOAD LOSSES.

No doubt the surest way to reduce light-load distribution losses in an alternating-current supply system is to convert it to a continuous-current system; and perhaps it was owing to this somewhat obvious answer to the question implied in the title of Mr. Boot's recent Paper that the discussion on it at the Municipal Electrical Association was brief and brought out no new facts. Yet the subject should be one of the greatest interest to engineers of alternating-current stations, for these all-day losses in the distributing apparatus militate more than anything else against the financial success of their undertakings, and it is not in every case that the drastic remedy mentioned above can be applied. The adoption of alternating-current systems in so many cases in which, even at the low limit of "declared" pressure formerly imposed by the Board of Trade, continuous current would have been more economical, has to some extent been due to the convention, at one time accepted by the majority of electrical engineers:—Continuous current for "compact" districts; alternating current for "scattered" districts. Every engineer in designing a supply system hoped that his district was a "scattered" one. He desired as large a load as possible, and trusted to create a demand for electrical energy from the residential districts round the outskirts of his town. The electric light, instead of remaining a luxury became soon a business necessity, and now every engineer knows that even with the Wright maximum demand tariff system, a small public house is probably a better customer than a large "residential mansion." Had not Parliament from the outset set its face against preferential charges, the Temperance League would doubtless have found itself compelled ere this to start a crusade against the methods of the supply station engineer.

But to return to the subject of diminishing the all-day losses on an alternating-current system in a district where the probable increase in demand is not sufficient to warrant a complete or even partial introduction of continuous-current supply. Mr. Boot's long Paper can be resolved into an almost unnecessary recommendation to use the best and most efficient transformers, and a recommendation to switch out transformers from the secondary network during the hours

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of light load. The second recommendation might also seem to be an obvious one were it not that 13 out of a total of 15 supply station engineers who replied to the enquiries in Mr. Boor's circular letter do not follow this practice regularly. Of course, as with all other debatable questions in electrical engineering practice, its solution must depend on the special circumstances governing each particular case. In a large system such as the alternating current ones in London, it is obvious that a considerable saving can be effected by this means, so much so that at several sub-stations in the metropolis at least one man is employed continuously for several hours a day. But in the case of sub-stations with smaller outputs, although the loss may be the same proportion of the whole output, it is intrinsically less important than before, while a man's wages remain more or less at a fixed figure. It is thus that a large number of station engineers find it more economical to put up with the all-day magnetising losses as a necessary evil inherent to the alternating-current system, than to try and reduce them by increasing the item of wages. Mr. Boor's figures as to the amount of these losses at Tunbridge Wells are not very clear, but taking it even that nothing but the actual losses at no-load are represented in the £200 he mentions, the saving, say, of half this at the expenditure of an additional £50 a year in wages would only just be worth while, and would be no great economy; besides, the additional risk is brought in of a breakdown of the diminished transformer plant in the daytime through overload if the sky were suddenly overcast by a fog or thunder-cloud. With smaller loads than at Tunbridge Wells, therefore, it would seem that, with a fair number of sub-stations, it would hardly pay to switch transformers on and off according to the magnitude of the load unless an automatic device can be made which will do this with certainty. When, however, the sub-stations are comparatively few in number, the cost of sub-station switchboard attendance need not be great, for, as the attendant would only have to manipulate the switches at the times that the load was coming on and going off, he could perform other duties as well. In such cases it would often be economical to combine the sub-station with central offices, stores, meter and lamp testing room, or a drawing office, which need not be in immediate proximity to the works.

Coming now to the question of automatic switches for this purpose, there is a possibility of a compromise between an absolutely automatic arrangement and an attendant. Two years ago (Vol. XL., pp. 391 and 393) we described two automatic devices for switching in transformers as the load increased. Of these the one which appeared to us to be constructed on the most solid lines unfortunately only cuts transformers in but does not cut them out again, thus effecting but half of the desired saving. This apparatus, due to Mr. A. H. Walton, who was at that time with the Metropolitan Electric Supply Co., has, we believe, proved itself thoroughly useful in the sub-stations of the company. The other device, due to Mr. Alfred Schlatter, was most ingenious; but although it was said to have proved its value for eighteen months in Budapest, we do not believe that it has been used extensively elsewhere, probably owing to a natural distrust evinced by electrical engineers towards mercury contacts in high-pressure apparatus. An alternative worthy of consideration is an electrically actuated switch, worked, not automatically by the current in the transformer falling to a sufficiently low value or rising to a sufficiently high one, but simply controlled by a switch on the main switchboard of the supply station. As the sub-station switch would only be in motion a few minutes each day, a strong current drawn from the secondary network could be used for working it, while at the same time the mains leading to the station need not be heavy, as for the short time they would carry current a considerable overload would not have time to heat them. The current flowing from the sub-station 'bus bars could be read off in the station by an ammeter of the shunted Weston type, the main circuit resistance to which the instrument was shunted being of course in series with the sub-station 'bus bars. In considering the value of such an apparatus, the degree of reliability and the capital cost have to be weighed on one side against the cost of the wasted kilowatt-hours on the other side. Probably in most cases the balance will be against the automatic or electrically controlled apparatus, so that the choice will once again lie between switching off by an attendant or allowing the all-day magnetising current to be wasted. The moral is, however, that it is the wisest practice to diminish the number and to increase the size of the sub-stations as much as possible, and to place them in easily accessible situations. This having been accomplished, it should be no difficult matter to arrange for the necessary switching in and out being done by hand at the two critical periods of the day.

THE REDUCTION OF LIGHT LOAD LOSSES IN ALTERNATING SUPPLY WORKS.*

BY HORACE BOOT, M.I.E.E.
(Corporation Electrical Engineer, Tunbridge Wells)

The question of light load losses in electricity works, be they continuous or alternating, deserves more attention from engineers than it has hitherto received. These losses might be divided under two heads—viz.:—

Work Losses.—(1.) Fuel used in keeping up steam ready to supply. (2.) Radiation losses in boilers, separators, brickwork, steam and drain pipes. (3.) In running larger generators at light loads to enable the voltage to be kept constant, should motors or other apparatus requiring heavy starting currents be in circuit. (4.) Wages paid to the men during the hours of light load. (5.) Interest and sinking fund on the buildings and machinery during light load hours.

Distribution Losses.—(1.) Losses in transformers (magnetising watts). (2.) Losses in the shunts of meters. (3.) Interest and sinking fund on capital, outlay on cables and distribution appliances. (No. 2 and 3 apply equally to alternating and continuous systems, but No. 1 only applies to the alternating, except where continuous-current transformer systems are in use.)

The author does not purpose in this short Paper dealing with the losses under the works heading, as there are many ways in which these can be reduced to a minimum, but he has not yet come across a system, be it direct or alternating, in which these in the course of a year do not total up to a very large amount which would make an appreciable difference in the cost of supply if they could be overcome. In distribution, the most important losses requiring consideration, and which are more or less complicated, are the transformer losses during light loads, and, since it is increasingly evident that in the near future transformers dealing with alternating currents of mono, di or polyphase, will be used by both what are now known as "continuous-current" and "alternating" engineers it is important to both sections to endeavour to meet these losses and to ascertain the manner in which they can best be reduced to a minimum. Low-tension engineers of a few years ago are all of them propounding schemes involving high pressures, and it is notable that all these schemes propose using alternating currents and transformers or motor generators. There is a concensus of expert opinion that the most economical way to supply electricity over large areas and on a large scale is by a form of high-tension transmission, and therefore the author does not feel called upon to apologise to his continuous-current friends for wasting their time over problems which they now see they will have to tackle in the future.

The transformer losses may be divided into "iron" losses and "copper" losses, the iron losses being dependent upon the eddy current loss, varying of course with the temperature and periodicity, and the contact between the adjacent plates and hysteresis loss depending upon the quality of the iron and the temperature to which is is heated, the E.M.F. curve, and the maximum induction; also, a not unimportant item, the mechanical strains and stresses to which it is

* Paper read before the Municipal Electrical Association, at Huddersfield, June 21.

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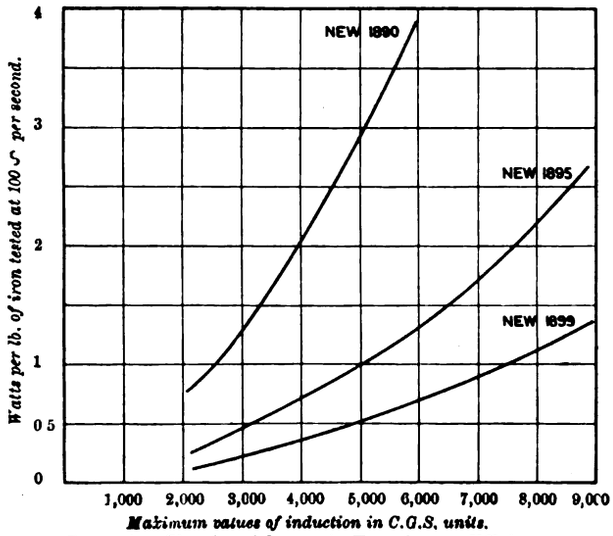
exposed. The copper losses may be summed up as the C^2R loss due to the magnetising current and resistance of primary winding. These, of course, again vary as the square of the current, the resistance of the copper, the temperature to which the winding attains, sectional area of same, and the length. The author has found, however, that the C^2R loss, due to magnetising current, is about 0·20 per cent. of the maximum output. It is important to note that the limit of work which a transformer can undertake is governed by the overheating permissible, as this exercises a very important function when short circuits on the distributing networks take place, as the transformer only requires to be fused to its burning up limit, which is usually very much higher than its output. It will be seen that it is important to design a transformer in such a manner that it has sufficient means of radiating its heat, as only in that manner can a transformer be kept within decent limits in weight and size. With regard to improvements in transformers, it is interesting to reproduce a curve having for ordinates the watts per pound of iron tested at 100 frequency, and for abscissæ the maximum volts of induction in C.G.S. units, for which the author is indebted to Mr. Berry. From this it will be seen that the efficiency of transformers has advanced enormously since 1890. This increase of efficiency plays a very important part in the light load losses, as by comparing efficiency curves it is now possible to obtain an all round efficiency, including light load hours, of something like 94 per cent., that is, taking 20 hours at no load, two hours at full load. Many works, however, are fortunate in obtaining a longer period of load. Comparing the efficiencies for the last 10 years, there has been an improvement of something like 16 per cent. It therefore will be seen that one of the ways to reduce light load losses, *is to instal transformers of high quality.* It is of course apparent to anyone that the copper losses from the all day efficiency point of view are of less importance than the iron ones, because the iron like the poor, "is always with us,"



Curve A. Showing Advance in Transformer Efficiency.

whereas the copper losses do not play such an important part until the transformer becomes loaded. The ageing of the iron is a very important matter, and the author has found, from tests carried out, that in the case of old transformers the effect of age has been to increase the magnetising watts by as much as 45 per cent. This should not be the case with our present knowledge, as in the case referred to it was due to the number of lines forced through the iron to a very large extent, whereas if the iron density had not been pushed so far, also the temperature limit both in the iron and in the copper, there is no reason why the watts taken to magnetise should have increased so enormously. In other instances tried by the author they have increased 10 per cent. after nine months' use. He thinks it is here that in all probability our systems put down with English plant will eventually show their superiority over American-made machinery, as it is well known that Americans load their machinery up to the limit. In his transformer specifications the author finds it necessary to insert a clause that the tests on the core losses shall be taken after the transformer has been six months at work on its full load, and he is even of the opinion that this six months would be better if it were 12 months, because a transformer appears to get better as it gets older, until it reaches a certain point, and then the increase in iron loss runs up. The ageing which increases the iron loss can be governed by temperature rise, the quality of the iron, and the strains of a mechanical nature to which it is exposed when in use.

In a table below are given the actual tests obtained from different sizes of transformers in sub-stations in Tunbridge Wells, showing the increase in magnetising watts with age, also the number of watts

Sub-stations or Transformer Pits.

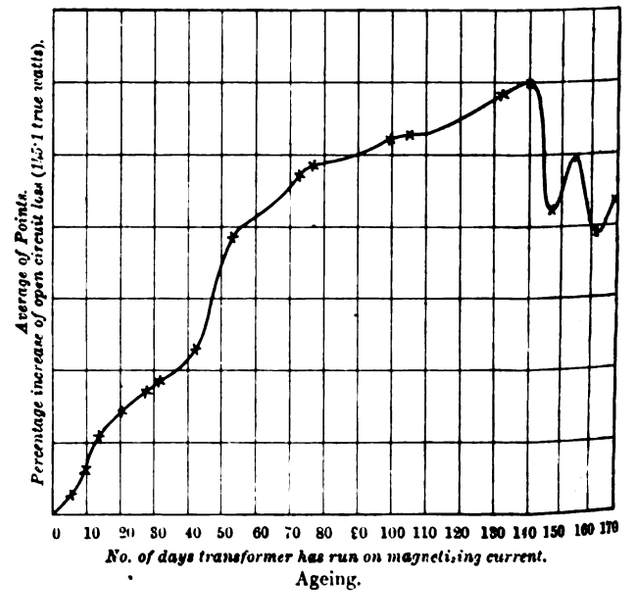
Size of transformer in kw.	Core loss in watts when first installed.	Core loss in watts now.	Size of transformer in kw.	Core loss in watts when first installed.	Core loss in watts now.
50	490	490	5	102	180
25	385	410	5	71	80
50	491	590	25	462	460
25	390	390	25	540	550
25	420	770	5	...	230
25	391	390	5	...	180
25	468	470	5	...	...
5	120	121	5	...	150
5	150	170	3	120	150
15	320	350	25	390	450
25	426	430	15	340	400

House Transformers. Core Losses.

Size kw.	Watts.	Size kw.	Watts.
2	110	3	150
1	45	2	110
2	110	1	45
1	45	2	110
3	150	1	45
2	110	2	110
1	45	1	45
1	45	1	45
1	45	1	45
3	150	1	45
2	110	1	45
2	110	3	150
3	150	3	150
2	110	5	180
1	45	—	—
2	110	Total 56 kw.	2,765*

* Total watts lost = 2,765 = 2·765 units per hour.

used on large transformers (calculated) during the period of light load. This is important, as from these figures can be calculated the saving that can be effected by switching the transformers in or out, according to the conditions of load, making, of course, provision for the labour, interest and sinking fund required for doing this.



Ageing.

With regard to ageing of transformers, there is an interesting curve published by the London Electric Supply Corporation, in 1895, and which, with their kind permission, is reproduced here.

The author has calculated that at Tunbridge Wells the units generated during the period of no load in 1899 amounted to 32,120. The units supplied to the transformers in circuit, calculated taking the same number of hours equals 10·75 × 3,000 hours = 32,250, and the total number of units generated in 1899 equals 466,901, showing that the number of units due to core loss amounts to 6·09 per cent. of the whole. The cost of supplying these "core loss" units (1·5d. per unit) amounts to £201. 11s. 3d., and it is this figure which the author is hoping at some future time to save entirely, and then he will be in the same position as his "Continuous Current Friends" so far as efficiency of distribution goes. By adopting the

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network inter-connection system and running a sufficiently large L.T. main into the works, or, if the works are situated some distance from the distributing area, supplying the whole of the distributing networks from either the works or one sub-station, the whole of the loss, with the exception of that occasioned by the use of one transformer, can be saved, against which, however, must be balanced the labour involved in visiting these sub-stations twice a day for the purpose of switching on and off the primary and secondary. The switchgear in these sub-stations should be as simple as possible, so that it does not require a particularly skilled man to operate same, nor should it be possible for him to kill himself. A few years back Mr. Walton (then chief engineer to the Metropolitan Electric Supply Co.) brought out and patented an automatic transformer switch, to switch in the transformers on both the primary and secondary, as soon as the load became sufficiently heavy to require a supply from that transformer. These have been in use since March, 1897, at the sub-stations in Marylebone-passage, Brook-mews, Rathbone-place, and I believe the London Electric Supply Corporation and the Brush Provincial Co. are also using them. This automatic switch is most useful in towns subjected to sudden demand, as the engineer can rest assured that a sufficient number of transformers will be switched in to cope with the load, and will not have to depend upon the vagaries of human intelligence. It is, of course, easy for any station engineer to calculate the saving effected in switching off these transformers; which becomes more marked in towns with a poor load factor, and in the provinces, where sudden heavy demands are almost unknown, from the following formula :—

$$\frac{\left\{\begin{array}{c}\text{The number of hours}\\ \text{per annum the trans-}\\ \text{former is not loaded}\end{array}\right\} \times \left\{\begin{array}{c}\text{the cost per Board}\\ \text{of Trade unit to}\\ \text{generate}\end{array}\right\} \times \left\{\begin{array}{c}\text{core loss in}\\ \text{units}\end{array}\right\}}{1{,}000}$$

Another advantage to be obtained by being able to cut out all transformers during the hours of light load, is that it places all the feeders, with the exception of one perhaps, at the disposal of the mains superintendent for testing purposes, or working thereon, and then there can be no excuse for not keeping them in perfect condition as they can be tested daily.

The question of the best position for fuses in the H.T. feeders is a very troublesome one, and the author has found that the safest place to have fuses is at the works, and at the works only, especially when we get to the condition of things where transformers never go wrong; as, unless fuses are constantly watched in the sub-stations, and frequently changed, no reliance whatever can be placed upon them. I venture to think, in the analysis of the number of extinctions, and the cause, 75 per cent. could be put down to the erratic behaviour of fuses, both on the H.T. and the L.T. side, and for that reason fuses should only be inserted where it is dangerous to do without them. In the distributing networks I have not found it necessary to insert fuses, except at the point of inter-connection as above stated. This method of reducing the light load losses to the minimum, unless precautions are taken, may introduce serious results, and be the cause of cables and transformers breaking down. Some time ago Mr. Hay wrote an article proving that when breaking a current, at the instant of breaking the current it had a higher value than its normal maximum, the core being left more strongly magnetised than when under working conditions. In some experiments carried out with transformers, it has been proved that transformers do not, as a rule, break down at the instant of connection, but the core settles down to the ordinary cycles of magnetism gradually, and there is no rise in P.D. across the terminals; but if they break down the damage was done when switching off. It would be interesting to hear from other members if they have found the life of the cables and the transformers, when intermittently used, to be shorter than when they are in constant use; beyond the strain of switching on and off, the author does not see that there should be any difference unless the transformers get unduly heated, in which case the continual heating and cooling may do mechanical damage. There is another danger which may be introduced at the time of switching in and out, viz., the capacity effect; but, provided care be taken to switch *in* the outer conductor first, and switch *out* the inner conductor first, it is unlikely that the conditions will be such as to break down the cable. Experiments were performed by Prof. Fleming and Mr. Alexander Siemens on the Deptford mains, which will be within the memory of the members, and the able articles written at the time with respect to the same are worth studying. One of the points to be borne in mind, however, is to avoid any discontinuities in the outer conductor of a concentric cable, and this can best be secured by earthing the outer without any fuse in circuit. This subject was ably treated by Mr. Gisbert Kapp, in the *Electrotechnische Zeitschrift*, December 28, 1899, in which he depicts some conditions into which we unhappy alternate current engineers may get and break down our cables. However, it is rarely that these conditions are present, but it is always advisable to take precautions, such as the adoption of Neufield's rule for switching in and out: "The earthing of the outer conductor, and omission of all fuses in the outer."

It is important that transformers should be constructed to withstand a considerable load for a short period, as, when such is the case, it is possible to use a transformer that will be fairly well loaded at normal times of heavy demand, and occasionally withstand a great deal more. In some of the transformers the author has tested there appears to be very little limit to their overloading capacity, one in particular, a 5kw. transformer, easily withstood a load of 12kw. without burning up; but he finds that when the larger sizes are dealt with the manufacturers are not so generous in giving more than you pay for. From calculations and tests made, it appears that about 140 watts are wasted in core losses for every 1,000 watts supplied to the lamps. Considerable economy may be gained in distribution by keeping the number of sub-stations to a minimum; in fact, the Board of Trade alteration in the permissible pressure of supply has been an immense boon to alternate-current as well as to continuous-current engineers. The insulation of the distributing mains is better maintained in the case of alternating than appears to be the case in continuous-current distribution systems, in which, by increasing the pressure, "shorts" and other troubles have been experienced. Taking the cost of coal, which in Tunbridge Wells is very heavy, at 1d. per unit, the cost of energising the transformers on circuit amounted to £137. 3s. 4d. in 1899. In order to overcome this loss, it is necessary that the L.T. networks supplied from the various sub-stations be inter-connected, as it is then possible to switch off all the transformers, except one, on both primary and secondary. For this purpose, the author has arranged the networks so that they can be fed in the daytime from a transformer situated at the works, and the whole of the transformers in the sub-stations can be switched out of circuit. This at once reduces the light-load losses from 10,750 watts to 590 watts, against which, however, has to be put the cost of the extra switchgear and men's wages, unless an automatic switch is used; but it will be seen that this arrangement enables the feeders to be tested every day, worked upon, and kept in perfect order, without in any way discontinuing the supply, which, as prescribed in the act, is continuous during the 24 hours. In towns where it is possible and economical to build a large sub-station and make it a centre of distribution, transformers can be banked, and it is usually arranged for one man to attend to these, but in Tunbridge Wells the area is very extensive, and no particular sub-station can be looked upon as the feeding centre, so that the most economical way is to place one large transformer in each instead of providing several small ones and switching them in as the load comes on.

The author has found from experience that the most satisfactory arrangement for fuses on the outer networks is to make them comply with the following conditions: Each transformer sub-station should be allotted a certain small area, which should not exceed the maximum load of the transformer at the time of full demand even if it were isolated from the other sub-stations. A fuse box on the distributors should be inserted before connecting that particular transformer area with the other network area. This is what he has carried out throughout and found to work admirably.

It is advisable to test the transformers at least once a year, to obtain the magnetising watts on open circuit, and the full load voltage drop, and compare them with the previous tests, and, in most instances it will be found advisable to scrap the old transformers, and buy others more up to date having more permanent efficiencies. With a reduction of frequency to a standard of 50 periods, many alternating troubles would disappear, such as impedence. With regard to skin effects, Lord Kelvin showed that the current only penetrated to 0·0393 of an inch after increasing the frequency above 150, but the loss occasioned by this may be more or less neglected with low periodicities.

A very important point to bear in mind in alternate-current distribution is to keep the power factor as near unity as possible. This problem is not easy, and is often the cause of great loss in efficiency. The effective volts and amperes rarely exceed 0·75 of these apparent: it may be much less than this when motors, arc lamps, and various inductive apparatus are in circuit. This wattless current loads up the armatures and the cables, producing considerable phase difference. However, provided the frequency is kept low, the difficulties can be overcome, as the current lagging in phase depends upon the inductance in circuit and the periodicity. Various suggestions have been made for introducing capacity in order to give lead, and thus nullify the lag in an alternate-current circuit caused by induction, but the author is not aware of any system being in operation in this country. When it is necessary to calculate actual resistance these effects present difficulties, as it is apparent that the resistance must change according to the kind of load.

Another source of waste, although of not very large moment, is the energising watts supplied to maintain the shunts of the meters when no energy is being consumed. It will be seen that there are 1,000 meters on circuit, all of them taking a small amount, and most of them taking that amount for 20 hours out of the 24 for no purpose that a saving would be effected if this shunt were cut out when no current was flowing through the series coil. The autho has introduced into Tunbridge Wells a small

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Appendix.—*Information obtained from 17 towns.*

Towns.	Do you interconnect networks with fuses?	Do you bank your transformers?	Are any arrangem'nts made for reducing the idle magnetising watts in time of light load?	Magnetising watts and amperes given to mains.	Do you use any automatic switch for cutting out transformers?	Magnetising watts more after using transformers some time, per centage?	Does your low-tension network come into the works?
Bath	No.	Yes.	No.	.....	No.	.....	One circuit.
Bedford	Only occasionally.	In some cases.	No.	5 kw. and 6 amp.	No.	.....	No.
Bolton	No.	No.	.....	.....	.....	.....	Yes.
Bristol.....	Yes.	Yes.	Nothing daily.	About 30,000.	Not now.	.....	One does.
Cardiff.....	Yes.	Yes.	In the summer.	.....	No.	.....	No.
Croydon	Not generally.	Yes.	Yes.	About 10 kw.	All switching off is done by hand.	No increase noticed hitherto.	No.
Derby	No.	Wherever possible.	In the summer.	7 amp. primary.* Mag. watts abt. 10 kw.	No.	.....	One of four.
Hanley	Yes.	Yes.	No.	7 amps. at 2,050 volts.	.....	.....	No.
Halifax	No.	As little as possible.	No.	About 16 amps. at least at 2,000 volts.	No.	Cannot say definitely.	No.
Harrogate	Yes.	Yes.	No.	Abt. 13 apparent amp.	No.	.....	No.
Huddersfield ...	No.	Yes.	No.	About 15 kw.	No.	Depends very much upon make of transformer.	No.
Kingston-upon-Thames	Yes.	Yes.	Can be switched out in sub-stations.	7 amps. at 2,100 volts.	No.	Yes.	Not at present.
Newport	No.	Yes, in sub-stations.	No.	20 kw.—15 amps.	No.	.....	No.
Portsmouth ...	Occasionally.	No.	No.	Av. 15 watts per kilo. of rated output of transformers.	No.	Not ascertained.	No.
Southport	Will do so this year.	Yes.	No.	Mag. power amounts to 16 kw. and the current 8-9 amps.	No.	Not appreciable.	No.
Wolverhampton	Yes.	.....	.....	.....	.....	.....	No.
Worcester	No.	Yes.	No	8 amps. at 2,000 volts.	No.	Have never determined.	No.

* Full-load current at present about 300 amperes.

relay, which is governed by the current in the series coil, and is made to close the shunt circuit of the meter immediately 0·1 of an ampere flows through it. The arrangement is simple and works admirably: the three points in its favour being: (1) It prevents consumers complaining of the noises their meters are making all day long, when there are no lights burning; (2) it prevents consumers thinking that the meter is registering when they are not using any energy; (3) it saves the wasted watts during the time when the meter is not registering.

In conclusion, in order to reduce the light-load losses—(1) The low-tension distributing network must be interconnected, each sub-station interconnection being by a fuse on both poles; (2) the supply can be given by one transformer, preferably situated at the works, and so arranged as to feed the whole networks; (3) in each sub-station, switch gear must be arranged to disconnect the primary from the source or sources of supply, and the secondary winding from feeding or being fed by the low-tension network; (4) unless automatic switches are used, it is the main's superintendent's duty to arrange with certain men on their way to work to open the switches, and switch in the transformers at sunset; (5) the feeders should be so arranged that during the hours of daylight they can be tested and all pressure removed. In some instances, of course, this would necessitate cutting off the supply to a few isolated houses which may have separate transformers, but, no doubt, this could be arranged in the price charged to these consumers, as they would be situated outside the "compulsory" area.

The following is an abstract of the discussion on the above Paper:—

Mr. L. ANDREWS (Hastings) had made a test upon a new feeder and sub-station to see what saving was effected by switching off transformers; he found that he saved watts, but not current. He thought the loss was due to using too large plants during the daytime. The object of a fuse should be not to prevent the transformer from being overloaded but to protect the feeder.

Mr. H. FARADAY PROCTOR (Bristol) said Mr. Boot mentioned the noises which meters made all day long. He did not think, however, that anyone should have a meter which was an anoyance, as there were plenty of silent meters. With reference to the watts wasted in the shunt, he considered that in a good meter this would not come to more than 1s. 6d. per annum, and therefore was not of much account. Mr. Boot thought the supply could be given from one transformer; but in Bristol the area was so large that this could not be done. He believed that the amount of current consumed would not be more than 4d. per hour for the whole of the sub-stations mentioned, and he thought the wages of a man engaged in putting on and disconnecting the transformers would come to much more than this. If the low tension side of the transformer was put on first, when connecting up, there was not the least fear of the rise in voltage, and when taking the current off the transformer the high-tension side should be taken off first.

Mr. H. S. RUSSELL (London) said the subject did not concern manufacturers so much as the engineers. The idea of scrapping the transformers was a good one from the manufacturers' point of view. The question of ageing, which Mr. Boot dealt with, was not so simple as it appeared.

Mr. C. A. L. PRUSSMAN (Doncaster) thought it would not be possible to adjust matters by means of an automatic relay to act with 0·1 of an ampere through the shunt circuit when these meters had been fixed in damp places for some time. He did not think much would be gained by inserting automatic relays as there was the capital cost of these to be allowed for.

Mr. H. L. P. BOOT (Tunbridge Wells), in his reply, said the method of switching on and off the transformers should be left to each engineer to decide what was best in his particular case. Fuses were an abomination to the electrical engineer, and as soon as he found that transformers did not break down he would do away with the fuses altogether. He thought in the case of Bristol they had so much noise in the streets that they could not hear the meter, but in Tunbridge Wells it was very annoying to anyone in the sitting-room having a nap to hear the noise of his meter. He thought if Mr. Proctor inquired of his meter inspector he would find that consumers also complained in Bristol. He had found that the best system of distribution with the least trouble was to have each sub-station and network absolutely independent of any other, and if possible he would only have one feeder to each sub-station. Mr. Russell made a remark about scrapping transformers, but he (Mr. Boot) did not recommend this to be done indiscriminately, but only those which were very inefficient.

A FRICTIONLESS MOTOR METER.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on Mr. Evershed's Paper with the above title:—

Mr. T. D. LOCKWOOD, of the Bell Telephone Co., Boston, U.S.A., said it was a pity it was impossible to reproduce in the proceedings of the Institution the beautiful experiments they had seen, or the manner of the speaker; it was impossible to reproduce anything but the dry text of a Paper—although the text did not happen to be dry in this case. The difficulty Mr. Evershed had mentioned of learning what had been done before in the same direction was a difficulty which he apprehended occurred to most of them. He had read any number of English, American, and foreign specifications, and had come to the conclusion that it was very difficult to learn anything out of 99 of 100 of them. If the picture was all right the text was all wrong, and if the text was all right the picture did not agree with it. Mr. Evershed had also said that he did not know, until he had far advanced with the production of his meter, that anything in the same line had been done before. He (the speaker) was reminded by this of a passage in the preface of one of the first books ever written on electric lighting: "The people of former times had very little honesty, as they have stolen all our best inventions."

Mr. S. Z. DE FERRANTI could quite understand Mr. Evershed when he stated that he had been working for 10 years at this subject. If he had said more than this—were it not for Mr. Evershed's age—he would

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not have been at all surprised. He thought that perhaps the author had not sufficiently appreciated how frictionless some other meters actually were. He remembered in 1885 he was struck by a very curious occurrence to one of his meters, which first made him think he had discovered some marvellous new circumstance quite beyond his comprehension. One day when the current was turned off from one of his mercury meters—which he might mention were very "frictionless"—he found that the meter rotated without any connection whatever with an electric circuit, and that it also rotated backwards. It was watched very carefully and the meter continued to move backwards for two days. It was eventually discovered that owing to the jambing of the sixth or seventh wheel of the meter, the spring in the other wheels was sufficient to give a driving power to run that meter at an exceedingly slow speed backwards for two days. He found that a mercury meter constructed to register up to 300 amperes started with certainty with 0·1 ampere or 1/3,000th of its normal full load current. This was not 1/3,000th of the power but simply 1/3,000th part of the current, so that the internal friction of the apparatus—notwithstanding the residual magnetism which helped to start the meter—must be exceedingly small. It was very important in this particular class of meter that the little fan which was immersed in the mercury should be perfectly balanced, and elaborate precautions were taken that it should be so, as if not, the meter was a little bit out of level, and this interfered with the starting. They had had a certain amount of trouble, and had found out that a serious source of trouble in this direction was in varnishing or lacquering the fan immersed in the mercury more thickly on one side than on the other, as this displaced more mercury at one time than another and so put the meter out of balance in the mercury. He would like to point out that the Aron meter practically disregarded friction, and there were also other meters of that kind. There was, however, one objection to the Aron meter, as also to Mr. Evershed's—viz., the ticking noise. With regard to his own meters which he had mentioned, all these were practically speaking frictionless on the pivots, because they were compound balanced in air and mercury, and he did not think the friction due to the pivots was any greater than that of the bottom pivot in Mr. Evershed's meter. With regard to the commutator of this meter, he thought everybody would agree that it was a most beautiful thing. The nearest approximation to it was the one devised by Lord Kelvin, in which the commutator parts were rigid but the brushes were made up of a number of discs whose edges were split and turned up and then pressed against the commutator, thus forming a flexible electric contact. His own idea of this whole subject, without wishing to detract in any way from the most beautiful work done by Mr. Evershed, was that this meter was greater in scientific merit than in commercial value. Of course this was only a conjecture, but what he had found in the hard practice of having to satisfy all sorts of people wanting electricity meters was that they asked for the most absolute simplicity, and if they got this they were willing to sacrifice a good deal. He hoped that nothing he had said would detract from Mr. Evershed's work, because really he thought it was most splendid; he further hoped the meeting would excuse the mention he (Mr. Ferranti) had made of things that had occurred in his own meter experience, as, without mentioning himself, he could not have put some of these curious points before them.

Mr. REGINALD WOOD said he had attended that meeting specially to say that he claimed to be the inventor of the magnetic suspension exactly as Mr. Evershed had described it. This was rather a nasty thing to have to say, because in reading the Paper he could not help admiring the whole instrument, especially the electromagnetic connections between the motor and the train gear. He had really nothing but congratulation for Mr. Evershed, and hoped his claim would not be considered ungracious, although he was afraid it was.

Mr. W. M. MORDEY agreed with Mr. Ferranti as to the importance of simplicity in a meter. Although he admired the way in which Mr. Evershed had worked out this instrument he was of the opinion that commutators

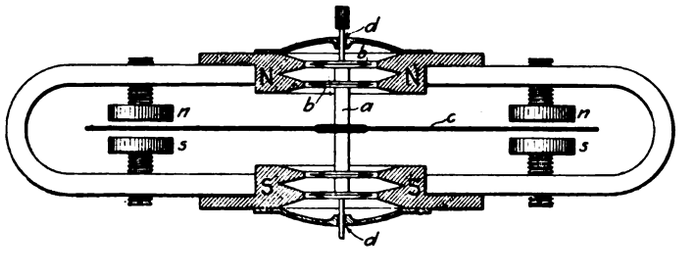

FIG. 16.—Diagram of Brake and Magnetic Suspension of Stanley Meter.

were objectionable in meters and that the greatest simplicity was got by mercury meters for direct currents and induction motor meters for alternate-currents. Mr. Evershed's meter shared one good quality with the Thomson meter—viz., it was suitable for either direct currents or for alternating of any frequency. Exceedingly small values were given for the friction which they might think very wonderful. Perhaps they were, but really the wastefulness of all meters was something terrible, when they remembered that a watt meant about 44 foot pounds per minute, and that few, if any, meters took less than one watt at the smallest load. He then sketched a diagram (Fig. 16) of the Stanley meter, which he said contained one of the most interesting magnetic suspensions so far produced, and he did not think Mr. Evershed had quite realised what a very pretty thing the Stanley suspension was. When he was in the States a couple of years ago he saw and tested the first meter made by Mr. Stanley. The shaft *a* was magnetically supported by the flux passing into the flange *b* from the encircling poles N and S, the disc *c* mounted on the shaft *a* being magnetically braked by passing through the field between the polar extensions *n s*. This method of suspension caused the shaft and disc actually to float in the air. Extensions of the shaft passed through guide holes at *d d*, but there was no pivot in the ordinary sense. It would be seen that friction could only take place at *d d* and that a fair amount of clearance in the magnetic gape, and good mechanical centreing would make this friction negligible. Mr. Stanley had told him, in fact, that some of his 6 kw. meters started with 2½ watts.

Mr. H. L. P. BOOT, as a user of meters, said he was glad to be able to have a "go" at the manufacturers, and to inform them of the difficulties he had had to contend with. In his six years' experience with different makes of meters, he had had to scrap no less than two of the types, and it had paid him to scrap them. He admired this meter immensely, but he personally preferred a meter which he could to an extent understand, so that he could alter it and adjust it, and also a meter in which there was not so much dependence upon permanent magnets. Mr. Ferranti had mentioned the fact of the meter ticking. It was also true that the Aron meter ticked; and unfortunately it was true that nearly all types of alternate current meters gave considerable trouble owing to the noise they made. He had designed a little arrangement, something in the form of a relay, which cut out the meter during the hours it was not being used. Lastly, he wished to impress upon the manufacturers of meters that rapid delivery was required.

Mr. E. SCHATTNER said he had had very little experience with motor meters. The one described by Mr. Evershed seemed very ingenious and very fine in every way, but his experience showed him that it was hardly simple enough. It also struck him that this meter could not be produced at the price which a meter nowadays ought to be produced. Since electrolytic meters had come into the market, reducing the price and being very much more simple, the tendency had been everywhere to produce a motor meter at a smaller price even at the sacrifice of accuracy.

Prof. W. E. AYRTON spoke first as to the question of complexity, and instanced the present Aron meter, the meter which, he said, was selling by thousands per year even in this country (backward as we were in electric lighting) with all its complexity, but on the other hand with all its accuracy. Compare it, he said, with the original clock which was shown in that very room 18 years ago with its single pendulum. They would have said that the original clock was the thing which would have sold in thousands, and that the present Aron meter, could it have been foreseen, would have had no chance. If they looked at Alfred the Great's candle and their watches of to-day, what chance did watches stand; they were far too complicated for anybody to buy them. If Mr. Evershed had the smallest feeling of despondency because he had obtained such marvellous results with a certain amount of complexity, he should bear up, as there was a possibility that his meter might rival, say, the Waterbury watch with its sale, and he had no doubt Mr. Evershed would then be quite satisfied. He did not know, however, what the Aron meter had to do with the Paper, which was on "A Frictionless Motor Meter." The Aron was not a motor meter, and it was not a frictionless meter. It was a meter in which the friction did not produce the error in the reading, but it was not a frictionless meter. There were other meters with various dodges, and so on, in which the friction, it was hoped, would not produce much error in the readings. The well-known starting coil in the Elihu Thomson meter, for instance; but what Mr. Evershed had tried to do and had succeeded in doing was to get a meter which did not require any of these devices and still should have a very high accuracy. He would like to know if Mr. Evershed had tested the friction of any of Mr. Ferranti's meters. Aron meters, so far as he knew, were all energy meters. In the same way Mr. Evershed had made an energy meter, but he had not introduced only one little improvement, he had taken the whole energy meter and had re-invented every single part of it, and so obtained perfection.

Mr. M. ARON confirmed Prof. Ayrton's statement that the present Aron meter was an energy meter. He would like to meet Mr. Boot on the ground of the noise of the meter, as it was rather satisfactory to know that the only objection to the meter was the slight noise. It seemed to him that a consumer who wanted an accurate measuring instrument was rather hypercritical if he was going to raise objections to the noise. For alternate currents there had been some trouble in arranging and adjusting the Aron meter, as there were so many periodicities in use, and here again the instrument made some slight noise. Mr. Evershed need not trouble himself very much about the noise of his meter, because he (the speaker) could assure him that of the thousands of Aron meters being made and sold in this country in only a very few cases was the question of noise raised.

The PRESIDENT (Prof. S. P. Thompson) wished to add to the congratulations which had been offered to Mr. Evershed on this Paper. It obviously represented a very large amount of very careful thought, of large experimenting, great care and patience, and it would be a thousand pities if work like this were lost either to the scientific world or to the world of commercial users of electricity. With regard to the criticism as to the noise, as a consumer of electricity he had a meter in his house which made ticks, and he was rather glad it was so, because going across his basement hall at the dead of night as he locked up before he went to bed, he could hear the meter ticking, and if he did not he knew something was wrong and immediately went to see how many hundred pounds it had charged against him since it was last read.

Mr. SYDNEY EVERSHED, replying to the discussion, thanked some of the speakers for their kindly references to his work. Broadly speaking, he thought the criticisms which had been made would amount to this: His meter was too complicated. He did not think he could possibly put this matter of complication better than Prof. Ayrton had done. But the question of complication was entirely a question for him and not the user. He might remind Mr. Ferranti, however, when he spoke of complicated things, that Mr. Ferranti himself was somewhat complicated, but it seemed that he worked very well, and had done for many years, and he appreciated rather than depreciated. At all events, they all appreciated him more and

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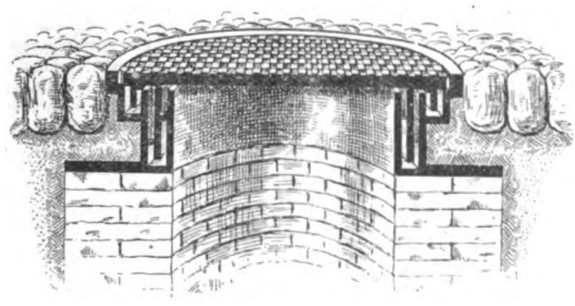
more. He was rather amused that the subject of the ticking of the meter should have been so prominent. When the meter was in its case the noise was hardly heard. The ticking was due to the lever striking metallic stops, and if rubber tubing were put over these stops they would hardly hear any noise even when the meter was out of the case. If there were any nervous persons who did not like the ticking they could have the rubber tubes. The mention of the Stanley meter, which he was glad to hear, brought him to the subject of anticipations. One never contemplated anticipation until one had worked for some time, and then, when the work was nearly finished, tried to find out what other people had done before. It was in this way that he discovered that Mr. Ferranti had, years ago, patented vario s devices for suspending the axles. He quite agreed with Mr. Ferranti that they were mostly bad. He was very glad to see the Stanley meter in the flesh. The examiner at the American Patent Office was a most benevolent gentleman. When someone applied for a patent this gentleman searched all over the world and trotted out some splendid anticipation and then sent it over saying that someone else had done the same thing before. The Stanley meter was sent over to him in this way, but he would draw attention to the fact that the Stanley meter was an induction motor meter and was only suitable for alternate currents. His opinion was that the bulk of domestic supply for the future would be by continuous currents. Mr. Boot very rightly went for the meter makers, and told them there was a great financial value in a good meter, a statement with which he quite agreed. Mr. Boot also said he preferred a meter he could alter, but he did not intend Mr. Boot or anyone else to alter *his* meter. He was going to seal it up in a case and if anything went wrong it would have to be sent back to the maker, as was the case with gas meters. Mr. Schattner had complained of complication and thought electrolytic meters appeared simpler. Personally he did not know of any electric meter more complicated than an electrolytic meter. Nothing that could be made was half so complicated as electrolysis. No chemist was yet agreed as to what was the exact process of electrolysis. As to the cost of meters, he maintained that first cost was not the last cost. There were repairs and depreciation to be taken into account. Mr. Aron also referred to the noise, and he was sorry he had not brought some of the rubber tubing he mentioned with him, as it would have saved time if he had done so.

A hearty vote of thanks was accorded Mr. Evershed at the conclusion of the discussion.

FULLER MANHOLE COVER.

The illustration below shows a new form of manhole cover made by Mr. J. W. Chisholm, of Washington, D.C. The cover forms a double water seal confining a double column of air under pressure,



and it is stated to prevent efficiently the entrance of water into the manhole without the employment of any kind of packing. The construction of the cover is fully explained by the sectional illustration.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Science Abstracts." July, 1900. Vol. III., Part 7. (London: E. & F. N. Spon.) 2s.

"The Official Gazette of the United States Patent Office." No. 3, Vol. XCII. Published by authority of Congress. (Washington: Government Printing Office.)

"Modern Electric Railway Motors." By G. T. Hanchett. (New York: Street Railway Publishing Co.)

ELECTRICITY WORKS ACCOUNTS.

Chester Municipal Electric Supply Works.

Again this year we are able to publish excellent results in respect to the Chester undertaking. Perhaps, with the very low figures for the costs which were exhibited as the result of the working during 1898-9 it was inevitable that there should occur a slight retrogression, especially in view of the unavoidable advance in the cost of fuel, and the decrease which has taken place in the load-factor. The costs which we give in our first table this week are, however, all so low in relation to the output and load-factor that, in spite of the low price obtained, the financial results are extremely good. As compared with the output of 1898-9 the units sold during the period considered indicates an increase of over 30 per cent., while the lamp connections have advanced nearly 32 per cent. The fuel item, as usual here, is extremely low, and notwithstanding a drop in the load factor from 15·4 per cent. to 13·3 per cent. the works costs stand at quite 0·4d., and the total costs at 0·57d. below the average at the same output. We hope that it will be found possible to maintain the present excellent position in the future, though, of course, the results of the current year's working must inevitably be rather marred by the continued high prices operating in the coal trade. So far, Chester stands as a good example of the influence for economy which a high load-factor has on an electricity supply works.

Bedford Municipal Electric Supply Works.

The accounts of the Bedford undertaking for 1899 show that a splendid improvement has taken place in the position of the undertaking. Owing no doubt to the very moderate charges in force which have resulted in an average price of but 2·68d. per unit for supply and an average revenue from all sources of only 3·91d. per unit, the lamp connections exhibit the excellent advance of nearly 55 per cent., while the output has risen from 828,343 units sold to 540,146—an increase of nearly 65 per cent. Not only has the amount of the load but its character has also improved: the load-factor last year was 12 per cent., as compared with 11 per cent. in 1898.

Excluding from consideration the fuel item, the remaining generating costs and the management charges have all fallen consistently with the altered conditions. The result is that in spite of the naturally high and increased fuel charge, the works costs are normal and the total costs well under the average 1898 figures for stations of similar output. In view of the improved state of affairs and the substantial payments for the extinction of debt, the deficit of £288 is a small matter and will no doubt give place to a decided balance to the good as the result of this current year's operations.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan.	12, 1900	Kingston-on-Thames (Mun.)	July	10, 1900
Ayr (Municipal)	Sept.	22, 1899	Lancaster (Municipal)	Jan.	19, ,,
Bath (Municipal)	April	20, 1900	Leeds (Municipal)	Dec.	1, 1899
Bedford (Municipal)	May	19, 1899	Leicester (Municipal)	Jan.	26, 1900
Belfast (Municipal)	July	6, 1900	Leyton (Municipal)	Sept.	8, 1899
Birmingham (Company)	Sept.	15, 1899	Liverpool (Municipal)	June	22, 1900
Blackburn (Municipal)	Jan.	19, 1900	London (Company)	June	8, ,,
Blackpool (Municipal)	Sept.	29, 1899	Londonderry (Municipal)	Feb.	16, ,,
Bournemouth (Company)	April	28, ,,	Manchester (Municipal)	Aug.	11, 1899
Bolton (Municipal)	Nov.	24, ,,	Newcastle and District (Co.)	Oct.	6, ,,
Bradford (Municipal)	June	22 1900	Newcastle-upon-Tyne (Co.)	April	14, ,,
Brighton (Municipal)	May	4, ,,	Newport (Mon.)(Municipal)	Dec.	15, ,,
Bristol (Municipal)	July	14, 1899	Northampton (Company)	Oct.	20, ,,
Bromley (Kent) (Co.)	June	15, 1900	Norwich (Company)	Nov.	17, ,,
Brompton & Kensington (Co.)	Mar.	23, ,,	Notting Hill (Company)	Mar.	16, 1900
Burnley (Municipal)	Aug.	25, 1899	Nottingham (Municipal)	July	21, 1899
Burton-upon-Trent (Mun.)	April	21, ,,	Oldham (Municipal)	Dec.	1, ,,
Bury (Municipal)	Sept.	22, ,,	Oxford (Company)	April	13, 1900
Cambridge (Company)	April	18, 1900	Pontypool (Company)	May	5, 1899
Cardiff (Municipal)	Dec.	15, 1899	Portsmouth (Municipal)	July	14, ,,
Charing Cross (Municipal)	Mar.	9, 1900	Prescot (Company)	Dec.	8, ,,
Chelsea (London) (Co.)	Mar.	23, ,,	Preston (Company)	Sept.	29, ,,
Cheltenham (Municipal)	Nov.	10, 1899	Reading (Company)	Oct.	13, ,,
Chester (Municipal)	June	23, ,,	Richmond (Company)	June	29, 1900
City of London (Company)	June	15, 1900	Salford (Municipal)	Feb.	23, ,,
Clerkenwell (Company)	May	18, ,,	Scarborough (Company)	July	13, ,,
Coventry (Municipal)	Feb.	23, ,,	St. Helens (Municipal)	Dec.	8, 1899
Croydon (Municipal)	July	20, ,,	St. James' & Pall Mall (Co.)	Feb.	16, 1900
Derby (Municipal)	Jan.	26, ,,	St. Pancras (Vestry)	June	8, ,,
Dewsbury (Municipal)	Nov.	24, 1899	Sheffield (Municipal)	Dec.	29, 1899
Dover (Company)	April	27, 1900	Shoreditch (Vestry)	Oct.	27, ,,
Dundee (Municipal)	Jan.	12, ,,	Southampton (Municipal)	Nov.	10, ,,
Eastbourne (Company)	May	4, ,,	Southport (Municipal)	July	7, ,,
Edinburgh (Municipal)	Nov.	17, 1899	South Shields (Municipal)	July	7, ,,
Exeter (Municipal)	Aug.	5, 1898	Stafford (Municipal)	Dec.	29, ,,
Folkestone (Company)	April	27, 1900	Sunderland (Municipal)	July	28, ,,
Glasgow (Municipal)	Sept.	1, 1899	Taunton (Municipal)	June	16, ,,
Guildford (Company)	May	5, ,,	Tunbridge Wells (Mun.)	Sept.	1, ,,
Halifax (Municipal)	July	21, ,,	Wakefield (Municipal)	Dec.	1, ,,
Hammersmith (Vestry)	June	29, 1900	Walsall (Municipal)	June	23, ,,
Hampstead (Vestry)	Aug.	25, 1899	Wandsworth (Company)	May	18, 1900
Hanley (Municipal)	July	27, 1900	Westminster (Municipal)	Mar.	9, ,,
Harrogate (Municipal)	Oct.	20, 1899	Whitehaven (Municipal)	July	28, 1899
Harrow (Company)	June	16, ,,	Windsor (Company)	Dec.	22, ,,
Hast'gs & St. Leonards (Co.)	Feb.	2, 1900	Woking (Company)	Dec.	22, ,,
Hove (Company)	July	6, ,,	Wolverhampton (Municipal)	July	27, 1900
Huddersfield (Municipal)	Oct.	6, 1899	Woolwich (Company)	Jan.	13, 1899
Islington (Vestry)	Oct.	27, ,,	Worcester (Municipal)	April	20, 1900
Kens'gton & Knightsbr'(Co.)	Mar.	16, 1900	Yarmouth (Municipal)	Nov.	3, 1899
Kingston-upon-Hull (Mun.)	July	13, ,,			

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	CHESTER.		BEDFORD.	
Undertaking Worked by	Chester Town Council.		Bedford Urban Sanitary Authority.	
Date of Commencement of Supply	December, 1896.		December 6, 1894.	
System of Supply	Three-wire continuous-current.		Alternate-current transformer sub-stations.	
Chief Engineer	E. Thursfield.		W. J. Hope-Johnstone.	
YEAR ENDED	MAR. 25, **1899.**	MAR. 25, **1900.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	575,131	763,154	447,196	702,060
„ **SOLD (TOTAL)**	**473,656**	**617,792**	**328,343**	**540,146**
„ sold to consumers	326,579	399,969	170,547	350,568
„ sold for public lighting, &c.	147,077	217,823	157,796	189,578
„ used on works	101,475[a]	86,262[h]	28,567	30,000
UNITS SOLD PER 8 C.P. LAMP CAPACITY	25·5	27·5	15·67	25·8
Maximum supply demanded	350 kilowatts	529 kilowatts	340 kilowatts	449 kilowatts
Number of public lamps	116 arc, 132 incan.[b]	165 arc, 206 glow[b]	488 glow	528 glow
Number of consumers	304	426	425	582
Connections to mains in 8-c.p. lamps	24,344	32,122	17,400	26,902
CAPACITY OF PLANT IN 8-C.P. LAMPS	22,500	22,500	20,940	20,940
CAPACITY OF PLANT IN KILOWATTS	720	720	670	670
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£65,000 / £90·3	£65,000 / £90·3	£64,050 / £95·6	£105,050 / £157
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	65,000 / 90·3	65,000 / 90·3	64,050 / 95·6	105,050 / 157
RECEIVED (TOTAL)	65,025 / 90·3	65,025 / 90·3	54,599 / 81·5	64,249 / 95·9
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	65,000 / 90·3	65,000 / 90·3	54,400 / 81·2	64,050 / 95·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	nil / —	9,650 / 1·44	41,000 / 61·2
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	nil / —	nil / —	9,650 / 1·44	41,000 / 61·2
REPAID (TOTAL)	nil / —	nil / —	4,680 / 6·99	7,049 / 10·5
RESERVE OR SINKING FUND	2,068 / 2·87	4,023 / 5·59	nil / —	nil / —
DEPRECIATION FUND	1,303 / 1·81	2,465 / 3·42	nil / —	nil / —
EXPENDED (TOTAL)	54,772 / 76·1	65,766 / 91·4	58,100 / 86·7	67,622 / 101
Lands and buildings	7,862 / 10·9	7,888 / 11·0	5,576 / 8·32	6,230 / 9·30
Plant	27,127[c] / 37·7	32,227 / 44·8	22,156 / 33·1	26,840[c] / 40·1
Mains	19,783 / 27·5	25,313 / 35·2	28,098 / 42·0	32,017 / 47·8
Miscellaneous	— / —	338 / 0·469	2,270 / 3·39	2,534 / 3·78
BALANCE OF CAPITAL ACCOUNT	+10,253 / +14·2	−741[j] / −1·03	−3,701[a] / −5·53	−3,373[a] / −5·04
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£7,619 / 3·860d.	£9,501 / 3·693d.	£5,874 / 4·295d.	£8,798 / 3·909d.
Revenue from supply	5,614 / 2·844d.	6,670 / 2·592d.	3,586 / 2·623d.	6,038 / 2·683d.
„ meters, &c.	183 / 0·093d.	251 / 0·098d.	141 / 0·103d.	193 / 0·086d.
„ public lighting	1,777 / 0·901d.	2,532 / 0·984d.	2,131 / 1·559d.	2,524 / 1·122d.
„ sale of lamps, &c.	44 / 0·022d.	48 / 0·019d.	— / —	32 / 0·014d.
„ miscellaneous sources	— / —	— / —	15 / 0·011d.	10 / 0·004d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£3,007 / 1·524d.	£4,568 / 1·776d.	£3,696 / 2·703d.	£4,881 / 2·169d.
WORKS COSTS	2,007 / 1·018d.	3,425 / 1·331d.	2,899 / 2·120d.	4,133 / 1·836d.
Generation of electricity	*1,686 / 0·857d.*	*2,752 / 1·069d.*	*2,649 / 1·938d.*	*3,901 / 1·734d.*
Fuel (including cartage, &c.)	598 / 0·302d.	1,155 / 0·445d.	1,459 / 1·067d.	2,535 / 1·127d.
Oil, waste, water, stores	163 / 0·083d.	306 / 0·119d.	228 / 0·167d.	354 / 0·157d.
Wages at station	612 / 0·310d.	791 / 0·307d.	747 / 0·546d.	689 / 0·306d.
Repairs and maintenance at station	312 / 0·158d.	500 / 0·194d.	215 / 0·157d.	323 / 0·144d.
Distribution of electricity	*47 / 0·024d.*	*39 / 0·015d.*	*91 / 0·067d.*	*78 / 0·035d.*
Wages, &c.	24 / 0·012d.	39 / 0·015d.	78 / 0·057d.	78 / 0·035d.
Repairs, renewals of mains, &c.	23 / 0·012d.		13 / 0·010d.	— / —
Public lighting	*274 / 0·139d.*	*634 / 0·246d.*	*159 / 0·116d.*	*155 / 0·069d.*
Attendance	239 / 0·121d.	366 / 0·142d.	75 / 0·055d.	97 / 0·043d.
Renewals	35 / 0·018d.	268 / 0·104d.	84 / 0·061d.	58 / 0·026d.
MANAGEMENT AND PROPERTY CHARGES	1,000 / 0·507d.	1,143 / 0·444d.	797 / 0·583d.	747 / 0·332d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*83 / 0·042d.*	*149 / 0·058d.*	*166 / 0·121d.*	*183 / 0·081d.*
Management	*917 / 0·465d.*	*994 / 0·386d.*	*631 / 0·562d.*	*564 / 0·251d.*
Salaries	654 / 0·331d.	723 / 0·281d.	280 / 0·205d.	360 / 0·160d.
Stationery, &c.	58 / 0·029d.	72 / 0·028d.	47 / 0·034d.	68 / 0·030d.
Establishment charges	113 / 0·057d.	138 / 0·054d.	45 / 0·033d.	81 / 0·036d.
Law charges, &c.	92[d] / 0·047d.	61[d] / 0·024d.	259[b] / 0·189d.	56[d] / 0·025d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£4,612 / 8·89%	£4,933 / 8·18%	£2,178 / 4·17%	£3,917 / 6·24%
Sum carried to Depreciation Fund	800 / 1·57%	1,140 / 1·89%	nil / —	nil / —
Sum carried to Reserve or Sinking Fund	1,318 / 2·60%	1,903 / 3·16%	1,760 / 3·37%	2,369 / 3·77%
Net interest on loans (incl. Debenture charges)	1,442 / 2·84%	1,889 / 3·14%	1,399 / 2·68%	1,836 / 2·92%
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—[e] / —	— / —	— / —	— / —
Deficit	— / —	— / —	*982 / 1·88%*	*288 / 0·458%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	39·5%	48·1%	62·9%	55·5%
Expenditure per kilowatt capacity	£4. 3s. 7d.	£6. 7s. 0d.	£5. 10s. 5d.	£7. 5s. 10d.
REVENUE PER KILOWATT CAPACITY	**£10. 11s. 7d.**	**£13. 4s. 0d.**	**£8. 15s. 5d.**	**£13. 2s. 7d.**
Expenditure per 8-c. lamp capacity	2s. 8d.	4s. 0½d.	3s. 8d.	4s. 8d.
REVENUE PER 8-C.P. LAMP CAPACITY	**6s. 9½d.**	**8s. 5½d.**	**5s. 7½d.**	**8s. 4½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**6s. 3d.**	**5s. 11d.**	**6s. 9d.**	**6s. 6½d.**
Price charged for lighting, per unit	5d.[f]	4½d.[f]	4½d.	4½d.
Price charged for power, per unit	3d.[f]	2½d. to 1½d.[i] [ann.	3d.	3d.
Price charged for public lighting	£18 per arc per ann.[g]	£18 and £14 per arc per	3d. per unit.	3d. per unit.

CHESTER.—REMARKS—*a* Includes 71,999 units used on works and 29,476 units used in batteries, transformers, &c. *b* The glow lamps are of 8 c.p. *c* Includes £4,671 on street lamps. *d* To insurance. *e* £1,052, being balance of preliminary expenses, has been written off. *f* Less discounts, varying up to 25 per cent. according to quantity. *g* For all night lighting. *h* Inclusive of 59,100 units used in batteries, transformers, &c. *i* By scale of discounts according to quantity. *j* Over-expended.

BEDFORD.—REMARKS—*a* Over-expended. *b* Includes £18 to insurance and £241 to lamps supplied to consumers. *c* Includes £1,920 to lamp columns. *d* Includes £39 to boiler insurance and £17 to lamps supplied to consumers.

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PROJECTED COMBINED ELECTRIC SUPPLY AND TRAMWAY WORKS FOR WILLESDEN.

(*Concluded from page 524*).

ELECTRIC TRAMWAYS.

. . . The seven proposed routes are detailed, in which particulars of length and the estimated cost of the complete equipment of each is given. In none of my estimates have I made provision for the cost of any alteration or widening of streets or roads which would be traversed by these tramways. As the streets are mostly too narrow for continuous double track, I have estimated for single track with turn-outs about a quarter of a mile apart. This will permit a service of any frequency up to 2½ minutes being given, if required, at a future date. In the meantime I recommend that a 10-minute service be given. It will be desirable to run seven days a week, and I estimate each car will run 14 hours a day. The maximum speed of the cars will be at the rate of 8 miles, or including stoppages 6 miles an hour. I strongly recommend the overhead side trolley system of electrical equipment as being not only the cheapest but also the most efficient.

The machinery I have recommended you to put down at the electricity works is eminently suitable for operating electric tramcars, and the supply for this purpose would be a most valuable addition to the load on the works, as the demand continues throughout the daytime when it will be at a minimum for other purposes. The increased output from the works would very materially reduce the cost of production for all purposes, and it is evident that the same staff can be employed at the electricity works and sub-station as would be necessary if the supply were given for purposes of lighting and general motor work only. Between the electricity

ESTIMATED COSTS AND REVENUE DURING FIRST YEAR OF WORKING AT WILLESDEN.

Without Supply to Electric Tramways.

	Equivalent in 30 watt lamps.	Probable max. demand Kilowatts.	Probable max. demand in kw.		Units.
Number of 8 c.p. lamps connected	18,000	540	270	Works output for private supply	216,000
Public arc lamps, 94 of 500 watts	1,567	47	47	Do. do. public lighting	148,000
Totals	19,567	587	317	Total output for year	364,000

ESTIMATE OF COSTS.

	Pence per unit.	£	s.	d.		Pence per unit.	£	s.	d.
To Generation of Electricity—					*By Sale of Electricity—*				
Coal	0·702	1,065	12	0	Private supply by meter	4·75	4,275	0	0
Oil, waste, water and engine room stores	0·125	190	0	0	Public lighting	2·69	1,662	0	0
Wages at works	0·532	806	0	0	Do. do. attending and maintenance		464	0	0
To Distribution of Electricity—									
Wages and stores at sub-station	0·189	286	0	0					
To Public Lamps—									
Attending and maintenance	0·306	464	0	0					
To Management Expenses—									
Salaries, engineers, clerks, &c.	0·495	750	0	0					
Stationery, printing, insurance	0·066	100	0	0					
To Rents, Rates and Taxes—									
Rates and taxes	0·197	300	0	0					
Total cost	2·612	£3,961	12	0					
Gross profit		2,439	8	0					
		£6,401	0	0			£6,401	0	0

PROFIT AND LOSS ACCOUNT.

To interest and sinking fund on loan £143,451 at 5⅝ per cent	£8,248	8	0	By balance from revenue account	£2,439	8	0
				Balance being *deficiency* on first year's working	5,808	12	0
	£8,248	8	0		£8,248	0	0

ESTIMATED COSTS AND REVENUE DURING FIRST YEAR OF WORKING

The Combined Electricity Supply and Electric Tramways Undertaking.

	Equivalent in 30 watt lamps.	Probable max. demand Kilowatts.	Probable max. demand in kw.		Units.
Number of 8 c.p. lamps connected	18,000	540	270	Works output for private supply	216,000
Public arc lamps, 94 of 500 watts	1,567	47	47	Do. do. public lighting	148,000
Tramways—10 cars running	4,000	120	120	Do. do. tramways	228,000
Totals	23,567	707	437	Total output for year	592,000

ESTIMATE OF COSTS.

	Pence per unit.	£	s.	d.		Pence per unit.	£	s.	d.
To Generation of Electricity—					*By Sale of Electricity—*				
Coal	0·600	1,480	0	0	Private supply per meter	4·75	4,275	0	0
Oil, waste, water and engine room stores	0·090	222	0	0	Public lighting	2·69	1,662	0	0
Wages at works	0·390	968	10	0	Do. do. attending and maintenance		464	0	0
Repairs and maintenance	0·060	150	0	0	Supply to tramways	2·50	2,374	16	0
To Distribution of Electricity—									
Wages and stores at sub-station	0·158	390	0	0					
To Public Lamps—									
Attending and maintenance	0·187	464	0	0					
To Management Expenses—									
Salaries, engineers, clerks, &c.	0·304	750	0	0					
Stationery, printing, insurance	0·040	100	0	0					
To Rents, Rates and Taxes—									
Rates and taxes	0·162	400	0	0					
Total cost	1·991	£4,924	10	0					
Gross profit		3,851	6	0					
		£8,775	16	0			£8,775	16	0

PROFIT AND LOSS ACCOUNT.

To interest and sinking fund on loan, £143,451 at 5⅝ per cent	£8,248	8	0	By balance from revenue account	£3,851	6	0
				Balance, being *deficiency* on first year's working	4,397	2	0
	£8,248	8	0		£8,248	8	0

Deficiency as above	£4,397	2	0
Estimated profit on tramways	1,746	14	7
Net deficiency to be met	£2,650	7	5

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supply and tramways undertakings an important fundamental difference exists. For the former purpose a large amount of capital must be expended on which the return can only be slow, since it cannot be expected that every householder will adopt electric light the moment the mains are laid. It is therefore almost impossible for an electricity supply undertaking to be immediately self-supporting. A tramway undertaking, on the other hand, will probably pay its way from the day cars commence to run. I have little doubt that not only would the short line I recommend you to construct pay its way, but, further, that it would show a profit which would go far to balance the deficiency inevitable during the first two or three years after the electricity works commence to supply the public. It would, therefore, seem judicious from every point of view to proceed with the undertakings simultaneously.

I give a detailed estimate of the cost of equipping routes 1 and 4, and an estimate of the annual cost of operating this line, together with an estimate of receipts. It will be seen that after making ample provision for repairs and maintenance, and interest and sinking fund on capital, the cost of working per car mile is 8·4d. It therefore follows that if an average of 8·4 passengers at the rate of 1d. per car mile were carried, the tramways would pay their way, while a profit would accrue to the electricity works from the supply. I have assumed that the supply would be charged at 2·5d. per unit, which would be a fair rate if the requirements for tramway purposes did not exceed 250,000 units per annum. I also indicate the profit which would be made if the receipts per car mile averaged 10d. and 11·99d. I find from the Board of Trade tramway returns that the average receipts per car mile during the last three years in the Harrow-road and Paddington tramways have been 11·99d. If this tramway, which can hardly be said to carry to important termini, earns this revenue, one traversing the heart of the Willesden district should certainly earn at least as much.

PARTICULARS OF ROUTES.—*Mileage and Estimated Cost of Construction.*

Route No.	Net length between termini.	Total length of single track including turn-outs, &c.	Number of cars required.	Estimated total cost of equipment.
	Miles.	Miles.		£
1	3·513	3·981	8	40,397
1A	3·636	4·104	8	41,430
2	3·772	4·272	10	44,130
2A	3·882	4·382	10	45,045
3	4·195	4·695	10	47,655
3A	3·863	4·363	10	44,890
4	1·3	1·38	2	12,350

The number of cars required is based on a 10-minute service being given.

ESTIMATED CAPITAL EXPENDITURE, COSTS AND REVENUE FOR ELECTRIC TRAMWAYS.

ROUTE I.

Distance between termini ..... 3·513 miles.
Total length of single track, including turn-outs and junction to car shed ..... 3·981 „

Estimate of Capital Expenditure.

3·98 miles single track, excavation, construction of permanent way, reinstatement and paving of track, providing and laying 100lb. per yard girder rails, fish-plates, bolts, tie-rods, points, crossings, &c., at £6,750 per mile	£26,872
Bonding rails at £200 per mile	796
Electrical equipment, side bracket system, including all trolley posts, brackets, conductors, insulators, section boxes, feeders, pilot wires, guard wires, and erection, 3·76 miles at £1,050...	3,948
	£31,616
Add 5 per cent. for contingencies	1,581
	£33,197
Eight motor cars, with trolleys, controllers, two motors, and brakes, &c., complete, at £650	5,200
Car shed	2,000
Total.....	£40,397

Estimated Annual Expenditure, based on a Car Mileage of 214,620 per Annum.

	Pence per car mile.		
Electricity per car mile at 0·85 unit at 2·5d. ...	2·125	... £1,900	5 6
Car shed expenses, wages, and stores.....	0·217	... 194	0 0
Management and office.....	0·363	... 325	0 0
Wages of drivers and conductors	1·750	... 1,564	18 9
Tickets, uniforms, &c.	0·167	... 150	0 0
	4·622	... £4,134	4 3
Repairs and maintenance of track, 2½ per cent. on £27,668.....	0·773	... 691	14 0
Repairs and maintenance of cars, 5 per cent. on £5,200	0·291	... 260	0 0
Repairs and maintenance of buildings, 2½ per cent. on £2,000.....	0·056	... 50	0 0
Repairs and maintenance of lines and feeders, 7½ per cent. on £3,948.....	0·331	... 296	2 0
Interest and sinking fund on £40,397 at 5¼ per cent. (30 years)	2·372	... 2,120	17 0
Total.....	8·445	... £7,552	17 3

ESTIMATED COSTS AND REVENUE DURING SECOND YEAR OF WORKING

The Combined Electricity Supply and Electric Tramways Undertaking.

	Equivalent in 30 watt lamps.	Probable max. demand Kilowatts.	Probable max. demand in kw.
Number of 8 c.p. lamps connected	32,000	960	480
Public arc lamps, 94 of 500 watts	1,567	47	47
Tramways—10 cars running	4,000	120	120
Totals	37,567	1,127	647

	Units.
Works output for private supply.....	384,000
Do. do. public lighting	148,000
Do. do. tramways.....	228,000
Total output for year	760,000

ESTIMATE OF COSTS.

	Pence per unit.	£	s.	d.
To Generation of Electricity—				
Coal	0·514	1,628	0	0
Oil, waste, water, and engine room stores	0·076	240	0	0
Wages at works	0·332	1,050	0	0
Repairs and maintenance	0·101	320	0	0
To Distribution of Electricity—				
Wages and stores at sub-station	0·134	425	0	0
To Public Lamps—				
Attending and maintenance	0·146	464	0	0
To Management Expenses—				
Salaries, engineers, clerks, &c.	0·268	850	0	0
Stationery, printing, insurances	0·038	120	0	0
To Rents, Rates and Taxes—				
Rates and taxes	0·158	500	0	0
Total cost	1·767	5,597	0	0
Gross profit		6,503	16	0
		£12,100	16	0

	Pence per unit.	£	s.	d.
By Sale of Electricity—				
Private supply by meter	4·75	7,600	0	0
Public lighting	2·69	1,662	0	0
Do. do. attending and maintenance		464	0	0
Supply to tramways	2·50	2,374	16	0
		£12,100	16	0

PROFIT AND LOSS ACCOUNT.

To interest and sinking fund on loan, £150,000, at 5¾ per cent.	£8,625	0	0
	£8,625	0	0
By balance for revenue account	£6,503	16	0
Balance, being *deficiency* on second year's working	2,121	4	0
	£8,625	0	0

Deficiency as above.....	£2,121	4	0
Estimated profit on tramways	1,746	14	7
Net deficiency to be met.....	£374	9	5

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Estimated Receipts.

(*a*) 214,620 car miles, at 10d. car mile	£8,942	10	0
(*b*) ditto 11·99d. car mile	10,722	2	0
If receipts averaged 10d. car mile, net profit would be	1,389	12	9
If receipts averaged 11·99d. car mile, net profit would be	3,169	4	9

ROUTE 4.

Distance between termini	1·31 miles.		
Total length of single track, including turn-outs	1·38 „		
Service 15 min.			
Single journey at 6 miles per hour takes 13 min.			
Number of cars required, 2.			
Estimated total cost of equipment	£12,850	0	0
Car miles per annum, at 14 hours daily	53,563		
Units of electricity at 0·85 units per car mile	45,500		
Working expenses at 8·4d. per car mile	£1,874	14	0
Revenue at 10d. per car mile	2,231	15	10
Net profit	357	1	10
Total of Route 1	£40,397	0	0
Total of Route 4	£12,850	0	0
Total cost of both sections	**£53,247**	**0**	**0**

Total Annual Working Expenses.

Section 1	£7,552	17	3
Section 4	1,874	14	0
Total	£9,427	11	3

Revenue at 10d. per Car Mile.

Section 1	£8,942	10	0
Section 4	2,231	15	10
Total	£11,174	5	10

Net Profit.

Section 1	£1,389	12	9
Section 4	357	1	10
Total	**£1,746**	**14**	**7**

CORRESPONDENCE.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: While making some experiments here in wireless telegraphy, using a vertical wire and general arrangement similar to that adopted by Mr. Marconi, a somewhat curious screening effect has come under observation. Experiments were first made with a tall pole to which the vertical wire was attached, and which could be carried about and held upright in any required position. Working in this way in the fields, and with a pole about 20ft. high, it was possible to get very good signals up to a distance of nearly half a mile. In these experiments the sending and receiving stations were separated by a belt of trees about 50 yards in width, but not very near either to the sending or receiving stations.

It was then decided to arrange a signalling station for experimental purposes, at a distance only very slightly greater than that experimented over in the first instance; as nearly as could be estimated the distances in the two cases were 800 yards and 900 yards respectively.

On erecting poles, however, rather over 30ft. high at the sending and receiving ends, the signals were not at all distinct, though, according to Marconi's law, this height of pole should have been sufficient to signal nearly a mile with the instruments used.

After some consideration it was decided that this want of effect must be due to the screening action of a number of lime trees (also about 30ft. high) which closely surrounded the house to which the receiving pole was fixed, the trees nearest the pole being not more than 6 yards distant. The trees, which are planted in a row approximately perpendicular to the line of transmission, would form a screen similar to the wire grids used in polarization experiments with waves of shorter length, though on a somewhat larger scale. This effect of the screening action of trees near the receiving station is the more interesting, in view of the fact that the steel ropes and masts of a ship in Marconi's experiments appeared to have very little disturbing effect. With trees, however, the interlacing branches should screen the space much more completely than the steel stays of a ship.

The earth connection (which was made to an earth plate 6ft. by 2ft. at the sending end) should have been very good at the receiving end, where connection was made with a water pipe laid in very damp soil. The nature of the earth connection has, of course, a good deal to do with the effectiveness of signalling, but it cannot account for the effects described above, since the earth was probably better in the second series of experiments than in those carried on in the field. It seems probable that the greater distance to which signalling can be carried over sea than over land with a given height of mast is due (partly, no doubt, to the complete absence of obstacles) but chiefly to the excellence of the earth connection, which can be made direct to the sea water at both ends.

It may be of interest to record here some observations that were made on the spark at the sending station with a revolving mirror. One terminal of the spark-gap, which was 1cm. in length, was attached to a vertical wire 22ft. high of 7/16 stranded wire, the other terminal being connected to the earth plate mentioned above. The light was reflected from the surface of a revolving mirror (running at about 450 revs. per sec.) on to a photographic plate, placed in an ordinary camera, which was focussed on the spark-gap. It was never possible to see more than two or three half oscillations of the spark on the plate, thus demonstrating the extremely rapid damping with this arrangement. The frequency calculated from these photographs was about 2,500,000 per sec., corresponding to a wave-length of about 130 metres.—Yours, &c. E. W. MARCHANT.

Blythwood Laboratory, Renfrew, N.B., July 30, 1900.

PARLIAMENTARY INTELLIGENCE.

MUNICIPAL TRADING.

The Joint Committee on Municipal Trading met again on July 24, the Earl of Crewe presiding.

The EARL OF MORLEY, Chairman of Committees in the House of Lords, gave evidence as to private bill procedure in the House of Lords. When the session began, he said, he went through every bill with the promoters and argued every point that arose. These interviews were entirely private, the object being to facilitate the progress of bills in both Houses and to save cost and trouble to promoters by getting the amendments he thought necessary introduced in the first House. If any important question of principle arose he consulted the Chairman of Ways and Means in the House of Commons, and if the matter was very important indeed the head of the Government department concerned sometimes came to see him. He was, of course, merely the agent of the House of Lords. The question whether corporations should be allowed to work tramways was very much discussed in 1892. The decision in favour of giving corporations the power could only be effected by an alteration of the standing orders, so that both Houses had ample notice of what was being done. When smaller matters arose, such as the manufacture of fittings for electric or gas work, he dealt with them himself. The veto on the manufacture of fittings had been inserted in private bills for the last two years. He consulted several experienced gentlemen who came before him for the promotion of bills, and they all said that they did not want power to manufacture at all. He did not quite agree with a former witness who said that it would be easy when a corporation bought up a company to cut out any power to manufacture which the company might possess. The undertaking would be purchased as a whole, and the power to manufacture would affect the terms of purchase. Witness did not regard the running of omnibuses as a fit subject of municipal trading. The local authority having control of the traffic might very much handicap any competitors. As far as he knew the power of generally using omnibuses had not been allowed. The Tramways Act of 1870 required amendment in regard to the absolute consent of local authorities being required before a tramway could be made. Local authorities, who had an absolute right to stop a bill, might stop a very useful enterprise, and had the power of imposing conditions which were very often extremely onerous. While he was all for giving local authorities every opportunity of being heard, he thought that the right of absolute veto ought to be modified. He thought it would be an advantage to have a new general Tramways Act.

The CHAIRMAN: As to electric lighting orders, we have had complaints that local authorities—particularly small ones—have obtained orders and have not used them.—I think that the Clauses Bill of 1899 embodies exactly the practice enforced by the Board of Trade up to that time. The clauses of that measure give the Board of Trade powers to revoke a provisional order after a certain time, but I fancy that that power has, so far, been very sparingly used. I think it would be far better that there should be a limit of time put on the completion of the works, and that if at the end of that time the local authority seeks power to extend the period, it should be extended. I do not think that it should go on indefinitely.

Sir ROBERT HUNTER, solicitor to the Post Office, explained the legal position of the Post Office with regard to the National Telephone Co. with reference to the opening of streets in Glasgow. In 1892 an agreement was made between the Postmaster-General and the National Tele-

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phone Co., to the effect that the trunk wires connecting different towns should be worked by the Postmaster-General, and that business inside towns should be left in the hands of private companies. The Postmaster-General also agreed that he would confer on the National Telephone Co. the powers he possessed of taking up streets under an act of 1892, and also that he would lay pipes for the Telephone Company to connect two or more exchanges in the same area. He did not think the Glasgow Corporation had any particular grievance with regard to the arrangement between the Post Office and the company.

Mr. J. W. BENN, L.C.C., said that of the 115 miles of tramways in London 72 miles had already been purchased by the County Council, leaving 43 still in the hands of private companies; 48 miles were leased by the Council to the North Metropolitan Tramways Co., and 24 miles south of the Thames were worked by the Council itself. The northern lines cost £817,000 and the southern £889,433. The net receipts from the northern lines were £75,777, and the surplus, after deducting charge for interest on capital and sinking fund, was £38,111. On the south side the net receipts were £92,991, and deducting charges for interest and sinking fund, there was a surplus of £48,283. Regarding the matter as an investment for the ratepayers, the Council had been able to pay the same percentage to the investors in the south as in the north and out of the southern surplus to make several very valuable concessions to the passengers and to those employed on the tramways. The Council had set up an all-night service practically without regard to whether it would pay. This service had proved extremely popular and had paid its way. There was a much more frequent service of cars in the south than in the north. The Council's charge per passenger came to 0·89d. against 0·94d. charged by the company formerly owning the southern lines. That meant a difference in passenger receipts of £17,000 a year. The charge per passenger in the north was 1·12d. against the southern charge of 0·89d. As to whether a local authority could work a tramway as cheaply as a company, he had compared the working of the southern lines by the company in 1898 with the County Council working in 1899, and found that under the company the total receipts were £414,922, the total expenses £335,958, and the balance of revenue £104,964, while under the Council the total receipts were £467,180, the total expenses £383,030, and the balance of revenue £84,150. That showed an apparent loss, but against the loss must be charged £14,000 for the provision of better wages and a six days' working week for the employées, and the fact that the Council set aside for repairs and renewals £8,392 more than did the company. Thus the actual working showed a balance in favour of the Council of £1,578. The Council hoped for very important results from the adoption of electric traction. They expected an extra profit resulting from the conversion of the motive power of 3·38d. Assuming that only as many miles as at present would be run, that would show an addition to revenue on the south side of £140,633. Deducting the interest on the extra capital and the sinking fund, this meant an extra annual profit on the 24 miles of £79,008.

On July 27 Mr. G. BRIGGS, managing director of the Shap Granite Co., Westmorland, and representing a number of manufacturers of concrete slabs, protested against the way in which certain Corporations were competing with such manufacturers by means of paving material made out of the refuse from destructors. Some of the Corporations were selling the slabs at a loss of 25 per cent., that was to say, at 25 per cent. under that which it would cost a private manufacturer to produce them. This was the case in Aston Manor and Bootle. From this loss had to be deducted the 9d. a ton which it would cost the corporations to get rid of the refuse.

Mr. MAXWELL, president of the Scottish Co-operative Wholesale Society (Ltd.), Glasgow, expressed his satisfaction with the manner in which Glasgow Corporation had conducted its various undertakings Under company proprietorship gas was 4s. 7d. per 1,000ft., and to-day was 2s. 2d., while the quality was better. The conditions of labour had also greatly improved under the management of the Corporation. The wages of the tramway men had been increased by from 4s. to 5s. per week, and the service had been greatly improved. He would like to see the municipal system further developed. He thought that all cemeteries should be in the hands of local authorities, and suggested that Corporations should start fire insurance and life insurance businesses. He did not see what was to hinder corporations going into banking, and he thought that the issue by corporations of notes for very small amounts should at least be tried.

Mr. W. E. L. GAINE, general manager and solicitor of the National Telephone Co., said he wished to reply to evidence given by the Lord Provost of Glasgow with reference to the Glasgow telephone service. The Lord Provost had stated that the real reason why the Corporation obtained a telephone licence was that the company's service was inefficient. A report on the subject was, however, made by a Treasury Commissioner, the Sheriff of Perthshire, after a long inquiry, in 1897, and his decision was that the inefficiency of the company's service in Glasgow was largely due to the action of the Corporation in refusing to grant the company wayleaves for putting down the metallic-circuit underground system. The inference which the Treasury Commissioner drew from the evidence placed before him was that the true cause of the refusal of the Corporation to allow the company wayleaves was that they were resolved to establish a telephone system of their own by which they believed they would be able to extinguish the company so far as Glasgow was concerned, and to establish a cheaper and better service. The Commissioner also expressed the opinion that as the telephone was used only by certain classes of the community and not by all it was not a proper subject for municipal enterprise. It was pretty clear that men living in houses of an annual value of under £20 would not be likely to use the telephone, and in Glasgow 85 per cent. of the whole of the ratepayers were assessed at less than £20. Witness did not think that in the case of the telephone service competition was right or proper. The telephone service was part of the telegraph service of the State, and ought to be in the hands of the State. If it were not in the hands of the State it ought, like a great railway, to be a monopoly under the control of Parliament, otherwise the multiplying system of different local areas worked under different regulations would cause great trouble. He did not think that more than two or three municipalities in this country, with the exception of Glasgow, had thought it wise even to consider the adoption of a telephone system.

The CHAIRMAN: You say that it was by harassing you in Glasgow that the Corporation put you into a position which enabled them to obtain powers from the Postmaster-General. Do you think that is likely to happen elsewhere?—Yes, it may happen elsewhere.

Can you tell me if competition is allowed in foreign countries?—There is no competition in France or Germany, and none anywhere in Europe, except in Sweden. In the case of Sweden there is competition in Stockholm, and that is between a great company, which does the bulk of the work of the State itself. In America the position is quite different. There the telephone interest is dominated by one great finance corporation, and they have licensed a large number of different companies to exploit the various States one after another. There is a certain amount of competition there. There is much greater freedom in America for anybody to set up systems than in this country or in any European country.

Even in the powers of taking up streets?—Yes.

The sitting then closed, and it is believed that no further evidence will be taken.

SOUTH WALES ELECTRIC POWER DISTRIBUTION BILL.

On July 28 the House of Lords Committee, presided over by the Duke of Argyle, considered this bill.

Mr. PEMBER, Q.C., for the promoters, said the opposition had now gone down to something very small. A clause was put in by the House of Commons Committee providing for compensation to the Swansea Gas Light Co. and the Aberdare and Aberaman Gas Consumers Co., but it was struck out by the Government draughtsman and the Board of Trade. He was, however, quite willing that it should be re-instated if counsel for the two companies mentioned could convince their lordships that it was necessary.

The Committee agreed that a protecting clause for the two gas companies should be put in the bill. The preamble was then declared proved, and the bill was ordered to be reported for third reading.

LONDON COUNTY TRAMWAYS (NO. 1) BILL.

On July 24, the Select Committee of the House of Lords, of which the Earl of Camperdown is chairman, commenced consideration of this bill. The House of Commons proceedings were fully reported in our issue for June 22 and 29.

Mr. FREEMAN, Q.C., for the promoters (the London County Council), said the object of the bill was to enable the Council to link up the various systems of tramway in the Metropolis which had been constructed by various companys, and to reconstruct particular tramways. The form of the bill had been agreed with nearly all the local authorities; and 11 out of the 15 tramways proposed had been put in the bill at the urgent request of the local authorities themselves. He submitted that the general question of allowing tramways had been decided by the general Act of 1870; and he should contend that petitioners against a tramway must allege and prove specific injury and inconvenience. The opposition of the frontagers and of the railway companies affected by this bill was purely a matter of clauses.

The CHAIRMAN said none of the petitioners, as far as he was aware, opposed the bill as a whole. In that case the most convenient way would be to allow the bill to proceed and then deal with the opponents on clauses, as suggested by counsel. The Committee accordingly declared the bill.

The consideration of clauses proceeded, and evidence having been given as to Tramway No. 4 (St. James's-road, Holloway—Drayton Park-road—Gillespie-road—Blackstock-road), the CHAIRMAN said the Committee had decided to strike this line out of the bill.

The proposed line along St. John-street-road, from the Angel at Islington to Smithfield Markets, was then dealt with.

Mr. FREEMAN said this line would be double all the way. St. John-street was wide all its length except at one place, and that the County Council were taking powers to widen.

The evidence of frontagers objecting to the line was taken, the opposition being to the block of market traffic likely to arise from the tramway.

The Committee then considered the proposed line along Rosebery-avenue.

Mr. COURTHOPE MUNROE, for the Holborn District Board of Works, pointed out that the London County Council, at the instance of the Clerkenwell Vestry, agreed to carry out in Clerkenwell parish, about half a mile away from Rosebery Avenue, an improvement which was more local than general in its character, which would cost some £200,000, but they made it a condition that the Clerkenwell Vestry should consent to the line along Rosebery Avenue. He contended that that was an improper bargain, especially having regard to the fact that in 1897 and 1898, when a similar scheme was before them, the Vestry felt they could not, in the public interest, consent to the line being made.

The CHAIRMAN said the Committee could not discuss the motives of Clerkenwell.

Mr. MATTHEW HALE, clerk to the Holborn District Board, said there were six lines of trams and 10 lines of 'busses converging at the Holborn Town Hall, where the new line would join the existing lines, the traffic otherwise was very heavy.

Mr. FREEMAN, in reply for the County Council, pointed out that there were only 200 yards of the Rosebery Avenue line in the Holborn district and when made it would allow ample room for carts and waggons to pass. The matter of congestion was simply one for the police to deal with.

The Committee decided eventually to retain in the bill both the Rosebery Avenue and St. John-street-road tramways, and the bill was ordered to be reported.

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LANCASHIRE ELECTRIC POWER BILL.

This bill came before the Duke of Argyle's Committee of the House of Lords on July 26. The House of Commons Committee proceedings and a sketch map of the area of electricity supply embraced by the bill have been given in previous issues of *The Electrician*. Opposition to the bill proceeded from the local authorities of Liverpool, Bootle, Bolton, Manchester, Salford, Southport, and Stockport, who wished to be cut out of the bill because they objected to the promoters of the bill having wayleaves empowering them to lay wires through their districts.

Mr. WORSLEY TAYLOR, Q.C., for the promoters, said it was necessary this wayleave power should be given in order that the company to be incorporated under the bill might supply electricity to places on each side of the opposing districts. It might not be necessary to put the cables through the principal parts of those opposing districts, but only through some parts of them. The opposing corporations objected that they were themselves sudplying electric current, and therefore that they did not require to be supplied by this company. He urged although that might be the case at present it did not follow that they would not require to be supplied "in bulk" at any future time. Therefore he could not understand the opposition. Blackburn had its own electricity works, but did not stand in the way of this company. But Manchester not only objected to the promoters laying cables through their streets, but also objected to cables being laid through the roads and streets of neighbouring authorities.

Mr. GRIPPER thought the scheme of the promoters an excellent one. There were 129 local authorities in Lancashire, and 16 or 18 of them had already electric works in operation; 19 had obtained provisional orders, but had not yet constructed any works, although some of them had had their orders for 10 years; in 87 districts no attempt had been made to obtain provisional orders. Many of the local authorities would be only too glad to do their own lighting if they could get supply in bulk from the promoters of this bill, as then they would only have to spend their money for laying down mains. He did not consider Manchester was at present in a position to supply the outlying parishes as advantageously as this company hoped to do, although they might be when they had finished the extension works they were now carrying out. The promoters wanted to supply current at 1d. per unit. He was not aware that Liverpool supplied it at less than 1d., but probably Manchester was able to supply current for tramway working at less than 1d. Shown some photographs of trenches which were dug in Manchester streets for laying cables, witness said his company would not dig trenches like that; they were more like earthquakes than anything else. His company could lay all their cables in the space Manchester was wasting. They wanted power to go through Salford in case they were asked to supply districts on the other side. He was not aware that Salford supplied the tramways with electricity at ¾d. but even that was not an unusual price for tramways. If Liverpool cannot supply electricity for street lighting at less than 2½d. they would possibly require his company's supply, because it would be cheaper. He did not think it would be necessary to run cables through Stockport, but Stockport might want his company's supply at some future time, as might also Southport. They would enter into a contract with Southport to-morrow to supply them at 50 per cent. less than they supplied themselves. He had before him a list of 66 local authorities who were supplying themselves with electricity, but not six places were supplying electricity as cheaply as Southport. He was certain his company could compete with Southport, even though their cable would have to go a long distance.

Mr. WORSLEY TAYLOR, in reply to the Chairman, said that if Bolton and the other towns were struck out of the bill the promoters would not have power to supply them with electric current if they eventually wanted it, as they would not have statutory rights to spend their money for the purpose.

Evidence in favour of the bill was given by, amongst others, Mr. Arthur H. Leach, chairman of the West Houghton District Council.

Mr. SCULLY, chairman of the Electricity committee of the Gorton District Council, said his Council had a provisional order of their own, but had not constructed any works. They had now three alternatives: They could put down their own works, or could arrange with Manchester, or could arrange with this company if the bill was passed. His Council desired that Gorton should remain in the area of the bill, and it would possibly be to their advantage to take electricity in bulk from the company. At all events, they would like to have the opportunity of doing so.

The Committee decided that Liverpool, Bootle, Manchester, Salford and Stockport should be exempt from the area of the bill; that wayleaves be granted in the case of districts which had entered into contracts with Manchester; and, in regard to Bolton, that wayleaves be granted up to within a radius of 2½ miles of the town hall.

On July 26th, Mr. BALFOUR BROWNE, Q.C., asked the Committee to reconsider their decision with regard to Southport. He said the Corporation were unanimously in favour of being left out of the bill, as they had their own electricity works, and could supply themselves with current more cheaply than it could be supplied by this company.

The CHAIRMAN said the Committee had considered the matter, but would not change its decision, as above set out.

SHANNON WATER AND ELECTRIC POWER BILL.

On July 28 this bill was before the House of Lords Committee presided over by the Duke of Argyle. A full report of the proceedings before the House of Commons Committee appeared in *The Electrician* for July 6, p. 411, and a sketch map of the proposed area of water collection and electricity supply was published in our issue of July 13.

Mr. BUSHE, Q.C., for the promoters, said the opposition was of a very restrictive character, and was offered by a few fishery proprietors along some 5 miles or 6 miles of the river. Of course they were entitled to be heard, but he thought their opposition would have no weight with the Committee. They stated that they had valuable spawning beds in the river, and that the scheme of the promoters would do those spawning beds injury. But anyone who knew Ireland was aware that of whatever else they might fall short it was not rain. What was proposed by the bill had been done extensively in America, Italy, Switzerland, and Germany, and it had been a great source of wealth and advantage to the districts served. The promotion of the bill gave a good sign of awakening enterprise in Ireland. They proposed to supply electricity for lighting and all other purposes to Limerick and other places within a radius of 30 miles of their works. The project had received support of 24 local bodies and three county councils.

Mr. S. G. FRASER, engineer to the project, repeated his evidence before the Commons Committee, and added that the Shannon Company's working expenses might be estimated at £2. 16s. per H.P. per annum. Labour was very cheap in that part of the country. The purchase of land and the cost of the works would carry an expenditure of £183,000.

Mr. H. F. PARSHALL said the chief necessity in connection with electric lighting was economy, especially in Ireland. He estimated that the cost of the production of electric current would be 1d. per unit. At Cork electricity was generated by the electric company there working by means of coal, and it was very expensive.

The CHAIRMAN said the Committee regretted that the scheme seemed to them at present incomplete for the purpose assigned, inasmuch as the promoters would have to come to Parliament again for the conclusion of the project (the question of erecting a weir on the river which had not been mentioned in this bill), but they were ready to hear counsel for the promoters on that point.

On Saturday Mr. BUSHE said that, having regard to the very serious consequences which might ensue if the Committee's view was adhered to, he would like to put before the Committee the views of the promoters. There was an understanding that a case should be presented in a complete form, but he contended that this was a case to which such a rule was never intended to apply. The case was complete, and the provision of a weir was a subsidiary question. He therefore asked the Committee to hear the evidence of his witnesses. If that evidence satisfied the Committee that it was a complete scheme, then the promoters could come to Parliament next year to ask for what was a very small thing, because all the big issues of the case would have been decided. The weir was not for the promoters' satisfaction, but for the satisfaction of the opposition, and also the Board of Works, who had asked for a weir.

Mr. BALFOUR BROWNE said the promoters knew they could not expend one penny until they got water, and they could not get water until they constructed the weir, which showed that the scheme was incomplete. This scheme, if allowed, would kill the salmon fisheries.

Mr. FRASER, recalled, said he saw no reason why they could not make their intake at such a height that they could not get water until the river was above a certain level.

Mr. HASSARD, recalled, said the promoters could get sufficient water for their purpose and still leave sufficient for fishing purposes.

Mr. BALFOUR BROWNE said his clients would oppose this scheme to the bitter end unless the promoters carried out their contracts. He had expert witnesses who said there was no means of measuring the water except with a weir.

Mr. ARMISTEAD, manager of the Solway Hatchery and Salmon Fisheries Co., said deep water was not necessary to enable salmon to spawn; a foot or two would be ample. There were not many spawning beds between the proposed intake and outlet, nor would this scheme injure the salmon fisheries.

Mr. A. L. JOYNT, director of the Limerick Electric Tramway Co., said he was sure the promoters of this bill would find plenty of customers for their electricity in Limerick. The whole of the local bodies in the district, numbering 23, had passed resolutions in favour of the scheme.

Mr. QUINN, a member of a large manufacturing firm in Limerick, said the promoters' scheme would be of great advantage to his own firm if they supplied electric power at a low rate, and it would be the means of many more industries springing up in Limerick.

Mr. BROWN, chairman of the promoting company, and a member of the firm of Brown, Thomas & Co., of Dublin, said he had been watching the Shannon running to waste for years, and he had often wondered what could be done with it.

Other evidence for and against the scheme having been tendered, chiefly in the latter case, to the effect that the passing of the bill would ruin the salmon fisheries and take away the livelihood of the fishermen and their families,

The Committee stopped further evidence, and the Chairman announced that the preamble of the bill was not proved, and it could not be proceeded with.

BATLEY CORPORATION TRAMWAYS BILLS.

This bill, a measure to confirm a provisional order, came on June 27 before the Select Committee of the House of Lords, presided over by the Duke of Northumberland.

Mr. FITZGERALD, Q.C., said the bill sought to confirm a provisional order authorising the Batley Corporation to construct an electric tramway within the borough. The population of Batley had doubled since the charter was granted in 1868. There was an existing tramway worked by steam, and this the Corporation would, in time, be able to acquire. The scheme now proposed would complete the tramway system. The opponents of the bill were the British Electric Traction Co., who had promoted a measure before the Light Railway Commissioners called the Spen Valley Railway, and since the Batley Corporation had started proceedings to obtain the present bill, the company had brought forward another scheme to get their Spen Valley railway. He also pointed out that under the general law relating to tramways it was customary to give local authorities power to

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work tramways within their districts when they were so disposed. In this case it was specially desirable such powers should be granted as they were the lighting and water authority; and if entrusted with the tramways would have the whole control of the breaking up of the streets and roads.

Mr. J. ILLINGWORTH, Mayor of Batley, said there were a large number of manufactories in the town. On the north, east, and west sides of the town there were districts without a tram service at all, and in the best interests of the public it was desirable that these districts should be furnished with means of communication by tramway. The Corporation were unanimously in favour of an electric tramway system, considering that such a system would tend to its development, and would benefit the inhabitants who favoured the scheme. The Corporation proposed to work the tramways in connection with the electric lighting, for which they had already obtained an order. The present bill was first formulated about a year ago—before the Spen Valley scheme was put forward. The Corporation were prepared to help that scheme outside their own boundaries by giving running powers over their own line. The cost of the Corporation tramway, with the generating station for electric lighting and tramways, would be £100,000. Working powers to be given to the Spen Valley Railway would be subject to arbitration under the bill.

Mr. G. HIRST, manufacturer, chairman of the Electric Lighting and Tramways committee of the Batley Town Council, also gave evidence in favour of the bill. The Corporation obtained electric lighting powers in 1898, and shortly afterwards a committee was formed to report on a scheme for electric lighting and tramways. It was subsequent to that that notice was received of the Spen Valley scheme. Engineers engaged by Batley Corporation had reported before August last.

Mr. S. V. CLIREHUGH (Messrs. Lacey, Clirehugh & Sillar) said his firm were first instructed in January, 1899, to report on the question of an electric lighting scheme for Batley, and also to report briefly as to the possibility of a tramway scheme. It was not until March 11, 1899, that they received formal instructions to give a full detailed report and estimates with regard to tramways, but in January, 1899, he had visited Batley, and, in his own mind, formulated routes. When he made the report to the Corporation he had no idea of the existence of the Spen Valley scheme or of the route of that scheme. It was perfectly clear to anyone acquainted with Batley that Halifax-road was one of the most obvious routes in the borough for a tramway. Provision was made in clause 40 of the Corporation's order giving the Spen Valley promoters the right to run over the tramway in the Halifax-road; and there would be no difficulty in doing that. His estimate for the whole work, excluding the generating station, was £107,000.

Mr. STEPHEN SELLON, for the opposition, said he was engineer to the Spen Valley scheme of the British Electric Traction Co. The scheme started from Dewsbury, and its main line ran through Heckmondwike, Gomersal, and Cleckheaton, passing through a small portion of Batley (Halifax-road). When the scheme was brought forward a local inquiry was held by the Light Railway Commissioners, at which the three towns mentioned propounded a rival scheme. But in consequence of the difference of opinion among the corporations it was held advisable to put the scheme into the hands of one company. Since then the three corporations had entered into agreements with the company and were now supporting them. The line as it passed through Batley would adequately serve that town. The Batley scheme was very small compared with the Spen Valley scheme, and if it were sanctioned the traffic on the much larger system would have to be dependent on the Corporation as to running powers. If the Corporation's scheme were sanctioned at all the line in Halifax-road should be given to the company and the Corporation given running powers over it. He regarded the Corporation tramways rather as a counter move to the company's proposal.

Mr. SYDNEY MORSE said he was solicitor to the British Electric Traction Co., and acted for them in the promotion of the Spen Valley order. The local authorities of Dewsbury, Heckmondwike, Cleckheaton, Liversedge, Gomersal, and Ravensthorpe were all favourable to the company's scheme, and at the local inquiry said the powers should be in the hands of the company and not in those of the Corporation.

Mr. FREEMAN, Q.C., for the opponents, pointed out that for the sake of a small section of about 2 furlongs in the borough Batley sought to be entitled to interfere with a line originally 8½ miles, and now, with extensions, 40 miles long. Moreover, they sought to have priority of service, and thus might derange the traffic on the whole line. He contended it was not right the power should be given, but that the company should have thorough control of their own lines. They should be empowered to make the disputed portion of line, and if the Corporation made the other parts of their proposed system they should be given running powers over the disputed portion.

Mr. FITZGERALD, Q.C., having replied,

The CHAIRMAN said: The Committee find that the preamble is proved, but they think that sub-section 4 of clause 40 should be modified so as to make it quite clear that the Corporation shall not be able to impede unduly the exercise of the company's rights over the line.

On July 30 the Batley bill came before the Select Committee of the House of Commons, presided over by Mr. Seale-Hayne.

Mr. J. D. FITZGERALD, Q.C., for the Corporation, said the only opponents of the bill were the British Electric Traction Co., who had a large capital, head offices in London, and owned tramways and light railways in different parts of the country. Their connection with this district arose in this way: In November, 1898, they gave notice of an application to the Light Railway Commissioners for leave to construct a light railway called the Spen Valley Light Railway, some 8 miles in length, which differed very little from the tramways to be constructed under the present order. The Batley Corporation opposed that scheme, which was, however, sanctioned by the Light Railway Commissioners, but had not up to the present received the sanction of the Board of Trade. The B. E. T. Co. opposed the Batley Corporation scheme on the ground that the Railway Commissioners had sanctioned the Spen Valley scheme, and that they were about to ask for authority to carry out another scheme which would run across Batley. When the matter came before the Board of Trade they had the whole case before them—the application of the Batley Corporation, the order already sanctioned by the Light Railway Commissioners, and a very full statement by the B. E. T. Co. The Board of Trade, however, sanctioned the Batley Corporation tramways in the order now before the Committee. After the order was granted to Batley for a tramway along the Halifax-road the B. E. T. Co. was given powers to run over the line and to make junctions with it, and in the House of Lords words were inserted binding the Corporation not to exercise their rights as owners of the tramway so as to interfere or impede the company in the exercise of such rights. While the present bill was pending in Parliament the company went on with their new railway scheme, which included the making of a line identical with one of the Corporation tramways. That matter came before the Light Railway Commissioners, who took the view that, as opposition to the Batley scheme was pending, they ought to make an order by which, if the Batley scheme were confirmed by Parliament, then the light railway was not to be made by the B. E. T. Co. The Board of Trade had sanctioned the tramways, the House of Lords had passed the bill confirming the order of the Board of Trade, and he now asked the Committee to do the same.

Mr. FREEMAN, Q.C., for the B. E. T. Co., said the Batley Corporation had no feeling of hostility, as he understood it, to the Spen Valley scheme, and the Spen Valley promoters had no hostility either. What they wanted was to be able to carry their traffic continuously along as far as Ravensthorpe. If the present order was passed, the company would only have running powers over the Corporation tramway, the result of which would be they would not be able to make through running with their electric current over that bit. Their current would be cut off over a piece of the line—the Halifax-road, which was wide enough for both to lay their lines independently. At the point where there was a short gap between the systems the company were willing to couple up the lines and not to construct the line running parallel to the Corporation's.

Mr. FITZGERALD said he could not agree. The result of placing two independent lines on the same road would be that all the traffic going one way on each set of lines would be on the wrong side of the road.

The CHAIRMAN said what the Committee had to decide was whether the scheme ought to pass or no. It had been before the Board of Trade, and when the Committee had determined what had been referred to them the Board of Trade might deal with the Traction Company as they liked.

Mr. FREEMAN said the Corporation were asking to construct a line down the middle of the road, and if that were sanctioned the Board of Trade could not allow the company to put down another line.

The CHAIRMAN said the Committee might decide that the line should be laid down so as to leave room for a second line.

Mr. FREEMAN asked that Batley Corporation should not be allowed to close this road to the company's line.

Mr. FITZGERALD said the Board of Trade had decided in favour of the Batley scheme, subject to the running powers of the Spen Valley promoters (the B. E. T. Co.), who were now asking the Committee to override the decision of the Board of Trade.

The Committee decided to pass the preamble in regard to the Batley order, subject to the insertion of a clause providing that a double line could at a future date be laid down the Halifax-road, the user of which was to be regulated by the Board of Trade.

A clause to give effect to this decision having been submitted by Mr. Freeman, was approved, and the remaining clauses were disposed of and the order set down for report.

WARRINGTON CORPORATION TRAMWAYS.

The Select Committee of the House of Commons, presided over by Mr. Seale-Hayne, on Monday considered Provisional Orders (No. 4) Bill which confirms the order granted by the Board of Trade to the Warrington Corporation empowering them to construct and work about 7 miles of electric tramways within the borough at an estimated cost of £95,577. The bill has passed the Upper House.

Mr. WEDDERBURN, Q.C., said the only opponents were the London & North Western Railway Co. The point involved was who should pay for the construction of a bridge to replace a level crossing at Wilderspool Causeway, should the Board of Trade, owing to the making of the proposed tramways, decide to order a bridge to be built. Under the company's own act the Board of Trade might make such an order at any time, and the company would have to bear the whole cost. The Committee of the House of Lords had put in a provision that, if a bridge should be ordered by the Board of Trade the Corporation should construct the road over the railway and that that company should pay to the Corporation half the cost. This road was one down which there was at present a large daily traffic, and the proposed tramway would not, he urged, add very appreciably to the traffic.

The CHAIRMAN said that in the Southport and Lytham tramroads case the same point arose, and an argument that then had great weight with the Committee was that the road was an old one and there first, and therefore the Committee decided that the greater part, if not the whole of the cost, ought to be paid by the new comer.

During the proceedings the CHAIRMAN intimated that if the opposition were persisted in, in face of their Act of 1851, under which the company could be called upon to build a bridge over this crossing at any time by the Board of Trade, and at their own cost, the Committee could not be bound by the decision of the House of Lords Committee.

Mr. LITTLER said he would not press the matter further, but he had no doubt the Board of Trade would compel the railway company to have a bridge directly this tramway was constructed.

The Committee passed the preamble of the bill in respect of the Warrington order.

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GARSTON TRAMWAYS.

The Select Committee of the House of Commons presided over by Mr. Seale-Hayne, on Monday dealt with the Garston tramways provisional der.

Mr. WEDDERBURN, Q.C., said Garston was a residential suburb of Liverpool with a considerable population. Under the order the Garston & District Tramways Co. were to have power, with the consent of the District Council, to construct the proposed tramways, about 2 miles in length, at an estimated cost of £12,435. After construction the company were to sell the lines to the Council, and the Council would then lease them to the company for 21 years at a rental of £300 a year. When the order came before the Committee of the House of Lords there was a petition of the County Council of Lancashire, asking that their contribution in respect of the upkeep of the roads over which these tramways would pass should be reduced to the extent of the amount receivable by the Garston Council from the Tramways Company. The House of Lords inserted a clause reducing by £300 the contribution of the County Council for a period of 21 years. It was now sought by the District Council to have this clause taken out.

Mr. LITTLER, Q.C., for Garston Council, contended that the £300 to be paid by the company was not in respect of increased traffic on the roads.

The Committee decided that the £300 was in the nature of a rent under the agreement between the Garston Council and the Tramways Company, and the clause was accordingly struck out of the order, which, as amended, was approved by the Committee.

SOUTHAMPTON CORPORATION TRAMWAYS.

The Select Committee of the House of Commons, presided over by Mr. Seale-Hayne, on Tuesday considered the bill confirming the provisional order granted by the Board of Trade to the Southampton Corporation authorising the construction of additional tramways in the Borough, and borrowing £100,000 for the purpose.

Mr. FREEMAN, Q.C., said the bill would enable the Corporation to reconstruct certain tramways they had acquired from the former tramways company, and to construct new lines—about 8 miles of new lines—all to be worked by electricity.

There was no opposition, and the Committee passed the order.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY BILL.

This bill came before the House of Lords Committee (the Duke of Argyll in the chair), when it was announced that an arrangement had been come to with the opposition. After formal evidence the committee declared the preamble proved, and the bill will proceed.

LEGAL INTELLIGENCE.

Castner-Kellner Alkali Co. (Ltd.) v. Commercial Development Corporation (Ltd.).

On Monday, the House of Lords, consisting of the Lord Chancellor (Lord Halsbury) and Lords Macnaghten, Morris, Shand and Brampton, gave judgment in this case, which was argued before them on May 15, 17, and 21. A full report of the arguments before their lordships appeared in *The Electrician* for May 18 (pp. 142-145) and May 25 (pp. 170-172).

It was an appeal by the plaintiffs from an order of the Court of Appeal discharging a judgment of Mr. Justice Bigham. The action was brought for the purpose of restraining, by injunction, the Commercial Development Corporation from infringing plaintiffs' patent, No. 20,259 (1894). The defendants denied infringement and alleged that plaintiffs' patent was invalid on the ground that the invention was neither new, useful nor subject matter for letters patent; and also that the complete specification described and claimed inventions not comprised within the scope of the provisional specification. Mr. Justice Bigham decided in favour of the plaintiffs, and granted a perpetual injunction. By a majority the Court of Appeal reversed that decision. The plaintiffs now appealed.

JUDGMENT.

The LORD CHANCELLOR, in moving that the appeal be dismissed with costs, said: In order to appreciate the real nature of the dispute in this case, one has to remember that no chemical discovery is in question, no new mode of producing caustic soda, so far as the electrolysis itself is concerned. The turning of common salt and water by electricity, and making an amalgam with mercury and sodium, so as leave as a product caustic soda, is common to all the patents that have been brought before your lordships' notice in the course of this discussion. Between the immediate parties to this appeal, therefore, there is nothing whatever in dispute, except the mechanical machinery—the apparatus by which this chemical process of producing caustic soda can be put in operation. Now, Kellner, whose patent is the one we have had to consider, described in his provisional specification the mechanical contrivance by which the process I have referred to has to be put into operation, and the whole point in dispute is whether, in the description he has given in his provisional specification, he has or has not described the invention which he claims in his complete specification, or whether the latter does not, in addition to what he has described in the former, claim something different and outside his original claim. That is the whole question. Now there cannot be any doubt that an essential feature of his invention is what he has called a stationary mercury cathode, and the question is further narrowed to the single point, in what sense the word "stationary" is to be understood. It is said that there are two senses in which the words "stationary" may have been used. It may be considered "stationary" in respect of surrounding objects or "stationary" in respect of the vessel which contains the mercury. A scientific demonstration was made before your lordships that the mercury in the vessel was itself at rest, although the vessel itself was subjected to a considerable movement. I have some doubt whether that experiment is a sufficient proof of the proposition it was intended to support. No actual use of the apparatus has ever been made, and an experiment such as was made before your lordships and its actual use in practice is a very different thing; but independent of this consideration, the question must be determined by the fair construction of the provisional specification itself. It will not do to say that in looking at the specification there is a sense in which it is compatible with the provisional, but whether the provisional really is intended to protect the invention more minutely described afterwards in the compiete specification. My lords, I am unable to say that I think the provisional specification here ever contemplated the movement in any sense of the mercurial cathode. It is impossible to read the concluding part of the provisional specification without being struck by the absence of any hint of the arrangement claimed afterwards. These are the words:—

> "If the bells, after a suitable interval of time, be shifted back into the position shown in full lines, i.e., to the right hand, the mercury on the left-hand side of the anodes, together with the amalgam formed thereon, again becomes situated in the combining chamber of the trough, and consequently within the sphere of action of the water in such chamber, whilst, on the other hand, the mercury situated on the right-hand side of the anodes, and the amalgam portion of which has been acted upon in the meantime by water to remove the sodium therefrom, becomes again situated in the decomposing chambers for the purpose of forming fresh amalgam. It will thus be seen that by the to-and-fro movement of the bells the transposition of the amalgam formed in the decomposing chambers to the combining chamber, and the practically continuous formation of caustic soda in the latter, are caused to take place alternately on the one side and on the other side of the anodes, whilst the mercury cathode itself remains at rest."

My lords, it may be true that the mercury itself is a cathode, and not the vessel in which it is contained, but this a desciption of a mere mechanical appliance and I cannot doubt that when this description was given the thing which was meant to be at rest was the mercury and the vessel containing it, and I have come to the same conclusion as the Master of the Rolls (Lord Lindley) that the Claim 3 and the Figs. 7 and 8 to which it refers are an entire departure from the essential features of the invention as originally described. Indeed, I look upon the language of the complete specification as an ingenious effort to avoid what would be a glaring disconformity, and which has received the assent of Mr. Justice Bigham and that of Lord Justice Vaughan Williams; but, as I have said, I think one must look at the provisional specification and then consider whether it is really describing what is now claimed or what is in its essential features a different thing. I think it is, and for this reason I think the judgment of the Court of Appeal was right and ought to be affirmed.

Lord MACNAGHTEN: I am of the same opinion. This case comes before your lordships under somewhat peculiar circumstances. The appellants, who were the plaintiffs in the action, charged the defendants with infringement. The appellants' patent has never been put into practice at all. The defendants' patent has never been used commercially. The rival inventions are therefore little more than paper inventions. That being so, it is certainly not surprising to find that expert witnesses are by no means agreed as to what would happen in actual working. But it may be assumed for the purposes of this case that the defendants' patent, if it should be worked on an industrial scale, would be an infringement of the plaintiffs' patent. The defendants, however, say that, assuming their invention to be an infringement of the plaintiffs' invention, the plaintiffs' patent is bad for disconformity, and that seems to be the substantial question between the parties. It depends upon a very narrow point, namely, the construction your lordships should put upon the meaning of the expression, "stationary mercury cathode." That is the thing upon which the provisional specification insists, and it is the gist of the invention therein described. Now, notwithstanding the very ingenious argument of Mr. Fletcher Moulton and Mr. Bousfield, I am not satisfied that a revolving mercury cathode is a stationary mercury cathode provided the mercury within the vessel containing it is not shaken at all or only slightly shaken by the rotary motion to which it is subjected. Speaking for myself, I do not see why you should give the word "stationary" a non-natural meaning. It seems to me that if the mercury were put in a long trough, or in a series of troughs under fixed decomposing chambers or bells, and the alternate presentation of patches of charged mercury and uncharged mercury were effected by moving the trough or troughs to and fro, a very violent disturbance and churning up of the mercury would probably be produced. Now that is the very thing which Kellner wished to avoid. That would have been Castner's method over again. That is why the provisional specification insists on stationary mercury cathodes and moving bells. If there were any doubt about the meaning of the word stationary, there are other passages in the provisional specification which seem to me to make the meaning clear. At the very end of the provisional specification Kellner explains that the mercury cathode itself remains at rest. In an earlier part of the provisional specification he points out that the amalgam formed in the bells has, by reason of the shifting of the bells, its location alternately on one side and the other side of the bell without itself changing or moving its position. That being so, it appears to me that when Kellner, in his complete specification, proposes to move the mercury cathode and to make the bells stationary, he is

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describing a different invention from that described in the provisional specification, and an invention not merely different from that, but in its leading feature at variance with the invention described in the provisional specification. I am, therefore, of opinion that the appeal should be dismissed with costs. My noble friends, Lord Morris and Lord Shand, ask me to say that they concur in the motion proposed.

Lord BRAMPTON also concurred.

Appeal dismissed, with costs.

Brockie-Pell Arc Lamp Co. (Ltd.) v. Johnson.

This case was in the Court of Appeal list on Wednesday, on the appeal of defendant from the order of Mr. Justice Kekewich of July 26 (see *The Electrician*, last issue). Before the case was called on Mr. A. J. Walter stated the parties had settled all disputes, and by consent there would be an order in the terms which had been agreed upon between the parties, who were, of course, all *sui juris*.

The Court consisted of the Master of the Rolls and Lords Justices Rigby and Collins, and the order was granted as asked.

Overhead Telephone Wires.

At the Clerkenwell (London) Police Court on Wednesday the National Telephone Co. was summoned by the Islington Vestry for having in May last fixed an overhead wire within the parish without first obtaining permission from the London County Council. A further summons against the company was for fixing an overhead wire which was not supported at intervals not exceeding 115yds., the exact distance being 126yds., without having obtained permission from the London County Council or the local authority. On the first summons a plea of guilty was entered, and on the second the facts were admitted, but Mr. Goddard, who appeared for the company, denied that the definition of "street" in the act included such a passage as that called Dove's-yard (where the excessive span occurred), which led to a meeting house of Plymouth Brethren, and was of a private character. On the first summons Mr. Bros imposed a fine of £5, with 2s. costs, and on the second a fine of 5s. and 2s. costs in order that the point of law involved might be argued before a Divisional Court.

Fell v. British Electric Traction Co.

This was an action heard before Mr. Justice Kennedy and a special jury, and was brought by Mr. John Fell, the well-known contractor, to recover £5,872, which he alleged to be due to him under a contract made between himself and the defendant company to construct the permanent way of the Potteries Electric Tramways. Defendants denied the agreement, and counterclaimed against the plaintiff. Plaintiff tendered for the construction of the Potteries tramways for £75,590, the contract providing that the work should be commenced within ten days of the signing, and that the contractor should be entitled to payment for all extra work which, in the opinion of the engineer, was not provided for or contemplated by the contract. The whole of the works were to be completed within 14 months of the signing.

Mr. LYTTLETON, Q.C., M.P., for plaintiff, said under the contract the engineer had great power, and the remedies provided were extremely stringent. The contract provided however, that so long as the work was proceeding satisfactorily the contractor had to furnish a weekly statement of quantities, and 80 per cent. of the value of each month's work was to be paid to him within six weeks, subject to any legal deductions. The question in dispute turned on whether a verbal contract was made to pay Mr. Fell on the prime cost of materials.

Defendants urged that if they were to pay Mr. Fell on the prime cost it would include the prime cost of materials which had been condemned and which the company's engineer, Mr. S. Sellon, had declined to pass.

After hearing evidence, the jury returned a verdict for defendants and judgment was given accordingly, with costs.

National Telephone Co. v. Tunbridge Wells Corporation.

The National Telephone Co. have decided to appeal from the decision of the Divisional Court (Justices Grantham and Channell) granting a writ of prohibition against the County Court judge at Tunbridge Wells from hearing and determining an appeal from a refusal of the Corporation as the highway authority to allow the company to lay their wires underground.

National Telephone Co. v. Huddersfield Corporation.

An appeal is to be lodged in this case which involves a somewhat similar question as that raised in the Tunbridge Wells action.

Jandus Arc Lamp and Electric Co. (Ltd.) v. William James Davy.

We have received a copy of a notice that plaintiffs have discontinued this action. The notice to hand is dated June 22, 1900, and is purported to be signed by the plaintiffs' solicitors, Messrs. Faithfull & Owen, Dacre House, Victoria-street, London, S.W.

Railway and Tramway Competition.—The directors of the North Staffordshire Railway Co. in their half-yearly report state that for the first time for many years they have to report a decrease in the passenger traffic, owing chiefly to the opening of the electric tramways in the Pottery district, which have abstracted many of the company's short-distance passengers.

THE ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS AT THE FRONT.

In our last issue we published a letter from one of the members of the Electrical Engineers, giving an account of the engagement in which several of the corps were taken prisoners. One of these prisoners, Sergt. G. Charlton, who subsequently escaped, has written an account of his experiences to a friend in Leicester, and we now reproduce the main part of his letter from the *Leicester Post* :—

We had worked our way up the line as far as the Vaal River. There was not sufficient lighting for us to do, so they put us to bridge building, which is hard enough work I can assure you, and rough enough living. Pretoria was to have been our next place, but the Orange Free State men broke in upon the line, and burnt the bridges at the back of us, so we were sent back with the construction train to repair them. We had done three, and I think there were only two more to do, for another train was working up from Bloemfontein. The day-gang, of which we were a part, were asleep, and the night-gang were at work on the bridge. I think it would be about midnight on the 14th inst., eight of the electricals lay peacefully round a huge fire, made of the remnants of the bridge, when we were aroused by a tremendous rifle fire, at 50 yards, from the other side of the line. The panic was terrible. The train had moved off with our arms, and there was nothing to do but scoot for our liberty. The bullets went ping-ping over our heads like hailstones; one struck me on the Balaclava helmet, and I thought it would soon be all up. Soon after this I ran into Douglas, and three other fellows of ours, and soon after that we had the luck to run clean into the Boer Artillery. Another and another man were brought in later in the day. Our life with the righteous Boers was very rough, and at times even cruel. They fed us on uncrushed Kaffir corn and meat. There was no firewood, only cow manure to cook with, which when damp won't burn at all. So we sometimes had to starve. We were marched every day, and got so weak that our knees knocked together. Several times it rained, and we had to sleep hungry on the wet ground, with only one blanket. Well, on the 24th inst., I effected my escape by lying in the river bed with a young fellow from the Derby Militia. On the Sunday night, after creeping from the vicinity of the laager, we marched about 30 miles, guided by the southern cross, avoiding all roads. When day broke on Monday morning we spotted the Boer scouts not 1,000 yards from us, so dropped down in the grass and lay there all day, with Boers passing within 300 yards of us, without being seen. Well, we joined the British lines about eleven o'clock on Monday night after a very exciting time, creeping through the Boer lines. General Paget complimented us, and said we had come through the lion's mouth.

THE AMSTERDAM MUNICIPAL TELEPHONE SERVICE.

An interesting article, by Messrs. Ph. Falkenburg and J. H. van Zanten, has been published in *Municipal Affairs*, a New York magazine, on the development of the municipal telephone system in Amsterdam. In Holland, as elsewhere on the Continent, the telephone was introduced by the International Bell Telephone Co., whose offer in 1880 to establish a telephone exchange in Amsterdam, paying the municipality 21½ per cent. of the gross receipts, was accepted, the concession being transferred at the end of that year to a subsidiary company, the Netherlands Bell Telephone Co. The term of the licence was for 15 years. Subseqently the company obtained a licence from the Government for the operation of inter-communal lines, but in 1894 the Government introduced a law to transfer to itself the inter-communal system, the transfer actually taking place in November, 1897. A petition by the Amsterdam Municipal Council, that the Government should also take over the local telephone system in that town proved abortive, but the company's concession was only renewed until Nov. I, 1896, to give the municipality time to complete a system of its own, as that of the company had not extended with sufficient rapidity, and its equipment had become out of date, in addition to which the subscription rates were considered too high. In Holland, as in this country, telephones were considered to come under the definition of telegraphs under the original telegraph act, and after much discussion the municipality, having already started its telephone service on Nov. 1, 1895, found itself compelled to secure a Government concession on April 1, 1896.

The Bell Telephone Company at first used without exception aerial single conductors of bronze wire covered with gutta-percha, but since the year 1892 had placed several conductors underground, so that on October 31, 1896, they had 13,900 metres of underground cables, with 566,181 metres of wire. The exchange was equipped with primitive non-multiple boards. The municipal telephone system uses overhead conductors as little as possible and leads a double conductor into the house of each subscriber. On January 1, 1899, the length of the cable network was 137,635 metres of 28-pair cables, 4,684 metres of 56-pair cables, and in addition 2,243 metres of cables laid through the canals. There were also

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28,654 metres of 14 double wires, and 973 metres of water cable of one double wire—altogether 8,378,034 metres of single wire—an increase in two years and two months of 1,380 per cent. Work is now being pushed in placing more of the above-ground conductors, which are of bronze wire, in underground conduits. There is only one central exchange, which is equipped with a horizontal multiple board having a capacity of 10,800 subscribers.

The yearly subscription price under the Bell Telephone Company was £9. 9s., the cost of the apparatus and of making the connections being included. At the outset the burgomaster and aldermen proposed a subscription price of £6, which entitled the subscriber to 800 calls yearly; for each 100 calls in addition up to 10,000 2s. 5d., and for each additional 100 calls 1s. 7d. should be paid. Strong opposition was raised on all sides to this tariff, and especially by the tradesmen, with the result that the Council established a fixed price of £7. 4s. for unlimited service, with a single payment of £2 for the installation. A single call from a public call office costs as much as 5d., however.

The number of subscribers to the Bell Company was 612 on January 1, 1882, or 1·8 per 1,000 of the population of the town. In 1884 it had increased to 1,057, or 2·9 per 1,000; in 1890 it was 1,515 or 3·7 per 1,000, and in 1896 1,784 or 3·9 per 1,000. Under municipal control on November 1, 1896, there were 130 subscribers; on January 1, 1897, 2,143 or 4·3 per 1,000; and on January 1, 1900, 3,031, or 5·8 per 1,000.

The number of calls under the Bell Company's *régime* was, during 1883, 2,006,539, or an average of 2,352 per subscriber. These decreased gradually to 1,110,368 in 1886, equivalent to 912 per subscriber, and again rose gradually to 3,650,000 in 1896, corresponding to 2,046 per subscriber. The reason for this decrease and increase is not stated in the article. Possibly it has been an experiment with the toll system of charging. The municipal exchange counted 3,916,450 calls in 1897 and 5,651,200 in 1899, corresponding to 2,181 and 2,221 per subscriber respectively, the maximum number in one day being 12,938 and 20,714 respectively.

The number of intercommunal and international calls has increased continuously from 25,923 out-going and 25,400 in-coming in 1891 to 43,038 and 48,528 in 1896. The trunk lines then passed into the hands of the Government, and the number of calls on them amounted to 149,702 out-going and 150,262 in-coming during the year 1899.

It may also be mentioned that the Bell Company had only a day service, whereas the municipal system is in operation day and night. in the year 1899 there was an average of 344 calls, and a maximum of 466 calls in a night—reckoned as from 10 p.m. to 8 a.m. The employés are slightly better off under municipal rule. They work seven hours a day instead of nine, and are paid from 8s. to 16s. a week (apprentices 3s. 3d.), as against 9s. 7d. by the Bell Company. There is also a scheme for sick pay and pension.

In 1882 the Bell Company paid £1,307 to the municipality as its royalty of 21½ per cent. of the gross receipts, and in 1894 this the royalty for the year had increased to £3,425. The municipal telephone began with a sum from the municipal treasury of £40,000, of which almost £8,800 was needed for the building for the central exchange. On January 16, 1899, the capital expenditure was £98,000, of which £80,000 more or less had been paid from loans.

The revenue of the telephone system amounted, in the year 1897, to £15,997; and in the year 1898 to £19,193. The cost of operation amounted to :—

		1897.	1898.
A.	Salaries and assessments for old age pensions	£2,697	£3,695
B.	Maintenance of buildings and equipment	1,234	1.408
C.	Office expenses	80	107
D.	Electric current	139	167
E.	Sundry	592	537
	Total	£4,742	£5,914

The gross surplus was expended in the following manner :—

Interest on loan capital	£2,248	£2,365
Redemption of loan capital	2,437	3,180
Payment to the municipal treasury	4,000	4,000
Total	£8,685	£9,545

The net profit, which was used for extensions, thus keeping down bonded indebtedness, was in 1897 £2,568 and in 1898 £3,734.

Thus at the outset the taxpayers receive no great direct advantage from municipal operation, since the payment which the municipality received from the Bell Telephone Company, amounting during the last year to £3,425, has been increased to £4,000, and stereotyped at that amount. When the capital is redeemed—and this will be accomplished in a short time—the situation will naturally be changed; but it must not be overlooked that each new addition to the existing net costs considerable capital, and more proportionately the further it extends from the central exchange. This cost will also be added to if the subscribers increase to over 3,600; since at present a switchboard for 3,600 subscribers is used. Should the number increase to 10,800 (which so soon as the fees are reduced will not be long delayed) it is stated that the entire central exchange must be re-arranged, or the system of a single exchange must be abandoned.

The municipality of Amsterdam in late years has had much experience in the municipalisation of public undertakings. Ten years ago it possessed no single large monopolistic undertaking, and now it owns the gas works, the waterworks, a slaughter-house, a telephone system, a clothing factory for the uniforms of municipal employés, a horse-railroad presently to become an electric railroad, and two steam ferrries.

A DOUBLE CARBON ARC LAMP.

The accompanying illustrations show the construction of Messrs. Körting and Mathiesen's latest pattern of shunt arc lamp arranged for double carbons. One of the characteristics of this

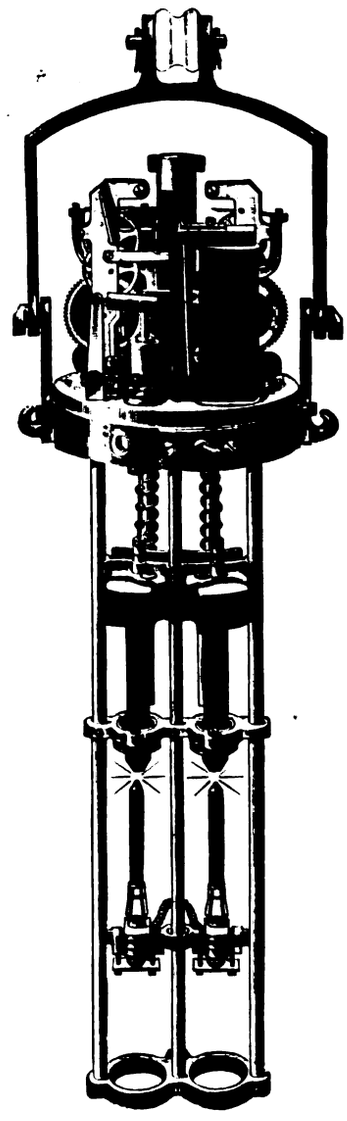

Fig. 1.

lamp is that it is provided with two independent clockwork motions, built, however, on the same bedplate. Fig. 1 shows the general construction of the lamp and Fig. 2 is an enlarged view of the mechanism. The last-named figure shows the regulating parts, which, by means of a balanced anchor or detent, controls the descent of the carbons. The mechanism consists of a shunt magnet A together with a clockwork train B connected by means of the rod O to the magnet anchor M. Spiral springs N supply the controlling force. The flywheel P of the clockwork B touches the tongue 2 which is carried by a double arm lever V which, together with the second tongue 2, are under the common influence of the heating compensator K, which keeps the regulating tension always constant. To adjust the variation in the weight of the carbons, the clockwork is slanted to one side, and of course the necessary dash-pots are provided to prevent sudden movements of the parts. It is claimed

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that this double carbon lamp will burn either singly on 110-volt circuits or in pairs across 220 volts or 230 volts, a matter of considerable importance now that consumers are supplied at these higher

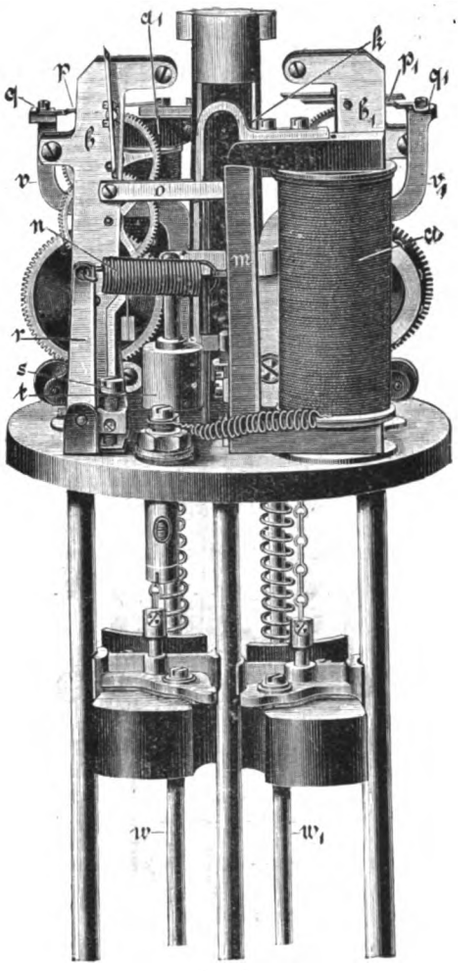

FIG. 2.

voltages. It is further claimed that the double carbon lamp, as regards intensity of light, is far superior to the enclosed arc. The agent for these lamps in this country is Mr. G. Braulik.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Accrington.—The Electric Light committee anticipate being in a position to supply electric current by Oct. 1. The price has been fixed at 5d. per unit for lighting purposes, and 1½d. per unit for current for power purposes.

Bellingham.—At a parish meeting last week it was unanimously resolved to consent to the application of the Northern Counties Electricity Supply Co. for a provisional order.

Bootle.—The Board of Trade have issued their award in the dispute between the Council and the Liverpool Corporation over the electric tramways. It was announced by the chairman of the Bootle Highways committee (Councillor Hall) on Wednesday that the award settled the terms between the two corporations for a period of 25 years, and that it was favourable to the Bootle Corporation.

Brisbane (Queensland).—The Municipal Council received four applications for the transfer of their order to establish electricity works—viz., Messrs. Arthur Wright & Hy. Reason (Brighton, England), the Electrical Construction Co. of Australasia, Mr. E. C. Barton (Brisbane), and the Brush Company. The Council obtained the opinion of Mr. John Hesketh on these applications. In his report, Mr. Hesketh reminds the Council that in July, 1897, he advocated the municipalisation of such works as local transit and lighting, and he was still of opinion that unless there were special reasons to the contrary, such works should not pass into the hands of private companies. If the Council retained the order in their own hands they would have to contemplate an initial capital expenditure on the most favourable scheme of not less than £30,000, but if the work were properly carried out of from £100,000 to £150,000. The public lighting would then cost them more than the price quoted to them, and if they entertained the offer they would, in addition, have 10 arc lamps free of cost. If they generated their own current the cost would in all probability be greater than the figure given by Messrs. Wright and Reason, for they had quoted a price which he did not think they could hope to approach for many years to come. The possibility of recouping the difference from private lighting would not be so good with the municipality whose operations were confined to the city area as with a company supplying adjacent councils such as South Brisbane, as he understood it was the intention of the company to do. Looking at the financial aspect of the question there was nothing to lose and something to gain by accepting the offer. Having regard to all the circumstances he was of opinion that the terms offered by Messrs. Wright and Reason were more advantageous to the Council than either the proposition to instal separate plant or the alternative of their distributing a supply of electricity obtained by them from the tramways company. The report together with the various offers were discussed, but were eventually referred to the Works committee.

Bristol.—The accounts of the electricity department for the year ended March 25 were presented last week. The number of consumers was 1,215, an increase of 248 during the year. The equivalent number of 8 c.p. lamps connected was 85,956, compared with 68,536 at the corresponding period last year. During the year a number of motors had been connected to the mains. The number of units sold was 1,812,511, an increase of 449,725. The gross receipts amounted to £31,717. 14s. 2d., and the gross expenditure to £17,962. 1s., leaving a gross profit of £13,755. 13s. 2d., from which has to be deducted interest on loans (£6,019. 15s. 8d.) and sinking funds (£7,590). There was thus a credit balance of £145. 17s. 6d.

Burnley.—The Corporation have served notice on the Burnley and District Tramways Co. of intention to purchase the company's lines within the borough.

"Cassier's Magazine."—The August issue contains articles on "Electric Cranes in German Harbours," "Openings for Mechanical Engineers in China," "The Manufacture of Light," and "Some British Milling Machines."

City of London.—At the Court of Common Council on Thursday last the Streets committee presented a report on the application of the Postmaster-General for permission to take up the roadway in St. Bride-street and Holborn Circus for forming a connection with certain subways for telegraph wires. The Postmaster-General would not undertake to pay any fees or rent in respect of the subways. It was recommended that the application be complied with, and this was agreed to. An application by the National Telephone Co. for permission to lay wires in the subways in front of the Mansion House was refused.

The following recommendations by the Streets committee were agreed to :—

(1) That the purchase money to be charged against the City undertaking for the portion of the site required for the erection of the City generating station be determined *pro rata* to the cost of the whole site. (2) That the Charing Cross & Strand Electricity Supply Corporation shall not acquire any interests in adjoining land without the previous consent of the Corporation being obtained; such consent, however, not to be unreasonably withheld. (3) That the Corporation agrees to allow the company the necessary running powers over the proposed line of railway shown on the plan submitted, subject to a nominal rental, and without prejudice in any way to the rights of the Corporation to use or alter such line of railway.

Cork.—The Corporation were recently recommended to erect 85 additional arc lamps in the principal thoroughfares, but a deputation from the Cork Gas Co. has succeeded in inducing the Corporation to defer the matter. The deputation stated that by the adoption of electric lighting the Corporation had already thrown upon the hands of the gas company 250 gas lamps, and by this new proposed extension they would add another 300 gas lamps. The electric lighting company was entirely composed of strangers, whereas the gas company's shareholders were all local ratepayers. They asked that the matter be deferred until the Corporation would have more experience of electric lighting and incandescent gas lighting. They objected to the wholesale extension of the light at great cost to the ratepayers. This pleading was, as we have said, successful, and Cork must wait for its improvements.

Crewe.—The proposal to borrow £10,000 for electric lighting extensions was approved by the Council on Wednesday.

Derby.—Power to construct a system of electric tramways, estimated to cost about £200,000, is to be sought by the Council.

Gravesend.—The report on electric lighting which was recently prepared by the consulting engineer (Mr. W. H. Trentham) was discussed by the Council last week. The report deals with the proposal to erect a refuse destructor, as well as the supply of electric current for lighting and traction, and the Council are recommended, in view of the possibility of current being required for tramways, to adopt the low tension three-wire system of distribution with a pressure of 450 to 460 between the outers; 24 arc lamps of 800 c.p. each would be erected in the leading thoroughfares, and the total cost of the scheme is estimated at £30,580. The report was reserved for further consideration by the Council in committee.

Hampstead (London).—The Lighting committee are making an experiment in incandescent electric lighting. Belsize-avenue is to

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be lighted with incandescent electric lamps of 50 c.p. and 150 c.p., in place of arcs.

Hanley.—The charge for electric street lighting has been increased £3 each per annum for arc lamps and 5s. each for incandescents, making the charge £22 and £3. 5s. respectively.

Helston (Cornwall).—This town has up to the present been lighted by gas by a private company at 5s. 10d. per thousand, the street lighting costing £100 per annum. Several members of the Town Council consider that the electric light could be introduced with advantage; and there is now to let a large water mill belonging to the Corporation filled with expensive machinery used in corn grinding. This mill is said to possess the best supply of water of any mill in the county, and is let, we learn, at a low rental. We have reason to believe the Helston Council would entertain favourably a proposal for the establishment of electricity works in the town, and there seems a probability that current would be taken by the Council for the public lighting. Water is plentiful, and there really seems a good opportunity for establishing electricity supply at Helston.

Infirmary Lighting.—The electric light is being installed at the Wolverhampton Eye Infirmary by the District Electric Co. to the specification of Mr. L. Stallybrass, of Wolverhampton.

Inquest.—At the inquest at Upper Sydenham on the bodies of F. W. Elliston, stoker, and W. H. J. Philbrook, labourer, who died from the effects of the boiler explosion at the generating station of the Crystal Palace District Electric Supply Co., at Upper Sydenham, after formal evidence had been taken the inquiry was adjourned for three weeks.

Leatherhead.—The Board of Trade have notified the Council that they will not sanction the proposed leasing of the Council's provisional order to a firm of electrical engineers, as there must be an actual transfer of powers. The question has been referred to committee.

Light Railways.—The Light Railway Commissioners have submitted the Aldershot and Farnborough Light Railway (Extension) Order to the Board of Trade, and objections must be lodged by 18th inst.

An inquiry was held at Bath on Monday into the joint application of the Bath Corporation and a private syndicate (consisting of Sir James Sivewright and Mr. L. Hirsch) for authority to construct a system of electric tramways in Bath and district. It was stated that the promoters had agreed to construct and work the tramways paying the Corporation a rental for wayleaves increasing from £400 to £500 per annum. The Corporation retain power to purchase. The Commissioners decided in favour of the application.

Liverpool.—The work of converting the tramways to electric traction is actively proceeding. In 1898 the experimental line from St. George's Church to the Dingle was opened. Last year 30 miles of track were relaid. Up to date 80 miles have been reconstructed and equipped for the overhead system, and the electric tramways department hope to complete the system this year. By the end of this year the Corporation will have cars adequate to carry 100 million passengers a year, and by next summer for 150 millions. It is likely that by that time a uniform 1d. fare will be established, and passengers will be able to travel nearly 8½ miles for 1d. The Old Swan electric tramway route will be opened for traffic on Monday.

London County Council.—At Tuesday's meeting a loan of £42,400 was made to the Shoreditch Vestry for electric lighting.

The report of the Highways committee in connection with the application to be made to Parliament for tramway extensions (set out in our last issue) was adopted.

Maidstone.—It has been resolved to apply for a provisional order for constructing and working electric tramways. The Corporation are engaged in establishing municipal electricity supply.

Manchester.—The Council on Wednesday decided to adopt the Gamewell system of fire alarms. The Watch committee recommended that the plant should consist of 200 street box stations, and that the apparatus should be purchased outright. The total cost of equipment would be £9,300, plus £6,300 for leasing from the electrical department 100 miles of lines for 10 years, and wages, depreciation, and repairs for 10 years. The cost would be at the rate of £8 per box per annum, and at the end of 10 years cost of maintenance would be £3. 7s. per annum.

Marylebone (London).—A meeting of this Vestry took place last evening, and the discussion was resumed on the report of the advisory special electric lighting committee recommending that negotiations be concluded with the Metropolitan Electric Supply Co. for the transfer to the Vestry of its undertaking under the West London electric lighting order. A heated discussion followed, during which Dr. Snape urged that an expiring Vestry should not consider a vast scheme like this, but should leave it to be dealt with by the new Council. After much talk the resolution that the special committee be empowered to conclude negotiations with the company was put and carried with only one dissentient.

Norwich.—The Board of Trade inspection of the track of the Norwich Electric Tramways Co. took place on Thursday last. Some of the cars commenced running on Monday, and the whole of the system was opened for traffic yesterday (Thursday). The line was fully described in *The Electrician* for May 18 and 25 last.

Oldham.—The Council have applied for sanction to borrow £280,000 for electric tramways.

Penistone (Yorks.)—A conference of representatives of the Penistone and Thurlstone Councils is to be held to consider the advisability of adopting a joint electric lighting scheme.

Pwllheli.—An offer by Messrs. Bennett and Ward-Thomas to take a transfer of the Pwllheli provisional order is to be considered at the next meeting of the Council.

Rathmines (Dublin).—The electricity supply works will be officially opened by the Lord Lieutenant on 24th inst.

Salford.—The Corporation have decided to increase the salary of the borough electrical engineer (*pro tem.*), Mr. F. A. Wilkinson, from £160 to £250 per annum.

Sheffield.—The Abbeydale electric tramway route has been opened for traffic, although not yet officially inspected by the Board of Trade.

Stockport.—The accounts of the Gas and Electricity department show a profit on the electricity branch for the first 16 months' working of £118, which is considered satisfactory. It has been decided to introduce the maximum demand system of charging—5d. per unit for the first hour's maximum demand, and 3½d. after.

Stourbridge.—The Council have resolved to establish municipal electricity works, and to oppose the proposed application of the Midland Electric Corporation for Power Distribution for a provisional order.

Sunderland.—A satisfactory trial trip over the Christchurch and Roker electric tramway took place on Tuesday.

Swansea.—The work of laying mains in connection with the Council's electric lighting scheme has been commenced.

Technical Instruction.—The annual report of the Middlesex County Council Technical Education committee states that the classes on electricity in the county, although small, have been much appreciated by the students. The first year's work in electric wiring has been successful, the class having been attended by artisans representing gas and hot water fitting, plumbing, and electric light wiring.

Trowbridge.—On the advice of their consulting engineer (Mr. D. Stevenson) the Council are making a canvass to ascertain the support likely to be accorded the proposed electric lighting project.

Tunbridge Wells.—At a meeting of the Town Council this week a discussion arose on a report of the Lighting committee recommending the Council to at once proceed to erect an additional chimney at the electricity works at an estimated cost of £3,500, to provide a new flue and economiser at an estimated cost of £1,000, and to authorise the committee to consult Sir William Preece if necessary from time to time during the progress and upon the completion of these works, and to obtain a further report or reports from him. These, and other recommendations in the report were approved.

Utilisation of Water Power in Austria.—Plans are being prepared by the Austrian Schuckert Co. for the erection of a water power electricity station at Krottersdorp, Styria.

Water Power Utilisation in Italy.—La Società per le Strade Ferraté del Mediterraneo has secured a 30 year concession of the water power of the Ticino river, Milan, for the generation of electrical energy.

Watford.—The Council have decided to engage Mr. Arthur Wright to prepare a report on the present position of the electricity works, and particularly as to the necessity of carrying out extensions.

Whitechapel (London).—The foundation stone of the new electricity generating station in Osborn-street, E, was laid by the Chairman of the Board (Mr. John Harris) yesterday.

Wrexham.—The Wrexham Tramways Co. have applied to the Board of Trade for an extension of 12 months to comply with the terms of the Wrexham Tramways Order (1899).

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

TENDERS INVITED.

Portsmouth Corporation invite tenders for plant and apparatus for the equipment of their proposed tramway power station. Specification may be obtained from the tramways engineer (Mr. E. Rotter), and further particulars are set out in an advertisement. Tenders must be delivered to the town clerk (Mr. Alex. Hellard), Town Hall, Portsmouth, not later than 10 a.m. of Sept. 4.

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Belfast Electric committee invite tenders for the supply and erection of auxiliary feed water heater, with pipe connections. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen), and tenders must be delivered at the offices of the town clerk (Sir Samuel Black) by noon on 15th inst. See advertisement.

Hanley Electric Lighting committee invite tenders for two Lancashire boilers and fittings, including steam receiver; water-tank, girders, and pumps; fuel economiser, with engine or motor; smoke chimney, exhaust fan, with engine, &c; feed water heater, forced draught fittings, fire bars or other appliances to boiler furnaces, and coal conveyor and bunkers. Specifications from the borough engineer and surveyor (Mr. Joseph Lobley) and from the Corporation electrical engineer (Mr. C. A. Cowell). Tenders to Mr. Lobley before 25th inst. An advertisement contains further particulars.

South London Electric Supply Corporation invite tenders for condensing plant. Further particulars are set out in an advertisement, and specifications may be obtained after 7th inst. of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders to the secretary of the company (Mr. H. H. Boyer), Bengeworth-road, Loughborough Junction, S.E., before 10 a m. on 14th inst.

Luton Town Council require tenders for watt and demand meters. Specifications after 13th inst., at the offices of the consulting engineer (Mr. Albion T. Snell), Suffolk House, Cannon-street, London, E.C., and tenders to the town clerk (Mr. George Sell), Town Hall, Luton, by noon of Sept. 14. An advertisement contains further particulars.

Warrington Corporation invite tenders for wiring and fitting up the Parr Hall and markets for the electric light. Specification from Mr. W. H. Grimsdale, Bank House. See also advertisement.

Grimsby Corporation invite tenders for an additional steam dynamo and extension of switchboard. Specification, &c., from the consulting engineer (Prof. A. B. W. Kennedy), 17, Victoria-street, Westminster, and tenders must be delivered at the offices of the town clerk (Mr. W. Grange), St. Mary's Gate, Grimsby, before 18th inst. An advertisement contains additional particulars.

Grimsby Corporation invite tenders for wiring their electricity works. Specifications from town clerk, to whom tenders by Aug. 8.

Newcastle-on-Tyne Corporation invite tenders for constructing about 5 miles of double-track tramway. An advertisement contains further particulars, and tenders addressed to the New Tramways committee must be in by Wednesday, 22nd inst.

Edinburgh Corporation invite tenders for arc lamp posts and for six (or nine) months' supply of steam coal for their electricity works. Tenders to town clerk by 8th inst.

Central Electric Supply Co. invite tenders for dry back marine boilers with mountings, feed and drain pipes, &c. (or, alternatively, water-tube boilers). Tenders to general manager (Mr. F. J. Walker), 19, Carnaby-street, Golden-square, London W., by 10 a.m. Aug. 20.

Bradford Guardians invite tenders for an electric lighting installation at their workhouse. Tenders to clerk, 22, Manor-row, Bradford, by noon Aug. 13.

Halifax Corporation invite tenders for mechanical stokers, and also incandescent lamps. Particulars from borough electrical engineer (Mr. H. F. Street), Foundry-street, Halifax.

The *Pacific Cable* committee invite tenders for the supply and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cable between Vancouver and Queensland. Forms of contract, &c., from and tenders to Messrs. Clark, Forde & Taylor, 4, Great Winchester-street, London, E.C., by noon 14th inst.

Pembroke (Dublin) Council invite tenders for wiring the town hall, &c. Tenders to clerk by 9th inst.

Accrington Corporation require tenders for wiring their electricity works. Tenders to town clerk by 10th inst.

Dorking District Council invite offers for leasing their provisional order. Tenders to clerk by Aug. 30.

Salford Corporation invite tenders for laying cables, tramway feeders, and street lighting. Tenders to town clerk by Aug. 13.

Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment. Tenders to clerk by Aug. 31.

Tenders are invited until Sept. 10 next by the *Hamburg* Finance deputation for two 30-ton electric cranes.

TENDERS RECEIVED AND ACCEPTED.

The London County Council Fire Brigades committee have received the following tenders for the wiring and fittings of Paddington fire station.—

Tamplin & Makovski (*accepted*)	£248	4	6	F. A. Glover & Co.	£280	0	0
G. E. Taylor & Co.	304	0	0	Concentric & General Contract Co.	264	0	0
F. J. Coleby	282	0	0	Barlow Bros. & Co.	257	0	0

Ealing District Council have received the following tenders for the supply of steam dynamo, alternator, and storage batteries for their electricity supply works. The tenders marked * are recommended for acceptance, subject to the sanction of the Local Government Board for the necessary loan :—

Steam Dynamo Alternator.

*Siemens Bros. & Co.	(Belliss comp. cond. engine)	£2,881	11	0
Ditto	(Browett c/c)	2,945	0	0
Ditto	(Bellis trip. exp.)	3,151	11	0
Crompton & Co.	(Belliss c/c)	2,784	15	0
Ditto	(Belliss t/e)	3,054	15	0

Storage Batteries.

					Ann. main. (for 10 years).
*Tudor Accum. Co.	£1,836	3	0	...	£88
D.P. Battery Co.	1,522	11	6	...	—†
E.P.S. Co.	1,671	5	0	...	153
Hart Accum. Co.	1,979	14	0	...	196
Marquand Accum. Co.	2,360	8	6	...	132
Chloride Elec. Storage Synd.	2,576	0	0	...	—‡

† Cost of renewals would be 4½ per cent. during six years.
‡ £142 first five years, £166 for second five years.

Cardiff Corporation have accepted the following tenders in connection with their proposeed electric tramway scheme :—

Dick, Kerr & Co.	(about 1,000 tons of steel tramway rails and fish plates)	£8,522
Ditto	(tie bars)	565
Ibbotson Bros.	(fish bolts and nuts)	170
Bayliss, Jones & Bayliss	(sole plates)	50
Askham Bros. & Wilson	(points and crossings)	355
Ditto	(drain rails)	378
Felten & Guilleaume	(copper bonds)	618

The following tenders have been received by the Walthamstow District Council for the supply of 45 arc lamps. Mr. J. Enright is consulting engineer :—

Oliver & Co. (*accepted*)	£1,373 17 6	Elec. Transmission Co.	£1,658 0 0
J. D. F. Andrews & Co.	2,064 19 0	General Electric Co.	1,627 15 0
Brush Co.	1,860 0 0	Johnson & Phillips	1,524 9 6
Callender's Co.	1,796 0 0	Gilbert Arc Lamp Co.	1,277 10 0
Brockie-Pell Arc Lamp	1,755 2 6	Frank Suter & Co.	1,273 10 0

The following tenders were received for the supply of lamp standards for the Victoria Embankment and Westminster Bridge lighting :—

W. Macfarlane & Co. (two designs) (*accepted*)	£29 10s. or £31	W. Lucy & Co.	£34 10
W. A. Baker & Co. (two designs)	£32 10s. or £35	R. Carr & Co. (two designs)	30 0
T. Brown & Co.	£39 10	J. Allen & Son	29 10
W. Singer & Co.	35 0	Mackenzie Bros.	28 5
		A Brown & Sons	27 0

Messrs. J. Whitley & Co.'s tender of £214. 2s. was accepted for an overhead traveller for the generating station at Victoria Embankment.

The Dublin Electric Lighting committee, acting on the advice of their consulting engineer (Mr. Robert Hammond), recommend the Council to accept the following tenders for the plant for the new electricity works at Pigeon House :—

General Electric Co.	(Polyphase generators with compound engines : Stewart engines and Oerlikon generators)	£33,061
Holdsworth & Sons	(Lancashire boilers)	6,653
Ditto	(economisers)	1,060
Babcock & Willcox	(water-tube boilers)	5,278

Chelmsford Council have accepted the tender of the Chelmsford Electric Lighting Co. for lighting the public lamps for five years from March 25, 1901, at the following rates : Arc lamps, £25. 5s. each per annum ; incandescent lamps, £3. 3s. A clause has been inserted in the contract to the effect that if at any time the Council should be desirous of extinguishing eight specified arc lamps at 11 p.m., or extinguishing the whole of the arc and incandescent lamps one hour earlier in the morning, or agreeing to the electric lighting being started half an hour later than the present time table, and shut down half an hour earlier in the morning, they shall be charged £23. 12s. 6d. per arc lamp per annum in the first instance, taking off a further 5s. per arc lamp and 3s. per incandescent lamp if the whole of the arc and incandescent lamps are extinguished one hour earlier in the morning. At present the charges are £22. 10s. per arc and £2. 6s. 10d. per incandescent lamp per year. If the eight specified arcs were switched off at 11 p m., and if the lighting were begun later and shut down earlier only £70 a year would be saved.

Croydon Town Council have accepted the tender of the British Thomson-Houston Co. for 35 car bodies, motor car equipments, feeders and overhead construction work in connection with their proposed electric tramway scheme at £57,140. The tender of Messrs. J. Smith & Sons for the erection of additional car sheds at £9,400 has also been accepted.

Bradford Corporation have accepted the tender of Messrs. S. Z. de Ferranti (Ltd.) for a switchboard for the Valley-road electricity works.

Newcastle New Tramways Committee have accepted the tender of the British Insulated Wire Co. for the supply of trolley wires at a

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cost of over £6,000, and that of Mr. S. E. Easton for building the superstructure of the power station at the Manors at £3.544, in this case the contractor guaranteeing to complete the work in 18 months.

Bootle Council have accepted the tender of Callender's Co. for supplying arc lamps, cables, &c., for the electric lighting of Derby, Rimrose and Knowsley-roads, for £6,855. 1s. 5d. £80 per annum has been agreed upon for the maintenance of the cables for 10 years.

Hull Corporation have accepted the tender of Messrs. Thomas Parker (Ltd.) for the supply of five high-tension continuous-current rotary transformers at £5,985. The Electric Construction Co. also tendered at £6,293. The Corporation have also accepted accepted the tender of the Walsall Electrical Co. for wiring and fitting Springhead pumping station for electric light at £210.

The tender of Messrs. W. T. Glover & Co. has been accepted by the Hampstead Vestry for the supply of electric light cables for the electricity department for the ensuing 12 months.

Hackney (London) Vestry have accepted the tender of Mr. J. Greenwood for the erection of electricity station buildings at £31,589. 8s. 6d.

APPOINTMENTS VACANT AND FILLED.

The tramways department of the Glasgow Corporation require a first-class mechanical engineer to take charge of the steam plant and general oversight of the tramways power station. Salary £250 per annum. An advertisement gives further particulars, and applications have to be sent to Mr. John Young, general manager, 88, Renfield-street, Glasgow, by Aug. 20.

Hull Electric Lighting committee have vacancies for two electrical improvers. Applications to the Chairman of committee, Town Hall, Hull, by noon of 23rd inst. Mr. A. S. Barnard is city electrical engineer. See advertisement.

The D. P. Battery are admitting two or three students as pupils in their works at Bakewell, Derbyshire. Particulars from 66, Victoria-street, London, S.W.

The Jandus Arc Lamp and Electric Co., Hartham Works, Hartham-road, Holloway, London, N., require an assistant electrician. See advertisement.

Applications are invited for the position of senior demonstrator in electrical engineering at the South Western Polytechnic, Manresa-road, Chelsea, London, S.W. Forms of application from the secretary. See advertisement.

The position of senior demonstrator in applied physics, at the South-Western Polytechnic is vacant. Particulars from secretary up to 13th inst. See also advertisement.

An assistant lecturer and demonstrator in electrical engineering is required for the Croydon County Polytechnic. Applications to chairman of committee (Mr. J. W. Helps), by Aug. 14. See advertisement.

A young man able to take photographs and who understands Rontgen-ray photography is required at the Middlesex Hospital, W. Application to secretary-superintendent. See advertisement.

A headmaster is required for the science department of the High School, Dundee. Applications to secretary, 46, Reform-street, Dundee.

Todmorden Technical Instruction committee require teachers for evening classes in electric lighting and power transmission and telegraphy and telephony. Forms of application from secretary.

The position of principal of the Heriot Watt College, Edinburgh, is vacant. Applications to clerk.

A principal is required for the Harris Institute, Preston. Applications to secretary by 13th inst.

Telegraph linesmen are required for Lagos, Africa. Salary £200 per annum. Applications to the Crown Agents for the Colonies, Downing-street, London, S.W., before Aug. 13. Inquiries to the consulting engineers to the Crown Agents, Messrs. Preece & Cardew, 13, Queen Anne's-gate, London, S.W.

Mr. D. O. Syd. Davies, B.Sc., lecturer and demonstrator in physics and electrical engineering at the Wolverhampton Technical School, has been appointed to a similar position at the City of Norwich Technical Institute.

Mr. Henry Cottam has been appointed junior demonstrator in physics at the South-Western Polytechnic, Manresa-road, London, S.W.

Mr. J. Ferguson Bell, hitherto engineer and manager of the gas and electricity departments of the Stafford Corporation, has been appointed chief engineer and manager to the Derby Gas and Coke Co.

Mr. H. Bohle has been appointed lecturer and demonstrator in electrical engineering at the Birmingham Municipal Technical School, and Mr. W. R. Parsonage has been appointed lecturer and demonstrator in the engineering department.

Mr. W. Beckit Burnie, of the South Western Polytechnic, has been appointed chief lecturer in electrical engineering at the Royal Technical Institute, Salford.

Dr. Albert Griffiths, of the University College, Sheffield, has been appointed head of the physics department at the Birkbeck Institution, London.

Mr. E. W. Marchant, D.Sc., A.C.G.I., has been appointed first assistant in the electrical engineering department of the City and Guilds Technical College, Finsbury, in place of Mr. E. A. O'Keeffe, resigned.

BUSINESS NOTICES.

The Edison & Swan Company, owing to the expansion of business, have removed their supply department to large warehouses at 27, College-hill, E.C. (almost immediately opposite their head offices and showroom in Queen-street), where there are departments for the supply of accessories, electroliers, bell goods, glass, wires and cables, &c, from large and varied stocks.

Messrs. F. E. & A. S. Elmore have entered into partnership as consulting electro-metallurgists, and have opened offices at 4, Bishopsgate-street Within, London, E.C.

Messrs. J. Coxon and J. H. Burrell have, we are informed, renounced their claims as partners of the firm of Coxon, Schmahl & Burrell, Grainger-street, Newcastle-on-Tyne, and Mr. S. J. Dickinson has entered into active partnership with Mr. W. Schmahl. The business will be continued under the style of Dickinson, Schmahl & Co.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination of George Stanley Green, electrician, &c., 43, Birchfield-road, Birmingham, took place at the local county court on Monday. The statement of affairs showed liabilities £279, assets £12. Bankrupt said he had derived his knowledge of electrical matters at the Midland Institute and by private study. He had been a gilder and plater before he entered upon electrical work. He had no capital, and the business had been a hand-to-mouth one. Examination closed.

It has been decided to wind up W. C. Bersey & Co. (Ltd.) voluntarily, and Mr. W. C. Bersey, 4, Hythe-road, Willesden, N.W., has been appointed liquidator.

A meeting will be held on 28th inst., at 23, Queen Victoria-street, London, E.C., to receive an account of the winding up of the Electro-Chemical Co. (Ltd.)

A meeting will be held at Bank Chambers, Corn-street, Bristol, on Sept. 4 to receive an account of the winding-up of the Western Counties Electric Light and Power Syndicate (Ltd.). Mr. H. Dyer is liquidator.

A meeting to receive an account of the winding-up of the Electric Automobile Syndicate (Ltd.) will be held on Oct. 3. Mr. A. Thom is liquidator.

A receiving order has been made against Walter Vernon Scott, electrical engineer, lately residing at 1, Shaftesbury-road East, Hammersmith, London, W.

Winding-up Petition.—A petition has been presented to the Chancery Division by creditors and contributories of the London Electrical Cab Co. (Ltd.) for a winding-up order. The petition will be heard on 8th inst.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. make a preliminary announcement in another column of the sale by public auction of high-class new engineers' plant and machinery, shafting, tools, accessories, stores, &c., at Ormonde Works, Romford, Essex, at an early date. Catalogues are in preparation.

Plant for Sale.—The Woolwich Electric Light Co. have for sale a 120kw. E.C.C. alternator. See advertisement.

The Leeds Corporation invite tenders for the purchase of plant at present in use in connection with their system of electric tramways. Further particulars are set out in an advertisement; and the plant, which is in excellent condition, can be inspected on application to the engineer-in-charge at the Corporation generating station. The consulting engineers (Messrs. Hopkinson & Talbot), 26, Victoria-street, London, S.W., will supply additional information; and tenders, addressed to the Tramways Committee, should be sent to the town clerk's office, Town Hall, Leeds.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 25 to July 31, with the ports of destination:—

Africa—Alexandria, £138 (telegraph material); Cape Town, £493; Chinde, £124 (telegraph wire); Durban, £382; East London, £892; Port Elizabeth, £1,250. *Argentina*—Buenos Ayres, £67. *Australasia*—Auckland, £105; Perth, £120; Lyttleton, £50; Sydney, £1,300; Wellington, £1,636. *Belgium*—Brussels, £27; Ostend, £350. *British Guiana*—Demerara, £87. *Ceylon*—Colombo, £24. *China*—Shanghai, £63. *Germany*—

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Bremen, £230; Hamburg, £51. *Holland*—Amsterdam, £35; Rotterdam, £180 (telegraph material). *India*—Bombay, £70; Calcutta, £1,410. *Japan*—Hiogo, £99; Yokohama, £657. *Malta*, £303. *Mexico*—Rosario, £522 (telegraph material). *Siam*—Bangkok, £42. *South America*—Parana, £291. *Straits Settlements*—Malacca, £229; Singapore, £198 (£129 telegraph material). *United States*—New York, 2,459 cases (telegraph material). Total £11,428, against £9,736 in the corresponding week last year (July 26 to Aug. 1).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

May 12, 1900.

8,827. H. W. BUTLER. London. Improvements in or connected with electrical batteries.

8,829. J. SKOPEC and N. HEID. London. Improved safety lock with electrical door-opening device.*

May 14, 1900.

8,866. P. A. NEWTON. London. Improvements in electric signalling apparatus. (H. G. Carleton, United States.)*

8,880. H. EICHWEDE. London. Improvements relating to means for recording the number and duration of telephonic communications.*

8,883. W. E. EMERY. London. A new and improved lock for switches and for other purposes.

8,894. H. KOLLER. London. Improvements in electric smelting furnaces.*

May 15, 1900.

8,901. M. J. ASTLE and C. H. GUEST. Derbyshire. A method of applying auxiliary electric drive to gas and other motors as used on cycles and motor vehicles.

8,945. A. J. BOULT. London. Improvements in or relating to electric motors particularly applicable for propelling boats. (T. B. Hatch, United States).*

8,968. M. J. P. O'GORMAN. London. Improved means for protecting electric conductors.

May 16, 1900.

9,033. J. P. MALLETT. London. Improvements in strap oils for electrical machines. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 17, 1899, being date of application in United States.)

9,058. F. C. NEWELL. London. Improvements in electric brakes.

9,059. F. C. NEWELL. London. Improvements in electric brakes.

9,060. F. C. NEWELL. London. Improvements in electro-magnetic brake shoe.

9,061. F. C. NEWELL. London. Improvements in automatic regulator for electric brakes.

9,084. A. G. STOCKWELL. London. Improvements in electric arc lamps

May 17, 1900.

9,110. M. PAUL. Glasgow. Improvements in contact pieces for transmitting the current from the fixed base to the revolving or swinging top of electric search light projector. (J. Paul, India.)*

9,111. H. ENGLAND. London. Improvements in or relating to apparatus for maintaining in a "taut" condition the cord or rope employed for actuating the "trolley-arm" employed in connection with electrically-propelled cars or vehicles.

9,133. L. LOMBARDI. London. An improved process for manufacturing thin homogeneous plates, more particularly applicable for use in electrical condensers. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 30, 1899, being date of application in Italy.)*

9,146. H. DEGENHARDT. London. Improvements in or relating to telephone systems and installations.

May 18, 1900.

9,169. W. LAWSON and CHAMBERLAIN & HOOKHAM (LTD.). London. Improvements in electricity meters.

9,181. W. F. JONES. London. Improvements in electrical apparatus.

9,186. W. DAVIES. Abercynon. An improvement on insulator and telegraph wire fastener.

9,200. F. HEIMEL. London. An improved dynamo-electric machine and driving gear for a vehicle.

9,203. The Hon. C. A. PARSONS and G. G. STOREY. London. Improvements in dynamos.

9,212. J. H. KILLIP. Liverpool. Improvements in or in connection with trolley or like current collectors for electric railways and tramways.

9,229. WILLANS & ROBINSON (LTD.) and G. L. ADDENBROOKE. London. Method of and means or apparatus for testing alternating current generators, transformers, meters and analogous apparatus.

9,233. M. WEINBERGER. London. Improvements in bayonet joint attachments for glow lamps, safety fuses, wall contacts, switches and similar devices.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

15,309. COLLEY. Insulating electrical conductors.

15,705. BARKER and EWING. Electric meters.

16,854. HALL. Connection fittings for various electrical purposes.

10,109. WILKINSON. Joint boxes for electrical installations and connections therefor.

10,153. WILSON, EVANS, and GODSAL. Method of controlling mechanisms by means of Hertzian waves.

10,671. PILKINGTON and ORMANDY. Utilisation of wrste sand from glass grinding works, and other materials for the manufacture of hones, holy stones, grindstones, and like blocks for abrasive grinding or polishing purposes, crucibles, emery, corundum, and other wheels, bath, fire, or other bricks, tiles, ornamental or other slabs, tablets, switchboards, imitation porcelain and pottery, and the like.

10,863. HOPKINSON. Switches for alternating electric currents.

12,731. HOLT and ATHERLEY. Electrical switches, particularly suitable for high-voltage connections.

13,118. ELLIS and CRICHTON. Mechanism for electrically driving roots and like blowers.

13,257. SMITH. Underground conduits for electric railways.

14,632. CHONÉ. Collectors for electrically-propelled vehicles.

14,704. BREMER. Electrodes for electric arc lamps.

COMPANIES' MEETINGS AND REPORTS.

City & South London Railway Co.

A general meeting of this Company was held last Tuesday under the presidency of Mr. CHARLES GREY MOTT.

Mr. W. F. KNIGHT (the Secretary) read the notice calling the meeting.

The CHAIRMAN said they had been so used in the past to meet half-year after half-year with an improving dividend that it had been a matter of very great disappointment to the Directors to have, as they had during the last two half years, to announce a decreased rather than an increased dividend. The only comforting thing was that they believed the decreased dividend was due to temporary causes, and when these were removed he believed that they would again be able to announce an increase in the dividend. Great efforts were made by the general manager and his staff to get the extensions open, and by means of hard work the extension to Moorgate-street was opened about March 1, and that to Clapham Common by June 1. But in order to accomplish this they had to submit to one or two questions of detail being in an imperfect condition. At first the engines at the generating station were not quite satisfactory, and the lifts at various stations were also not acting as they could have wished. He was glad to say that these difficulties were now overcome. They felt when they opened the extension last March, that whatever defects there might be with regard to the question as to the smoothness and convenience and regularity of the working of the lifts, they were, at all events, absolutely safe. However, the faith they had upon that subject was rudely shaken when one of the lifts at London Bridge broke down. The accident had arisen from a combination of circumstances which were never likely, he believed, to occur again in any shape or form. As the shareholders knew, they had worked that line for nearly 10 years without any accident to their lifts, and congratulated themselves upon that fact, and therefore they very much deplored the accident. The other lines of railway with which they hoped they would be connected and which they expected to bring them in traffic were not opened as early as they expected, but their most important connection, the Central London Railway, was on Monday last opened for public traffic. The subway from their own railway which connected the platforms of the two lines was now being used, and he believed that they would get, as soon as the public became aware of the convenience of the system, a very large accession of traffic passing through the subway between the Central London system and their own system at the Bank. The subway between their own line at London Bridge and the station of the L.B. & S.C.R. Co. was now being made, and that would prove another source of traffic as soon as they were able to open it, which he hoped would be within the next six months. The Baker-street and Waterloo Railway Bill had passed, with connections with Paddington and the Great Central Railway, and with a connection with the line of this Company at the Elephant and Castle, which would give them connection with a vast artery of traffic right through the best part of the West End of London, with connections with the north and with stations at Charing Cross, Piccadilly, Regent-street, and elsewhere in the best part of the West End, and there was no doubt that they would get a very large accession of traffic there. As regarded the extension to Islington the tunnels were now completed and there only remained to finish the stations—the underground stations, one of which was already done, and to build the surface stations, and to put in the lifts, and they hoped that the whole work would be completed by about next March. When the extension was carried out, they would be able to show what the capabilities of the railway really were. The main line would be completed, and he believed they would be able to show the shareholders that they had a good line and a good paying traffic. One of the reasons why they had a diminished dividend this time was that they had thrown out of use three-quarters of a mile of their line between the Borough and their old station in King William-street. That three-quarters of a mile of line was a valuable asset.

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If that portion of the line had been worked by the Company, and they had received the receipts for their ordinary traffic upon it, they would have been in the position of being able to pay to the shareholders a dividend of at least 2 per cent. upon that occasion. They had approached the City and Brixton Railway with a view of coming to a slight modification of the agreement in order to enable them, if possible, under certain more favourable terms, to raise the money requisite for the construction of that line. The result had been an agreement whereby the City and Brixton Company should have a first charge upon the gross receipts up to an amount not exceeding 3½ per cent. instead of 3 per cent., the Directors to determine how much they would give between the 3 per cent. and 3½ per cent., and another alteration was that the City and Brixton Company were entitled to share for an additional amount after the City and South London Company had paid 3½ per cent. dividend instead of 4 per cent. as in the original agreement; and in addition, the agreement provided that the City and South London Company were to receive the income for the three-quarters of a mile of line which would go against any absolute loss which they might incur under the arrangement. That was what the shareholders would be asked to approve at the extraordinary meeting.

With regard to the accounts, on capital account they had received for calls on the last issue of shares £79,212, debenture stock sold £169,278, received for premiums £33,790, making a total of £282,280. Against that they had expended upon works and rolling stock £158,263, and interest chargeable to capital was £7,759, making a total of £166,022, leaving a balance outstanding of £126,258. The revenue accounts showed that they had an increase in the number of passengers carried of 629,619, and in the receipts of £6,934. Season tickets had decreased by 82, and in money by £76. In parcels there was an increase of £28; in transfer fees a decrease of £6; in rents an increase of £234; and in sundries a decrease of £96, so that the total net increase was £7,019. Expenditure showed a decrease in maintenance of £49, but there was an increase in locomotive and generating power of £1,727, carriage repairs £134, traffic expenses £2,946, general charges £85, passenger duty £43, law charges £4, rates and taxes £119, so that the net increase amounted to £5,009, so that they were left with a net increase of £2,010. The increased interest amounted to £626, making up a total of £2,636, and the decreased balance, £165, made up the amount of £2,801. The increased interest on debenture stock was £1,213, and the dividend on preference stock £3,333, together £4,546, less the £2,301, which made the amount available for dividend on the ordinary stock less by £1,745, and they had to pay upon £855,000 against £630,000, so that they could, only pay a dividend of 1¼ per cent., as against 2¼ per cent. He concluded by moving the adoption of the report and accounts.

Mr. C. S. GRENFELL seconded the motion.

In reply to a question, the CHAIRMAN said that the expense entailed in consequence of the accident to the lift would fall upon the contractors and not upon the Company.

A LADY SHAREHOLDER asked if there was any intention of extending the railway further than the "Angel," and suggested that they might go to the foot of Highgate Hill.

The CHAIRMAN said that the Board contemplated no further extensions at present.

In reply to Mr. Davidson, the CHAIRMAN said that the Board had come to an arrangement with the London County Council in re the Islington Station. The Company considered that they had been badly treated, but he understood from the solicitor that the whole matter was now settled.

The resolution was unanimously carried.

The dividends proposed by the directors were then approved.

At an extraordinary meeting which followed resolutions were approved ratifying the new agreement between the Company and the City & Brixton Company.

Votes of thanks to the Chairman and Board, the Secretary (Mr. Knight), the General Manager (Mr. Jenkin), and the staff of the Company closed the meeting.

Globe Telegraph & Trust Co. (Ltd.).

The twenty-seventh ordinary general meeting of this Company was held on 27th ult., under the presidency of the Most Hon. the Marquis of TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett), having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I have now to ask your approval of the report and accounts. I believe that the report will be regarded as highly satisfactory. We are not able to recommend a larger dividend than last year, but our position has been well maintained, and we are paying the same enhanced dividend as we did last year. The receipts, after deducting all expenses, amounted to £198,420, showing an increase of £530, while the expenses—which are never large, amounting to only ⅛ per cent. on the capital of the Company—are somewhat less this year than they were last. We are able to recommend a final dividend of 4s. 6d. per share on the ordinary shares, or, in other words, after paying 6 per cent. for the year on the preference shares there remain funds available for a dividend at the rate of 5¼ per cent. net on the ordinary shares, leaving a balance of £982 to be carried forward. The dividend paid on the ordinary shares was in 1895 at the rate of 4⅛ per cent., in 1896 4½ per cent., in 1897 4½ per cent., in 1898 5⅛ per cent., in 1899 5¼ per cent., and we now maintain that increased dividend.

Turning to our investments, the first investment is the *Anglo-American Telegraph Co.*, and you will observe that for the first time our report shows that we hold none but preferred stock of that company, having sold the remaining £70,000 deferred stock at almost the highest price it has ever reached. The proceeds were invested in shares of the Brazilian Submarine Telegraph Co., now known as the Western Telegraph Co. The return on the Anglo-American preferred stock is £6. 11s. 6d. per cent., against £5. 5s. 11d. per cent. last year.

Commercial Cable Co.—We have increased our holding in this Company by 100 shares. Towards the end of 1899 the Commercial Cable Co. issued some new capital, which was offered to their shareholders at the rate of one-third of their existing holdings at par. We took up our proportion, which makes our present holding 400 shares, with the result that the average cost per share is reduced from £33. 16s. 8d. to £30. 10s. 7d., while the return per cent. per annum is increased from £4. 13s. 7d. to £5. 2s. 7d., the return on the 100 new shares being 8 per cent.

Direct United States Cable Co.—This company has benefited by the growing Atlantic traffic, and has increased its dividend from 3½ per cent. last year to 3½ per cent. this year, making the return per cent. per annum on this investment £6. 2s. 11d. against £5. 14s. 1d. in the preceding year.

Eastern Extension Telegraph Co.—This company has recently issued new share capital, which was offered to their shareholders in the proportion of one-fifth of the existing holdings at £13 per share, the market price at that time being £16. We availed ourselves of this offer, thereby adding 11,143 shares to our holding in that company. This investment has, of course, not as yet yielded any dividend, but assuming that the Company maintains the present dividend of 7 per cent., the investment will return to us £5. 7s. 8d. per cent. The cost of this purchase will be met by the sale of some other securities.

London Platino Brazilian Telegraph Co.—We have sold, during the year, 27 debentures in this company at a substantial profit, and have used the proceeds in the purchase of the Commercial Cable shares, to which I have already referred.

Submarine Cables Trust.—The increase in the income of the Submarine Cables Trust has enabled the trustees not only to meet the half-year's coupons, which, until recently, were somewhat in arrears, but also to provide a surplus sufficient to enable them to draw a certain number of certificates for payment at £120. It so happened that 10 of the certificates so drawn were held by this Company. The coupons of reversion, attached to those certificates remain with this Company, they will, however, earn no income, and it is not easy at the present time to assess or estimate their intrinsic value; but there is no doubt that when the Submarine Cables Trust comes to be wound up, these coupons will be of considerable value.

Western Telegraph Co.—This is the new name which has been adopted by what we have always known as the Brazilian Submarine Telegraph Co. The income for the year amounted to £26,124, against £22,805 last year, bringing the return per cent. per annum from £5. 12s. 6d. last year to £6. 8s. 11d. this year. The debentures formerly standing in the name of the Western & Brazilian Telegraph Co. have now been exchanged for 4 per cent. perpetual debenture stock of the Western Telegraph Co.

Our other investments, which I have not named, remain unchanged, and do not call for any special remarks. You are aware that the market price of most of the Submarine Telegraph Co.'s stocks has fallen during the last year or two. This is due partly to the experiments in wireless telegraphy which Mr. Marconi has been carrying on, partly to the proposed Pacific cable—or rather cables—and perhaps also to the general political outlook, which is not as reassuring as we should like it to be. Notwithstanding these adverse influences, the market price of our investments shows at the present day a very considerable surplus over the capital—a surplus, I think, amounting to just short of £600,000. With respect to the threatened Pacific cables, I understand that tenders have been invited for an all-British cable from Vancouver to Australia, vid Fanning Island, and will probably be sent in in a few weeks. Besides that, two bills are before the Congress of the United States for a cable connecting California with Honolulu and the Philippine Islands. One of these is designed to be under Government superintendence, and the other is intended to be under a private company. The rival schemes will in all probability be disposed of in the course of next December, when Congress resumes its sittings. I need not assure you that the utmost attention is being given to this important matter by the directors of the companies which will be affected by the establishment of a cable or cables in the Pacific, and I have no doubt that the directors will do their best to protect the interests of the several companies concerned.

I now move the adoption of the report and accounts, and the dividends as recommended.

Sir JAMES PENDER, Bart., M.P., seconded the motion, which was carried unanimously.

Resolutions were afterwards passed re-electing the retiring director, Sir James Pender, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Mr. John Newton.

A cordial vote of thanks to the chairman and directors terminated the proceedings.

Edison and Swan United Electric Light Co. (Ltd.).

The seventeenth ordinary general meeting was held on Tuesday, Mr. JAMES STAATS FORBES presiding.

The SECRETARY (Mr. H. Charles Gover), having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, before dealing with the accounts I wish to make reference to the stocks of goods at our various depôts. From year to year we have accumulated an enormous amount of stock in hand. We have London with several depôts, one or two very important ones. We have in a number of great towns and centres an increasing number of depôts, and from year to year that involves, with the growth of our business, the accumulation of a vast number of articles at these places. If they only grow something like in proportion to the amount of the turnover there is no occasion for alarm, but we have thought it necessary, with the concurrence of the auditors, to have a very serious

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alteration in our stocktaking. Having been tolerably prudent and pretty careful hitherto, this stock has got so very large that it involves an enormous amount of labour. I forget how many articles there are in our big stock, and how many varieties of different kinds.

The MANAGER: About 75,000 to 100,000 varieties, and about 6,000,000 items. There are about 1,700 varieties of lamps alone.

The CHAIRMAN: You will see our business is made up of very small elements, but amounting in the aggregate to a serious one, particularly in respect of the stock on hand. We have to look to the possibility of fashions changing. It is not only that you have a great many articles, but some of them may be superseded by something better, and we came to the conclusion that we had better close the year after a stocktaking of a serious nature during the month of June, and earlier, which would really put us in something like absolute knowledge of whether the stock was present in valuable quantity to the extent shown in the books, and that has turned out to be rather a longer job than we expected. We have taken stock, and I think I can give you the assurance, as far as it has gone, that we have every reason to believe that the stock stated in the accounts as it stands is well within the actual saleable value from day to day. You will see by the report what the auditors say about it: "We have examined the balance-sheet, and find it to be correct and in accordance with the books and vouchers of the company. The stock having been taken on May 31, the profits of the month of June have been estimated on a basis which we approve." Since the report was prepared we have ascertained the exact value of the stock on hand, and as an asset of the company it is worth some few thousand pounds more than it was put at on May 31—£201,648.

Now, as to the report. We have already paid something in the nature of a provisional dividend for the first half of the year, and we propose to pay at the same rate for the second half, which will make a dividend of 6 per cent. for the year, and carry forward £6,199. The increased value of our stock means that the balance carried forward might have been £12,000 odd instead of £6,000 odd. The accounts show that we have largely increased the volume of the business, from £241,000 to £285,000, an increase of £44,100. On May 31, 1900, you will see the stock stood at £201,648. The figure last year was £160,000, and therefore the item has increased by £41,648. On the other side of the profit and loss account you will find depreciation of plant, &c., £13,936. This item has increased by £4,500 odd on the year, which means that having a very large stock and bigger business, we feel it wiser to write down a corresponding amount out of the profits. The salient points of the account are that the balance brought forward amount to £10,509; the business has increased from £241,000 to £285,000; the stock has increased from £160,000 to £201,000; and the interest accrued to us from investments and other sources has increased by about £1,100. Against that there is the fact that the stock in hand on July 1, 1899, was only £160,000; wages, purchases, &c., £272,112; salaries, remuneration of directors, income tax, insurance, and general and law charges, £12,076, which has not materially increased; depreciation on plant, &c., £13,936, and a balance of £43,388, against £44,792 last year. But if I add the £6,000 which is required to bring the value of the stock up to its right figure, you will see that the balance would amount to £49,398. Another matter affecting the balance is that this year we have had to spend a good deal of money in anticipation of this year, and have had to raise fresh capital. That capital has come into charge, increasing the item of interest. The increase is £1,994. It has cost us less to pay interest than to pay the bankers for loans, and we have got out of debt at our bankers and have a considerable surplus in hand to go on with. The rather heavy sums standing in the balance-sheet against sundry debtors and debit balances (£143,959) is largely accounted for by the fact that the estimates of income for the month of June is a debt to the company at this moment, because we give everybody long credit, and there is no collecting money for some time in respect of anything sold in the month of June. Therefore the amount authorised by the auditors to be brought into the accounts as the approximate income of that month is owing, and is brought in as a debt. That is a large amount, but, under the same pressure as other people who have to face competition, we have to meet the convenience of our customers. I am glad to say that hitherto our bad debts have been inconsiderable. I now move the adoption of the report and accounts.

Mr. J. WILSON SWAN, F.R.S., seconded the motion, which was carried unanimously.

Resolutions approving the dividends were then approved.

The CHAIRMAN then referred to an agitation that had been threatened by the "B" shareholders. He said that having some reason to believe that a combination existed of "B" shareholders he issued a circular sounding a note of warning and suggesting to the shareholders that they should not be in too great a hurry to part with their shares at a large discount. There was no reason why shareholders should part with their shares of any denomination at less than their par values. The fear that a further call would be made on those shares was an illusory one. There was no reason whatever why the company should not become even more prosperous than now. They had an enormous business in lamps, and a growing business. That business of lamps would go on, but besides that they were largely occupied in fittings and an infinity of things. They had the largest business in "special" lamps of any company in the world. Their fittings department was developing rapidly, and had, in fact, outgrown the machinery provided for it, and he was not sure it had not also outgrown the brains which had conducted it. They had reformed all that now, had added to the machinery, and were following the American idea of labour-saving appliances, under an exceedingly capable man, in whom they had great confidence—an engineer by profession of some ability and reputation. It was a profitable business.

Mr. James Staats Forbes and the Earl of Lichfield were re-elected directors, and Messrs. Welton, Jones & Co. were re-appointed auditors.

A cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

Rand Central Electric Works (Ltd.).

The annual general meeting was held on Tuesday, Sir CHARLES RIVERS WILSON, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. H. Militz) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, I have to repeat the apology I made to you last year, but under somewhat different circumstances, for the late period at which we have summoned you for the annual meeting. But you will not be surprised when you recollect that circumstances beyond our control have made it very difficult for us to communicate with our people at Johannesburg, and to obtain the documents to enable us to prepare the report and accounts. This is a contingency which I sincerely trust will not be repeated. Before going into the question of the state of the works and the conditions under which we have been working in consequence of this disastrous war, I will just cursorily examine with you the accounts. Taking first of all the debtor side of the balance sheet, we have fulfilled our obligations by setting aside the small sum of £83. 19s. 9d. to the reserve fund, being 10 per cent. of the profits made, which is all we were able to do. I do not think there is any other item on that side of the account which calls for notice. On the other side I think the items which will chiefly interest you are the amounts set aside for depreciation. You will recollect that the equipment contract contemplated that the amount of depreciation to be provided should be £16,200. That estimate, however, was based on the assumption that the whole of the full load of 2,100 H.P. would be in continuous running. Well, that of course has not been the case, and therefore we have dealt with the depreciation on the same principle as we did last year. Last year the amount appropriated was about £8,000, being 50 per cent. of the estimated amount provided in the equipment contract, and this year we have provided 75 per cent., making a total of about £12,500. There are certain items on the credit side for which no depreciation is provided, therefore we were not able, even if we had wished to do so, to set aside any such amount for depreciation. Now that we are beginning this year to be relieved from our obligations to Messrs. Siemens & Halske it will be open to us, if times are good and the circumstances warrant it, to take into consideration what we shall do in the direction of setting aside depreciation for the separate items to which I have referred. Well, now, I have no doubt that you have examined the report, and have observed the fatal influences of the state of hostilities from which we, like all other industries in South Africa, have been suffering. Instead of a very considerable improvement in our revenue, as contrasted with the last two years, we have made but slight progress, and nothing to be compared to what we had anticipated. In 1897 we worked at a loss of £16,000, although I am bound to say that the power supplied only covered a part of the financial year. In 1898 our loss was £5,472, and last year, working under favourable circumstances for nine months and extremely unfavourable circumstances for the last three months of the year, we have come out on the right side with a small profit of about £840. In view of the special circumstances which are attending our Company and its operations at the present moment, I think that the state of things justifies the expectation which your Directors have always held out to you, that we should progress steadily and satisfactorily, and I consider that under the circumstances to which I have alluded the result is entirely satisfactory. Under the equipment contract to which I have referred, our contractors, Messrs. Siemens & Halske, guaranteed a dividend of 6 per cent. for the year 1897, 8 per cent. for 1898 (both of which dividends were paid), and 10 per cent. for 1899. Upon the first blush of the thing the shareholders may not unreasonably have expected to receive the dividend of 10 per cent.; but Messrs. Siemens & Halske advanced a claim which I am bound to say in morality, and I think very likely it may turn out in strict legality, to be a well-founded claim—viz., that some consideration should be shown and some relief should be given them in respect of the last three months of the year 1899, during which period the works, if not absolutely stopped—because that has never been the case—were working at a vastly decreased output in consequence of the war. In these circumstances and guided by other considerations which I need not perhaps very minutely enter into, your Directors and the local Board have unanimously arrived at the conclusion, after very grave consideration of the subject, that there is room for a compromise with Messrs. Siemens & Halske, and the result has been that an arrangement has been agreed upon, as explained in the report. Messrs. Siemens & Halske entirely understand that the arrangement which we have entered into is to be entirely subject to the decision and approval of the shareholders. If you do not see your way to agree with the view so strongly entertained by the London and the Johannesburg boards the responsibility will rest with yourselves, and the consequence will be that we shall enter upon a period of most undesirable litigation with Messrs. Siemens & Halske. The basis of the arrangement proposed is this: We assume that the revenue in the December quarter is £16,230. 12s., that being the actual amount of the revenue for the September quarter. We then deduct the revenue actually received in the December quarter, amounting to £6,365. 7s. 2d., and we further deduct the difference between the actual working expenses in the December quarter and the working expenses in the September quarter, amounting to £2,493. 11s. 3d. Those two items make a total of £8,859. 18s. 5d. which, deducted from the assumed revenue of £16,230. 12s., leaves a net loss in the December quarter of £7,371. 13s. 7d. The proposition of the Board is that you shall agree with us in relieving Messrs. Siemens & Halske of that amount. The total amount which would be payable by them under ordinary circumstances would be £29,244. If you see your way, as I said before, to agree to our proposal, that amount of guaranteed money would be reduced by the sum I stated just now—

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£7,371, and leaving their liability £21,872 instead of £29,000. The long and short of it all is that instead of getting a 10 per cent. dividend, which we all of us hoped might have been declared, and which which would have been paid but for this unfortunate political disturbance, the amount available for distribution will only be 7¼ per cent., after paying which we shall be able to carry forward a few hundred pounds to next year. I think it only right to mention that we have had two or three letters from shareholders deprecating any reduction in the amount of the guarantee. If they are here, perhaps I have anticipated what they may have to say, as possibly the explanations which I have given may induce them to change their views. As regards the actual position of our undertaking, you will perhaps, first of all, be interested to hear that during the war our works have been maintained in a very efficient state. No harm has been done us, and there has been no interference with our works, so far as I know. I think it only right that I should pay a tribute to our local chairman, Mr. Brakhan, and to our general manager, Mr. Gorrissen, and the staff on the spot, who have stayed by us throughout all these troubles. They have never left their work, and have kept all our works out there in most admirable order and ready to take up the work of the increased number of customers which we hope to have as soon as the war is over. It will interest you to hear that some time before our troops reached Johannesburg we received a confidential intimation that it was in contemplation in certain quarters to destroy the mines by means of a communication from some central point on the farm Brakpan, the headquarters of our works. We lost no time in putting ourselves in communication with our friends at Johannesburg. It caused us a considerable amount of trouble, but we achieved our purpose, and our property was secured. Otherwise everything has gone on very quietly and smoothly. When the war began we were in the happy position of having a steady increase of consumption. At that time the amount of power absolutely supplied—that was at the end of September—rose to 1,541 H.P., which was the maximum up to that time. The average load in the preceding year had only been 965 H.P. I mention that as indicating to you the steady progress of our output and increase of our consumption. Our prospects are as good as ever they have been. Notwithstanding all these troubles—or perhaps in consequence of these troubles, because I daresay our engineers had more time on their hands than they otherwise would have had—the efficiency of the works has gone on increasing and improving in such a manner that as soon as the war is over and we are again able to resume our full operations, we shall be in a position to do most excellent and profitable work, and on a much larger scale than we have done hitherto. Before I sit down I must allude with great regret to certain serious and deplorable losses which the Company has sustained. In the first place, we have lost Mr. Charubin, who is intimately connected with Messrs. Siemens & Halske. Mr. Charubin has returned to Germany. Our other two losses—one a member of the Board and the other a gentleman intimately connected with our Company, in which he was deeply interested—are of a different character. Mr. Barsdorf was one of our original Directors, and we lost by his death a man who had your interests very much at heart. Then within the last 24 hours we have received intelligence of the death of Mr. Adolf Goerz, the managing director of Messrs. Adolf Goerz & Co., and who was also a member of the South African Board of the Rand Central Electric Works. I cannot say how deeply I regret the loss of two such excellent supporters. One of the vacancies has been filled by the appointment of Mr. G. von Chauvio, a gentleman well known to most of you by name, and I think you may congratulate yourselves on having a Director who will take an intelligent interest in your affairs. I now move the adoption of the report and accounts.

Mr. ALFRED H. MÄRKER seconded the resolution.

Mr. SIGISMUND CAHN said he objected to the item in the profit and loss account, "Wages and stores at works, £22,286." According to the basis of guarantee stated in the German prospectus which he received in Berlin, the working expenses for the full capacity of the works were £15,200. Now making allowance for the partial inactivity of the works the working expenses ought not to exceed £13,500. This excess of working expenses meant in the future about 6 per cent. less profit for the shareholders, if any. On behalf of himself and other shareholders he demanded that the contractors should not be allowed any abatement on the guaranteed dividend, and he further asked that the Chairman adjourn the meeting to Sept. 15, in order to give the 1,300 shareholders living in Germany an opportunity to record their votes. He understood that for every £10,000 of additional revenue they had £2,500 additional working expenses.

The CHAIRMAN: I cannot agree to any adjournment. It certainly has turned out that the amount charged for wages and stores at the works has exceeded what was contemplated by the contract, but you must bear in mind one or two things. In the first place I think those figures were based on the assumption that there would be continuous working, whereas, in full reality, it has proved to be very far from being the case up to the present time. In the second place, you have not taken into consideration the labour question, which has given us and other interests out there so much trouble, and which I have no doubt was one of the disturbing influences in regard to the matter.

Mr. ALFRED H. MÄRKER said: In reference to the point that the working costs had exceeded the estimate, it was unfortunate in all undertakings they had always something to learn. Messrs. Siemens & Halske based their estimates upon the experience which they had gained in many tropical climes, but that experience did not tally with that gained in South Africa. The fact of the matter was that not only had Messrs. Siemens & Halske lost a considerable amount over this business, as shareholders could see for themselves, but he could also state that the amount of loss was greater than was apparent from the annual profit and loss accounts, but with men and money they had done all they could to help the Directors in seeing the Company through all its difficulties, and they were still standing by them, although their contract was up. He could assure them that Messrs. Siemens & Halske had done nothing else than protect the interests of the shareholders.

The resolution was then carried.

The dividend of 7¼ per cent. was then approved, and the retiring Directors (Sir C. Rivers Wilson and Mr. G. Zwilgmeyer), were re-elected, and the auditors (Messrs. Price, Waterhouse & Co.) reappointed. A vote of thanks to the Chairman and Directors brought the proceedings to a close.

Marconi International Marine Communication Co. (Ltd.).

The statutory meeting of this company was held on Wednesday, Major S. FLOOD PAGE presiding.

The SECRETARY (Mr. H. W. Allen) having read the notice convening the meeting,

The CHAIRMAN said he could not commence the proceedings without referring to the truly tragic event which had happened in Italy. He had heard Mr. Marconi say how greatly he had been indebted at the commencement of his work to the kind assistance, help, and consideration tendered to him by the King and Queen of Italy, and this must be his excuse for introducing the subject on that occasion. He had to apologise for the absence of the president of the company and many of their foreign colleagues, but M. Maurice Travailleur, manager of the company in Brussels, was present. They would remember that the prospectus of the company contained a list of names of gentlemen of the highest standing, experience, and financial position belonging to almost every country in Europe as forming the board of directors, and it was to these gentlemen that the shareholders would look to do the business of the company. This business was practically limited to ship-to-ship, shore-to-shore, ship-to-shore, and shore-to-ship communication. They had already made a commencement in Belgium. A site had been determined upon for the erection of the first Marconi mast in that country, and a Belgium steamer was to be fitted with the apparatus. The directors anticipated that an arrangement would be come to with the Belgium authorities by which the Marconi system would be working all along the Belgium coast. Their French directors had approached the French Government and were about to enter into negotiations with a view to obtain concessions for the Marconi Company in France. Senor Prendergast, who was also one of their directors and at one time Minister of the Colonies in Spain, had commenced negotiations with the Spanish Government with a similar object. The London offices were in communication with Newfoundland with a view to establishing stations there. It was true the company had not yet done very much, but it was impossible with a system such as theirs to set to work immediately the company was formed, more especially as a telegraphic monopoly existed in almost every country of the world. Their difficulty was to persuade the Governments who held these monopolies that the company was going to help them and not to trade against them, and that if they succeeded in doing their business they would increase the Governmental revenue. It was necessary that he should give a word of caution to the shareholders here and abroad with regard to rumours concerning other systems of wireless telegraphy. It was quite true there were other systems, but it was also quite true that none of them were successful. One thing was clear, that none of these systems could be worked with any degree of success without using Marconi patents in one form or other, and the question was how long their parent company should allow these infringements to continue. Litigation might be necessary, but it was first of all desirable they should find out whether their opponents were worth powder and shot. They were established, however, to earn dividends, and the way in which they must set to work to do this was, as he had said, to persuade Governments with which they would have business relations that they were not competitors with them for telegraphic business, but that if they were allowed to put up poles on the shores of foreign countries the Marconi Company would undertake before long to have the Marconi system on ships, by means of which communication could be carried on, and business would accrue to the Government telegraph systems in that manner. They had no difficulty whatever with regard to money; the shareholders in the Marconi Wireless Telegraph Co. had had the opportunity of taking up a large proportion of the shares and they had done so. He must say one word as to the opposition of the Post Office and what this opposition amounted to. He did not believe that if they had a Marconi mast and apparatus fixed in England that any Post Office or any department of the Government could prevent them from communicating with the post they had erected at Belgium. The Post Office claimed a monopoly, but to his mind it was iniquitous that (taking the case of the National Telephone Co., which paid the department £68,000 for royalties in six months) private companies should be treated as that company was being treated. Then again, the District Messenger Co. was another case in which the Post Office was in conflict. This Post Office monopoly simply rested upon the decision of two judges (Justices Pollock and Stephens), which was not a strong court. Both these judges were dead. They had read into the Telegraph Act the telephone system, which did not exist when the act was passed. The telephone company had been urged not to appeal against this decision. The Post Office said: "Do not appeal and we will give you a long licence," and the result of possessing that licence was that to-day the company was crippled to the extent of £130,000 per year, which they paid in royalties, and were now threatened with Post Office competition. The Marconi company could work in defiance of all the Post Office authorities in the world, who could have no legitimate grounds for interference with the company's operations in any way whatever. If the company fitted their system on to a ship and that ship traversed up and down the English coast, it could speak to half-a-dozen stations without interference by the Post Office so long as the ship was 3 miles and a yard away from the coast, and the onus of proof of the 3 miles and a yard lay with the Post Office and not with the ship. They did not want to quarrel with the Post Office

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but at the same time they had no intention of being bullied. He thought he might be permitted to say that the Marconi Company had the sympathy of some of the highest Government officials in this matter. He would give them one instance of this Post Office interference, which he regarded as simply monstrous. They had entered into an arrangement with the South-Eastern and Chatham Railway Co. to obtain the best instruments possible for communication between their ships and the shore. That company carried over 400,000 passengers a year in their ships, and had not lost a single life since 1863, and the Directors were alive to the value of wireless telegraphy. He had asked the manager of the railway why the matter had not proceeded, but was unable to discover whether the block lay with the French Post Office or with the English Post Office, or whether some clauses of the Postal Union Convention prevented their working. He held that it was simply monstrous that English industries should be hampered in this way by the bugbear of a Government monopoly, which, if it had been fought, would, he had legal authority to say, have no longer existed. He had one good thing to tell them, which was that the Marconi Wireless Telegraph Co. had entered into a contract with the English navy, which, if successfully carried out, would stamp the Marconi system once and for all, so that no one could question its merits and advantages. The contract provided that there should be 32 ships or torpedo stations fixed up with the Marconi apparatus, but they did not know the date when they would have to commence their work. The work they had to carry out was a difficult one. A ship was to be fitted at Portsmouth, and another at Portland, and these were to communicate one with the other. It was a long distance, and there was a high range of hills between the two places. They had had the Marconi apparatus at Delagoa Bay on four of Her Majesty's ships for several weeks, and in no case had it failed to give satisfaction. The Portuguese Government at Lourenço Marques were carrying out an installation, and they were expecting full details daily. He wished to impress them particularly with the fact that the Marconi system had never failed where it had been properly carried out. There was, he said, no business to transact that day, and, having thanked the shareholders for their attendance he declared the proceedings closed.

Anglo-American Telegraph Co. (Ltd.).

The half-yearly meeting of the proprietors was held on 27th ult., Mr. FRANCIS A. BEVAN in the chair.

The SECRETARY (Mr. T. H. Wells) having read the notice calling the meeting,

The CHAIRMAN stated that the ordinary receipts for the past half-year to June 30 had been remarkably similar to those for the corresponding period of 1899. There was a difference of only £983 in favour of the past half-year, and he thought that, so far as their ordinary traffic was concerned, they might congratulate themselves that they had not only maintained but had also increased their receipts. It must be remembered now that so far from the company or the associated companies having a monopoly of the Atlantic traffic, when the new German-Azores cable was opened there would be no fewer than 13 cables across the Atlantic. The competition was therefore becoming daily greater, and under those circumstances he thought it very satisfactory that they had been able not only to maintain but to increase their ordinary traffic; and he might state that for the present month the receipts were almost precisely what they were for the month of July, 1899. There had, however, been a large falling off in the earnings of the repairing ship "Minia." On a previous occasion, however, he warned them that the amount earned by the "Minia" was not to be relied upon—that, in fact, it was entirely exceptional, having arisen in consequence of the misfortune of their allies. Last year the company earned by the "Minia" over £19,000, while this year this amount was reduced by £17,975. This alone accounted for the diminished amount they were able to carry forward. Of course this was a matter over which the directors had not the least control, but there was something to be said on the other side in the extremely good working order of the cables. There was a large reduction in the amount owing to the company—a reduction of £57,000, but a good deal of the large amount of £12),000 shown last year was owing by the Western Union Company on account of repairs, and other items had also diminished the amount due to the company this year. There was an increase of £22,454 in the item of cable in stock. Owing to the repairs which were effected in the previous year their stock of cable had been brought down to a dangerous limit, and a large amount of spare cable had therefore had to be purchased. They had had for many years a cable running from Salcombe to Brest, but it had become very much worn, and they had therefore put down a new cable—not between these two places, but between Cuckmere and Havre, and they believed this cable would prove a great source of economy. In the revenue account there was an item of £83 for "damages recovered for injury to cable" in Valentia harbour. This was a very unusual entry. The directors thought the time had come when they ought really to make an example of a certain firm which had been particularly careless with their hulks in Valentia Bay, and brought an action, the net amount coming to them from the action being £83. With regard to the new German-Azores cable, the directors were informed that the new cable was to be opened on Sept. 1 next. When it was opened it would, of course, take a very large portion of the outward traffic, at all events, from Germany to America, and nothing which the directors could do could possibly prevent this. The cable was heavily subsidised by the German Government, and the line would no doubt be a very good one. There were only two collecting companies in America—the Western Union and the other American company, which was in partnership with the Commercial Cable Co. The Western Union Company, he believed, would be able to collect a very large portion of the German traffic coming this way, and whatever that company might collect would be carried over their own lines, or would be handed to the Anglo-American Company. It must, therefore, not be supposed that with the opening of the new cable the company were going to lose all the traffic; on the contrary, he hoped that they would retain a considerable portion of it. With reference to the old subject of the "P. Q." lawsuit, the solicitor desired that the proprietors should not press him on this point on the present occasion. Matters were going on, although very slowly, and what the result would be he could not predict. He concluded by moving the adoption of the report and accounts to June 30 last.

The DEPUTY CHAIRMAN (Sir Gerald Fitzgerald, K.C.M.G.) seconded.

Mr. EDWARDS enquired the total amount of German business involved.

Mr. WOOD desired to know if all the cables were working satisfactorily; he did not mean as regarded breakages, but whether the older cables were working in the manner the directors could wish, without hindrance.

The CHAIRMAN said the German business altogether was not a very large proportion of the whole. Their cables were working thoroughly satisfactorily. He understood the Commercial Cable Co. were going to lay another cable.

The motion was unanimously adopted.

A vote of thanks to the chairman and directors terminated the proceedings.

Crompton & Co. (Ltd.).

The twelfth annual meeting was held on Monday under the presidency of Mr. JOHN TROTTER.

The SECRETARY (Mr. E. Reeves) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN said he could congratulate the shareholders upon the results of the year's working. The company had returned to a state of prosperity, which he hoped and believed would last. The net profit earned had been £31,326 against £23,000 last year. The gross profits had amounted to £65,891, against £53,352. They had done a much bigger trade and had made larger profits also. The total of the working expenses altogether amounted to £35,564, equal to 54¾ per cent. of the gross receipts. For the previous year the percentage was 56¾ per cent. The figures for 1896 showed ratio of expenses to gross receipts 77½ per cent., 1897 72½ per cent., and 1898 67 per cent. In his opinion these expenses ought to be got down to 50 per cent. in the near future. The most important matter of the period under review had been the issue of new capital. The capital of the company amounted to £162,000, less £777 for unpaid calls. The shares were offered in the first instance to the existing shareholders at a premium of 5s. per share, and a very large number were taken up. The balance was issued to shareholders or the public at £3. 10s., or a premium of 10s. per share. The whole of the premium on the issue of the 21,902 shares had been carried to reserve. The available balance to be dealt with was £24,637, and out of this the directors proposed to set aside £2,500 for doubtful debts, to place £12,000 to reserve (raising it to £25,046), to pay a dividend at the rate of 9 per cent. per annum for the half-year, free of tax, making, with the interim 7½ per cent. for the year, carrying forward £3,729. The board proposed to set aside from the reserve fund £5,000 as a special contingency fund to provide for any shrinkage of value in the investments, to write £5,000 off goodwill. £5,000 from patents, and £3,000 balance for establishing the electric cooking department, carrying a balance of £7,046 forward. Having alluded to the improved position and prospects of the Chelmsford Electric Light Co., he said that the order book of Crompton & Co. was very full indeed, and they looked forward with considerable confidence to the future of the company.

The report and accounts were adopted.

Liverpool Overhead Railway Co.

The report of the directors for the half-year ended June 30 states that the gross receipts amounted to £38,124. 1s. 2d., and the working expenses to £25,113. 3s. 9d. The total passengers carried numbered 4,687,862, compared with 4,475,279 in the previous June half-year. The company's bill for powers to extend the main line to the Seaforth Station of the Lancashire and Yorkshire Railway awaits Royal assent. The capital authorised at the last meeting was offered to the shareholders, in 5,000 ordinary £10 shares at £8 per share, and applications were received for considerably more than the amount required. After deducting debenture interest and adding £4,591. 14s. 7d. from December there is £14,202. 12s., out of which it is recommended that dividends at the following rates (less tax) be declared: 5 per cent. per annum on the preference (£3,000) and 3 per cent. per annum on the ordinary shares (£6,750), leaving £4,452. 12s. to be carried forward.

ALUMINIUM CO. (LTD.)—At the annual meeting of the company the chairman (Sir Henry Roscoe) said the directors had entered into an agreement with the Cassel Gold Extracting Co., whereby an interchange of a portion of the profits of the Aluminium Co. and the profits of the Cassel Company had been arranged. If the amalgamation was carried through, in addition to the dividend of 15 per cent., the shareholders would be participating in the profits of the Castner-Kellner Alkali Co., in respect of three of their shares for every share the proprietors held in the Aluminium Co. from March 31; and assuming that the Castner Company continued to pay at least 8 per cent. per annum, the shareholders would actually receive for the 12 months' working within a trifle of 17½ per cent. per annum on each £1 share. The Aluminium Co. would be wound-up. The directors were satisfied that sodium could be made very much cheaper at the works of the Castner Company than at their own works. Resolutions approving the proposed amalgamation were carried.

CENTRAL LONDON RAILWAY CO.—The report of the directors for the half-year ended June 30, states that the expenditure for the half-year

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amounted to £185,712. 6s. 4d., the total to June 30 being £3,353,596. 13s. 4d. The directors hoped to be able to open the railway for traffic in the early part of July, but their expectations were not fully realised, some modifications in the plant being found necessary during the experimental working. The approval of the Board of Trade having been given, the railway was opened for traffic on Monday, July 30. As a commencement a week-day service of trains is being run from about 5 a.m. to 12 p.m. at intervals of 5 minutes, but more frequent trains will be provided, especially during the busiest hours of the day, as soon as practicable. A reduced service will be run on Sundays.

CHILI TELEPHONE CO. (LTD).—The eleventh annual report of the directors of this company (to March 31) states that the aggregate number of subscribers at all centres at the end of the year was 4 613, compared with 4,486 at the beginning, a gain of 127. The gross revenue in Chili from all sources was, in 1899-1900, $551,436, and in 1898-99, $599,994, and increase of $51,442. The expenditure in Chili was, in 1899-1900, $364,549, and in 1898-1899, $375,230, a decrease of $10,681. The net income in Chili from all sources showed an increase of $62,123. The average rate of exchange for the year was 15·17d., compared with 14·27d. in the previous year. Converted into sterling at these rates, the net income represented an increase of £4,764. The balance to credit of revenue (including £448 brought forward) is £12,847, of which £3,044 has been carried to reserve for depreciation and renewals. The directors recommend a dividend of 4s. per share, free of tax (at the rate of 4 per cent. per annum), absorbing £8,800, and leaving £1,033 to be carried forward. During the year capital outlay in sterling was £1,798. The total mileage of lines on March 31 was 8,298 miles 990 yards, an increase of 233 miles 477 yards over the previous year.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—The half-yearly meeting was held at Dublin on Tuesday. The chairman (Mr. W. M. Murphy) said the gross receipts were £12,000 more than in the corresponding half-year of 1899, and the working expenses £4,342 less. The net profits were, therefore, £16,742 more, £23,277 last year and £40,118 this, an increase of over 70 per cent. The net earnings of the Southern District Co.'s line were practically the same as the corresponding half-year, so that the whole of their increased profit was due to the conversion from horse to electric traction of the city lines. Their increased profits had had to meet increased wayleaves, together with increased interest, the total being £10,289 against £6,439 last year. They were able to declare a dividend at the rate of 7 per cent. per annum on the ordinary shares, an increase of 2 per cent. compared with last year. They had not yet arrived at the most economical basis for the production of electrical current, owing to the delay in the delivery of the polyphase plant. They had to keep Ballsbridge station open for the present, but when they shut it down and supplied all the current from Ringsend that would represent the saving of £2,400 in a half-year. During the last half-year they carried on the Dublin United Tramways system alone (excluding the southern district) 17,943,000 passengers, against 8,251,000 in 1891. At an extraordinary meeting which followed, the directors were authorised to increase the borrowing powers of the company by £300,000 in second debentures.

METROPOLITAN RAILWAY CO.—At the half-yearly meeting the chairman (Mr. John Bell) referred to the question of working the Inner Circle electrically. Their consulting engineers had stated that the experimental train was working satisfactorily. Other and important steps had been taken consequent upon their reports and the results of the experiments made by themselves at Wembley Park. It might possibly appear that too long a time had been spent upon these experiments, but the difficulties to be surmounted were greater than many people supposed. It was not a new railway they had to deal with, but a railway constructed for steam traction and carrying at the present time about 100,000,000 passengers per annum. That enormous traffic must be worked without a hitch so far as human means could provide while the change from steam to electric traction was being made. They also had to deal with traffic of other railway companies, which was brought on to and worked over a portion of the Inner Circle lines. The directors were, however, sanguine that those difficulties were capable of being overcome. The directors were convinced that electric traction had now so far advanced, and was so much better understood than it was even a few years back, that the new means of traction was practicable for working the circle, and they were determined to do all in their power to make the change as quickly as possible. They believed that the best and most practical knowledge of electric traction was centred in the leading electric traction firms, and what the board proposed therefore to do—and they were acting in concert with the District Company—was to ask some of the most eminent firms to submit their views as to the best method or system to adopt for the working of the circle, and invite them to submit offers, with plans and specifications, for the installation.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—An extraordinary meeting was held on Wednesday to consider resolutions increasing the capital of the company to £200,000 by the creation of 10,000 new shares of £10 each to rank as ordinary shares, and providing that 2,200 of the new shares be issued at a premium of £2 per share—1,100 to be offered *pro rata* to the holders of the founders' shares and the remaining 1,100 *pro rata* to the holders of the ordinary and ordinary preference shares, the remainder of the new shares to be issued from time to time at the directors' discretion in the same proportions to the holders of the founders', ordinary and ordinary preference shares. Sir Wm. Crookes presided, and stated that the resolutions were the outcome of a meeting held between representatives of the holders of the different classes of shares in the company. In answer to a shareholder, the chairman said that although the shares would be issued in the proportions mentioned it did not follow that they would be necessarily issued at the present premium of £2. The resolutions were carried.

WATERLOO AND CITY RAILWAY CO.—The directors' report for the half-year ended June 30 states that the capital outlay to June 30 was £589,073, 6s. 4d. The gross receipts, less Government duty, amounted to £14,133. 0d. 6d. From this the London and South-Western Co. have retained £5,398. 2s. 9d. in respect of working expenses, leaving £8,734. 17s. 9d. payable by them, in order to provide the agreed dividend at the rate of 3 per cent. per annum on the company's ordinary and borrowed capital. This dividend is payable on August 11. The number of passengers carried during the six months, exclusive of season ticket holders, was 1,868,737, an increase of 152,912 over the corresponding period of 1899. The season ticket holders numbered 911, against 747 at June 30, 1899. The following number of passengers carried (exclusive of season ticket holders), and the traffic receipts for each half-year since the opening of the line, were as under:—

	Passengers.	Net receipts.
December 31, 1898	1,442,855	£10,883
June 30, 1899	1,715,825	12,815
December 31, 1899	1,769,731	13,214
June 30, 1900	1,868,737	14,070

NEW COMPANIES, STATUTORY RETURNS, &c.

GARDNER ELECTRIC DRILL AND HAMMER CO. (LTD.)—This company was registered on July 28 with a capital of £40,000, in £1 shares, to acquire and turn to account inventions relating to electric power rock drills and electrically-operated hammers, and to carry on the business of electrical, mining and general engineers.

HARWICH ELECTRIC LIGHTING AND TRAMWAYS CO. (LTD.)—This company has been registered with a capital of £50,000, in £1 shares, to acquire the Harwich (Corporation) Electric Lighting Provisional Order (1892), and to carry on the business of tramway and light railway proprietors and of an electric light and power company in all its branches. The subscribers are G. E. Heyl-Dia (electrical engineer), G. Leve, W. W. Norman, W. J. Forsham, A. W. Howard, T. Burton, and J. Mason.

C. V. LAMP SYNDICATE (LTD.)—This company was registered on July 26, with a capital of £14,000 in £1 shares, to manufacture and deal in electric and other lamps, and to carry on the business of an electric light and power company in all its branches.

METROPOLITAN MOTOR MANUFACTURING CO. (LTD.)—This company was registered on July 28 with a capital of £10,000, in £1 shares, to acquire certain inventions from Messrs. A. E. Creese, F. Jackson and T. Underwood, and to carry on the business of electrical and general engineers, motor car manufacturers, &c. The first directors are A. Johnston, F. Jackson, T. Underwood, and another to be appointed by the subscribers.

CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)—The annual return to May 25 gives the capital as £200,000, in £5 shares, 20,000 of which have been taken up. Notice of increase of capital to £300,000 was filed on June 8.

TELEGRAPH MANUFACTURING CO. (LTD.)—The annual return to June 15 has been filed. The capital is £300,000, in 40,000 preference and 20,000 ordinary shares of £5 each, of which 20,000 preference and 20,000 ordinary have been taken up. £5 has been called up on each of 15,400 preference and 13,400 ordinary shares, and £134,000 has been received. £66,000 is considered as paid on 6,600 preference and 6,600 ordinary shares.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28d. per oz. (Aug. 2). Consols (2¾ per cent.) $97\frac{7}{16}$—$97\frac{7}{8}$ for money; $97\frac{9}{16}$—$97\frac{11}{16}$ for account; 2½ per cent. 96—96½ (July 26). Stocks and Shares Continuation Days, Aug. 13 and 28; Ticket Days, Aug. 14 and 29; Pay Days, Aug. 15 and 30; Mining Share Carry-over Days, Aug. 11 and 27.

ACTIENGESELLSCHAFT BROWN, BOVERI & CO., BADEN, SCHWEIZ.—This is the title of a company which has been formed with a capital of 12,500,000m. (about £625,000), to take over the business of Brown, Boveri & Co.

BLACKPOOL AND FLEETWOOD TRAMROAD CO. (LTD).—The directors recommend a dividend of 4 per cent. for the half-year ended June 30.

BRITISH ELECTRIC TRACTION CO. (LTD.)—Mr. C. Shirreff Hilton has joined the board of this company.

BRITISH NORTH BORNEO CO.—At the annual meeting on Tuesday the chairman (Mr. R. B. Martin, M.P.) announced that the telegraph system was still being extended, about 350 miles were working, and another 100 miles were in course of construction. The traffic so far had not been great, but the telegraph was invaluable to the Government, and more than paid for itself as a utilitarian and economic work. During the Mat Salleh rebellion it practically saved the situation, and it had also been of the greatest use in the construction of the railway.

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BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares, and an interim dividend of 5 per cent. per annum on the ordinary shares for the half-year ended June 30, payable 8th inst.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—An interim dividend on the 6 per cent. preference shares for the half-year to June 30, payable 1st prox., has been declared.

GERMAN ELECTRICAL INDUSTRY.—It is stated that in 1896 the capital invested in German electrical enterprise was 240,000,000 marks, while on Dec. 31, 1899, this capital exceeded 700,000,000 marks (about £35,000,000). Before 1890 only three great electrical companies were founded in Germany. The average dividend of 14 electrical companies for 1898 has been returned at 9·3 per cent., the highest being 15 and the lowest 4 per cent.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Interim dividends for the six months ended June 30 will be paid on Sept. 1, as follows: On ordinary shares at the rate of 8 per cent. per annum, and on preference shares at the rate of 4½ per cent. per annum, less tax in each case.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 6s. per share for the half-year ended June 30 has been declared. The transfer registers will be closed from 4th to 13th inst. inclusive.

RAND CENTRAL ELECTRIC WORKS (LTD.)—Mr. H. Rogers has been appointed secretary of this company in place of Mr. H. Militz, resigned.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has ordered 20,000 7 per cent. cumulative £10 fully-paid preference shares (Nos. 1 to 20,000) of the *British Aluminium Co. (Ltd.)* to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to £200,000 5 per cent. first mortgage sterling debentures of £100 each of the *Castner Electrolytic Alkali Co. (U.S.A.)*, and the provisional certificates for £100,000 4½ per cent. debenture stock of the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)* The committee has also been asked to appoint a settling day in the further issue of 10,000 £5 shares of the *Calcutta Electric Supply Corporation (Ltd.)*, and to allow the further issue of 21,902 ordinary £5 fully paid shares (Nos. 32,099 to 54,000) of *Crompton & Co. (Ltd.)* to be quoted in the official list.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD).—An interim dividend at the rate of 10 per cent. for the half-year ended June 30 (payable Sept. 1) has been declared.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	July 28	4,637	+ 131	3	14,024	+ 570
Blackpool Corporation...	„ 26	1,225	+ 352	17	11,577	+ 2,707
Blackpool and Fleetwood	„ 28	1,350	+ 231	4	4,592	+ 139
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 29	592	+ 174	17	8,543	+ 1,799
Brisbane Trams	June 13	1,809	+ 525	23	42,554	+12,102
*Bristol Trams & Carriage	July 27	3,544	+ 140	4	13,975	+ 161
*Buenos Ayres & Belgrano	„ 1	2,125	- 125	26	58,612	+ 4,290
City & South London Ry.	July 29	1,610	+ 652	4	5,905	+ 2,184
Cork Elec. Trams	„ 26	526	+ 22	30	11,615	+ 1,216
Dover Corporation	„ 28	270	+ 17	17	3,694	+ 327
Dublin & Lucan Rly. ...	„ 21	126	+ 30	3	367	+ 96
Dublin United	„ 27	4,001	+2,633	4	15,003	+ 3,978
Dublin Southern Dist....	„ 27	1,252	+ 77	4	4,545	+ 275
*Glasgow Corporation ...	„ 28	8,511	+ 363	...	...	...
Hull Corporation	„ 28	1,359	+ 840	4	5,407	+ 3,199
*Liverpool Corporation...	„ 21	8,884	+ 725	29	214,726	+25,753
Liverpool Overhead Rly.	„ 29	1,671	+ 74	4	6,864	+ 525
*Sheffield Tramways	„ 29	2,536	+1,063	30	63,046	+21,500
*South Staffs. Trams.....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, July 25.	Price Wednesday, Aug. 1.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 1. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	... ...	... ...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American.....xd	59 62	58 61	6 0 6	Feb., May, Aug., Nov.	...	...
£3,088,640	Stock	30/0	Do. Preferred .....xd	112 113	110½ 111½	5 7 7	„ „	11⁹⁄₁₆	110½
£3,088,640	Stock	27/0	Do. Deferred	1¹³⁄₁₆ 1¹⁵⁄₁₆	11⅝ 12⅛	11 0 5	„ „	12⅛	11⅝
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	102⅜	101½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15½ 16½	15 16	6 5 0	„ „	15⅛	15⅛
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100⅝ 104⅝	100⅝ 104⅝	4 6 7	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 11⅝	5 19 2	Jan., Apr., July, Oct.	...	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	148 153	145 150	4 13 4	Jan., Apr., July, Oct.	149	146
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	96 99	96 99	3 10 8	„ „	9 ½	97
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	112½	...
250,000	10	2/6	Eastern Extension.....	14⅛ 15	14⅛ 15	4 13 4	Jan., Apr., July, Oct.	15	...
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock.....xd	112 117	110 115	3 9 7	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909 ... ...xd	100 103	99 102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	100⅞ 103⅛	100⅞ 103⅛	3 17 8	May and November ...	...	...
180,127	10	2/6	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11⅝	...
180,042	10	3/0	Do. 6 per Cent. Preference	15 15⅛	15 15⅛	3 18 8	„ „	...	...
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July.....	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)..	98 101	98 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	52 56	52 56	4 9 3	May and November ...	51	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7⅞ 8⅛	7⅞ 8⅛	4 14 1	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	93 101	98 101	5 0 4	March and September	100½	...
30,008	2½	...	West Coast of America.....	¼ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 13 7	January and July.....	...	...
88,321	10	1/0	West India and Panama	⅝ ¾	⅝ ¾	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	... ...	... ...	4 15 3	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜ 15⅛	14⅜ 15⅛	4 11 10	Mar., June, Oct., Dec.	15	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2⅜ 3⅜	2⅜ 3⅜	4 5 9	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	... ...	... ...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National.....xd	4⅜ 5⅜	4½ 5	6 0 0	February and August	4⅜	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference xd	13 15	12 14	4 5 9	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference xd	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. xd	5 5⅛	4⅛ 5⅛	4 17 7	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December ...	98½	...
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4¾ 5¼	4¾ 5¼	6 13 4	July	...	...
16,689	5	2/6	Do. 5% Cumulative Preference.....	5 5⅛	5 5⅛	4 10 11	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, July 25.		Price Wednesday, Aug. 1.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 1.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	El'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	⅞	⅞	⅞	...			
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 3			
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10			
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0			
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September		
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6	6½	6	6½	...			
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9½	10½	9½	10½	4 5 9	February and August	10½	9½
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	⅞	5½	5½	3 18 2			
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½	7½	6½	7½	4 0 0	March	7	6⅛
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107	110	107	110	4 1 8	June and December		
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 20 yr. Gold Bonds (red.)	110	110	110	110	4 10 11	April and October		
70,579	10	8/0	City of London Electric Lighting Ord.	8	9	8	9	4 8 11	February and August	8⅛	8½
40,000	10	6%	Do. 6 per Cent. Cumulative Pref. xd	12	13	11½	12½	4 16 0	January and July		
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	123	128	3 18 5	June and December		
40,000	10	3/0	County of London and Brush Prov. Ordinary	8½	9½	8½	9½	4 4 3			
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12½	11½	12½	4 16 0	March and September	11⅞	11⅜
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109	111	107	110	4 1 3			
15,000	5	10%	Kensington and Knightsbridge Ordinary xd	12½	13½	12	13	4 1 6			
10,000	5	6%	Do. 6 per Cent. 1st Preference xd	6½	7½	6½	7	4 2 7	January and July		
110,000	3	...	London Electric Supply Ordinary	1	1⅛	1	1⅛	...			
49,840	5	3/0	Do. 5 per Cent. Preference	4	4½	4	4½	6 13 4			
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98	100	99	100	4 0 0	Mar., June, Sept., Dec.		
85,000	10	5/0	Metropolitan Elec. Supply Ord.	14	15	14½	15½	3 11 0	April and October	14⅞	14⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111	114	111	114	3 19 11	June and December		
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96	98	99	98	3 11 6			
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March		
10,000	5	5/0	Oxford Electric Ordinary	6⅛	6½	6½	6⅝	3 16 11			
300,000	1	8%	Rand Electric	1/16	1/8	1/16	1/8	10 13 4			
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	January and July		
15,000	$100	$2	Royal Electric Company of Montreal Shares	165	185	165	185	4 6 6	April and October		
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1			
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary xd	14	15	14	15	4 16 8	February and August	14⅛	14⅛
20,000	5	3/6	Do. 7 per Cent. Preference xd	8½	9½	8	9	3 17 8		8⅛	
£12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...			
£250,000	Stock	...	Do. 4% Debentures xd	85	95	85	95	4 4 3			
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3½	4½	3	4	...		3⅛	
79,900	5	3/0	Westminster Electric Supply Ordinary	12½	13½	12½		5 4 0	March and September	12⅝	
			ELECTRIC MANUFACTURING &c. COMPANIES.								
70,000	1	1/10d.	Alliance Electrical Co. 5% Cum. Pref.	1	1⅛	1	1⅛	4 0 0			
125,000	1	7/8d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞	⅞	⅞	⅞	6 17 2	March and September		
85,000	1	...	British Electric Works Co. Ordinary	⅛	⅛	⅛	⅛	...			
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅛	⅛	⅛	⅛	...			
£50,000	100	4½%	Do. First Mortgage Debentures	97	99	97	99	4 4 2			
40,000	5	15/0	British Insulated Wire Ordinary xd	11½	12½	11½	12½	4 0 0			
40,000	5	3/0	Do. 6 per Cent. Preference	5½	6½	5½	6½	4 16 0			
100,000	5	1/6½	British Westinghouse 6% Preference	4½	5½	4½	5½	...			
90,060	2	1/2½	Brush Electrical Engineering	1⅜	1½	1⅜	1½	4 5 1	September		
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	2	2½	2	2½	5 6 8		2⅛	
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109	114	109	114	3 19 10	February and August		
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	103	101	103	4 7 5	June and December	101	
32,000	5	10/0	Callender's Cable Construction Ord.	13	14	13	14	5 7 2		13⅛	
20,000	5	3/6	Do. 5 per Cent. Cumulative Preference	5½	5½	5½	5½	4 6 11			
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	114	110	114	3 18 11	November and May		
900,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1	1⅛	1	1⅛	6 8 0			
£150,000	Stock	7/0	Do. 4½ per Cent. First Mort. Deb. (red.) xd	99	103	97	100	4 10 0			
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	⅜	1	⅜	1	7 0 0	March		
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	½	1⅛	½	1⅛	5 6 8			
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3⅜	4⅛	3⅜	4⅛	5 5 10	January and July		
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	102	99	103	4 19 0			
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	½	1⅛	½	1⅛	5 6 8			
99,261	5	1/9⅛	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August		
17,189	5	2/9½	Do. (£5 paid)	3½	4⅛	3½	4⅛	6 13 4			
£344,022	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91	93	91	93	4 6 0	June and December		
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	48	52	68	72	...			
26,100	5	6/0	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛	5	4⅛	5	6 0 0	Half-yearly	4⅛	
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	91	102	93	103	4 8 3			
112,100	2	1/2⅜	Electric Construction Co. (Limited) xd	2	2⅛	2	2⅛	5 6 8	January and July		
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3	3⅛	2⅝	2⅞	4 6 2	July		
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102	103	102	105	3 16 2	January and July		
30,000	5	11/0	Henley's Telegraph Works Ordinary	13	14	13	14	6 15 9	February and August	13⅛	
50,000	5	1/6	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3			
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110	114	110	114	3 18 11			
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11		21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101	101	101	101	3 17 10	March and September		
37,350	12	13/0	Telegraph Construction and Maintenance xd	35	39	35	39	4 12 4	March and July		
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101	101	101	101	3 16 11	January and July		
20,000	5	9/0	Do. Manufacturing Ordinary	10	11	10	11	5 9 1			
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	5⅞	5⅛	5⅞	4 6 11			
30,000	5	7/0	Willans and Robinson Ordinary	10⅛	11⅛	10⅛	11⅛	5 4 4	April and October	10⅛	
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6⅛	7	6⅛	7	4 5 9			
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	105	107	4 0 4	May and November		
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	10/0	Blackpool and Fleetwood Tramways	17½	18½	17	18	4 8 11			
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103	105	103	105	4 17 1			
50,000	10	9%	Bristol Tramways and Carriage Ordinary	22	23	22	23	3 3 10	February and August		
25,000	10	4%	Do. Cumulative Preference (fully pd.)	10½	10⅝	10⅝	10⅝	3 15 4			
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	120	118	120	3 6 1	February and August		
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½	10⅝	10½	10⅝	4 13 0	May and November		
80,000	10	11/0	British Elec. Trac Ord. (Nos. 1 to 80,000)	14	15	14	15	4 0 0		14⅜	
15,000	10	8/7½	Do. (Nos. 60,001 to 75,000)	14	15	14	15	...			
50,000	10	6/0	Do. 6% Cum. Pref.	12	13	12	13	4 12 4	February and August	12⅞	12⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123	126	123	126	4 0 4		126	
£150,000	Stock	...	Do. (Issued Feb. 5, 1900)	121	124	121	124	...			
40,000	5	2/8 5/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞	5⅛	4⅞	5⅛	5 17 1			
27,500	5	...	Do. "B"	4	4⅛	4	4⅛	...			
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	105	103	105	4 15 0		105	
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs (all pd.)	96	99	96	99	5 1 0			
206,297	10	3/0	Central London Ordinary	9	9½	9½	10	3 0 0	June and December	10	8⅛
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	57	60	58	59	2 6 7	February and August	59	57
37,500	10	1/5 7/10	Do. (Nos. 32,501 to 60,000)	6	7	6	7	2 2 0			
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0			
£200,000	Stock	5%	Do. (1898)	132	137	132	137	3 13 8			
£344,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120	125	120	125	3 4 5	May and November		
20,000	10	8¾%	†Imperial Tramways Ordinary	22	23	22	23	3 6 8	March and September	23	21
10,000	10	6%	† Do. 6 per Cent. Preference	14⅜	15½	14⅜	15½	3 17 5			
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July		
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	1/8	¼	1/8	¼	4 1 0 0	March and October		
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/8	¼	1/8	¼	4½ 0 0		¼	
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10	10½	10	10½	4 17 6	May and November		
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9⅝	9¾	9⅝	9¾	3 19 10	February and August		
10,000	10	5%	Do. 5 per Cent. Preference	13⅛	13⅝	13⅛	13⅝	3 14 1			
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103	105	103	105	3 16 2	January and July		
24,000	5	...	New General Traction Ordinary	3⅛	3⅜	3⅛	3⅜	...			
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4⅜	5⅛	4⅜	5⅛	5 14 3	May		
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16	18	16	18	...	February and August		
4,000	10	5/0	Do. 5 per Cent. Preference	10⅝	10⅞	10⅝	10⅞	4 13 0			
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...			
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August		
£540,000	Stock	3%	Waterloo and City Ordinary	93	93	93	93	3 3 6	June and December		

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,160. [No. 16, Vol. XLV.] FRIDAY, AUGUST 10, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

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NOTES.

THE chief electrical events probably of the past almost uneventful week have been the severe thunderstorms. With these there has been the usual crop of stories of the vagaries of globular lightning. Globe lightning is a form of atmospheric discharge which has never yet been fully explained, partly, no doubt, on account of its rarity, and also on account of the difficulty of producing it experimentally. MAX TOEPLER, who is undoubtedly the highest living authority on atmospheric discharges, deals with the matter fully in the course of a lengthy work on continuous discharges in air, briefly referred to in Mr. FOURNIER D'ALBE'S notes in another column of this issue. He points out the analogy between globular lightning and certain forms of the "brush arc discharge" discovered by him. Briefly, his view is this: An ordinary lightning flash leaves behind it a track of comparatively highly conducting air. A continuous and slow discharge passes along that track for some time after the flash. Occasionally, a place occurs in the track where there is a high resistance, and when the quantity discharged is adequate, this place glows, and continues to glow while the slow discharge proceeds.

THIS luminous place is the "globe lightning," which, as we know, is usually described as upright and elongated. Its apparently free motion along the ground is due to the facility with which the foot of the track travels along the ground with the wind or with any change in the electrostatic forces. That it should approach conductors and "strike" human beings is quite natural. That it is sometimes described as finally "exploding" is probably due to the fact that the phenomenon is destroyed by a final ordinary flash with its accompanying thunder. The current in the globe is probably not great. Prof. TOEPLER arrives at some idea of it by comparing its duration with that of an ordinary flash, which, as we know, discharges some 60 coulombs to 100 coulombs of electricity. Considering that the globe lasts from 5 seconds to 30 seconds, we should expect a current of 2 amperes to 20 amperes. Comparing its size and luminosity with the brush arc, the current would come out as about 15 amperes. But the author points out that even with only 0·01 ampere a faintly luminous mass of the size of "a child's head" can be maintained.

WE referred recently to a Paper read by Dr. M. I. PUPIN, describing experiments he had carried out on an artificial cable, in which, besides adding capacity to secure a true imitation of a submarine line, he had tried the effect of the distributed inductance prescribed by Mr. O. HEAVISIDE. Mr. HEAVISIDE has, one would think, already discussed sufficiently the mathematics of this particular subject, but Dr. PUPIN has not been satisfied to take these conclusions as he finds them, and has devoted a mathematical investigation (part of which we have been compelled to omit from the abstract of his Paper in another column of this issue) to determine what is the theoretical maximum distance apart at which inductance coils may be inserted in the cable to obtain the desired effect of distributed inductance. He obtains the result that there should be several coils in a half wave-length, a conclusion which we think must be fairly obvious to those who have followed Mr. HEAVISIDE'S writings on the subject. Moreover, as one of the factors from which this wave-length has to be calculated cannot be predetermined with extreme accuracy—we refer to the inductance of the cable—it follows that the number of coils per mile will always have to be determined more or less by experiment.

WE must of course accept Dr. PUPIN'S assurance that due precautions have been taken to ensure correct conditions in the experiment with which he tested his conclusions, although we think he would have been wiser had his apparatus not been made so compact. However, he has no doubt taken the precaution of testing that there is no transformer effect analagous to

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that in the Langdon-Davies phonophore, by trying if telephonic transmission can take place by means of the coils when each half of the circuit is interrupted in the middle. If, then, Dr. PUPIN's apparatus can be considered identical in its electrical properties with a submarine cable he is to be greatly congratulated on his work, as he will then have demonstrated that better speaking can be obtained on an inductive line 250 miles long than on a non-inductive one of less than half the length, and we trust that he will find an opportunity to perform a similar experiment upon an actual long-distance telephone cable.

University of Glasgow.—The session opens on October 18th. Prospectuses, &c., can be obtained from the assistant clerk.

University College (London).—The 1900-01 session begins on October 2nd. Prospectuses may be obtained ftom the secretary (Mr. J. M. Horsburg).

Taunton Electricity Works.—The new machinery at the Taunton Corporation electricity works will be formally set in motion by the Mayoress on the 15th inst.

Glasgow and West of Scotland Technical College.—The next session opens on September 25th. Some particulars of the courses of instruction are given on another page.

University of Birmingham.—The session 1900–1901 commences on Oct. 2. Some particulars of the course of instruction in engineering are given in our advertisement columns, and a detailed syllabus will be forwarded on application to the secretary.

The Paris-Berlin Telephone.—The telephone service between Paris, Frankfort, and Berlin was opened to the public on Monday last. The charge for the use of the line for 3 minutes between Frankfort and Paris is 4fr., and between Paris and Berlin 6fr.

Parliamentary Naval Boiler Committee.—Among the members of the recently-appointed Committee to inquire into the merits of the boilers in Her Majesty's Navy we notice the name of Prof. A. B. W. Kennedy. The Committee will be empowered to report, among other matters, as to the suitability of the Babcock & Wilcox and the Niclausse types of boilers.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

Institution of Electrical Engineers—Students' Grants.—The Council has awarded the promised grant of £5 towards the expenses of a visit to the Paris Exhibition, announced in a previous issue of this journal (see *The Electrician*, July 20, p. 469), to each of the following students of the Institution:—J. F. Avila, A. Buckney, F. H. Clough, R. Fisher, A. J. L. Hurst, J. T. Urwin, T. L. James, F. K. Jewson, L. R. Lester, C. N. Nettley, R. L. Pearson, M. Solomon, C. T. Stephenson, H. J. Thomson, W. A. Toppin, A. J. Tracey, S. A. Tunbridge, G. E. Turnbull, J. H. West, and F. P. Whitaker.

Personal.—The Government of India has sent Prof. J. Chunder Bose, of Calcutta University, as delegate to the International Congress of Physicists, at the Paris Exhibition, and to the meeting of the British Association at Bradford. Prof. Bose is now in Paris.——We learn that Prof. S. H. Short has been appointed by the Commissioner-General of the Paris Exhibition an official delegate of the United States to the International Congress of Electricians at Paris on the 18th inst. It will be remembered that Prof. Short served on the International Congress of Electricians at Chicago in 1893, as a member of the Advisory Board. He was also a member of the International Congress at Philadelphia in 1884.

Proposed Duty on Raw Copper in Germany.—According to the *Elektrotechnischer Anzeiger* a number of German copper producers are agitating for a duty of 6 per cent. to be imposed on raw copper. Our contemporary does not favour this imposition, stating that not a quarter of the copper required in Germany is produced from German raw copper. It adds that German copper is used only for the older branches of the industry, such as the manufacture of brass pipes, &c., not being as suitable for electrical purposes as American copper, which, it states, is used exclusively in the German electrical industry. The following are among the figures given: In 1899 23,460 tons of copper were produced in Germany, and about 103,000 tons were used. Of this between 30,000 tons and 35,000 tons are estimated as having been required for electrotechnical purposes. German cable makers would be severely handicapped in their competition with foreign firms if the proposed duty is imposed.

Recent Thunderstorms.—Considerable damage to property has resulted from the recent thunderstorms throughout the country. On Sunday evening a severe storm swept over Derbyshire, and at Alfreton the schoolmaster's house was struck, portions of the roof being stripped off, the gas pipes being broken and the gas ignited, and three fire-places being blown out. No one was injured, however. At Boston, Lincolnshire, the same evening, St. Botolph's Church, better known as "Boston Stump," was struck by lightning, the discharge striking the high tower formerly used as a lighthouse. A heavy mass of stonework was dislodged and fell through the roof of the church, just missing the font. The Dead March in "Saul" was being played at the time in memory of the late Duke of Coburg, and had it not been for this the congregation would have been dispersing, and considerable loss of life must have ensued. Fortunately no one was injured.

The Utilisation of Blast Furnace Gases.—In a Consular report on the trade of Frankfort-on-the-Main, reference is made to the extending employment of blast furnace gases in Germany in gas engines for the generation of electrical energy. It is stated that gas engines on the Deutz system, built for this purpose, have been most successfully used in the large ironworks at Hoerde, and at the Friedenshütte, in Upper Silesia, as well as more recently in Oberhausen, Düdelingen, Völkingen, Donnersmarck, Seraing, the Rhenish steel-works at Ruhrort, and in other places. It is stated that at full load this gas engine uses only 2·6 cubic metres of the gas per B.H.P., and at one-third load 3·5 cubic metres, and that there is no unusual wear and tear in the working parts. Some of the works already mentioned are putting in additional gas engines on the same system, and the Kombach works in Loraine, in which are seven large blast furnaces, is about to erect two 600 H.P. four-cylinder gas engines for blast furnace gases.

Summer Meeting of the Institution of Junior Engineers.—The following programme has been arranged for the summer meeting of this Institution at Newcastle-on-Tyne. The meeting commences on Monday, the 13th inst., with a reception at the Town Hall by the mayor, followed by a visit to Messrs. Swan and Hunter's works, and the works of the Newcastle-on-Tyne Electric Supply Co. On Tuesday the Institution will visit Messrs. Sir W. G. Armstrong, Whitworth & Co's. works at Elswick, also the engineering department of the Durham College of Science and the works of the Newcastle and District Electric Lighting Co. On Wednesday there will be a river trip to view the Tyne Improvement Commissioners works, and on Thursday an excursion to Sunderland to see the works of the River Wear Commission. The meeting concludes on Friday, the 17th inst., with visits to the works of the United Alkali Co., and the preliminary works of the Corporation electric tramways, while in the evening a dinner will be given at the County Hotel, the president, the Hon. C. A. Parsons, F.R.S., in the chair.

Visit of the American Institute of Electrical Engineers.—On page 469 of our issue for July 20 we gave some particulars of the visit of the American Institute of Electrical Engineers. The following further particulars of the programme have been supplied us by the Secretary of the Institution of Electrical Engineers, who are entertaining these American visitors: The river party next Sunday will be given at Henley, electric launches taking a short run (probably to Shiplake and back)

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before the lunch, which will be at the "Red Lion"; after lunch the party will proceed to Boulter's Lock by launch, and will return to town by train from Maidenhead. The dinner on the 13th inst. will be at 7 for 7:30 p.m. at the Princes' Restaurant, Piccadilly. During the morning of the same day visits will be made to the laboratories of the Board of Trade, or (alternatively) to the telegraph department of the General Post Office, and in the afternoon to the Central London Railway, and to the Davies-street station of the Westminster Electric Supply Corporation. On August 14 the party will visit the School of Military Engineering and the Royal Dockyard at Chatham, and will partake of the hospitality of the Royal Engineers' mess at lunch. The members of the party have been most kindly invited to a reception by Lady Fraser in the afternoon.

Connecting up Accumulator Plates.—Dr. O. Schmidt, in a long article on this subject in No. 12 of the *Centralblatt für Accumulatoren und Elementenkunde*, states that the only rational method of effecting this at the present time is by autogenous soldering, and that in accumulator works the oxygen and hydrogen gas required for the process are best produced electrolytically. Small gasometers should be employed to equalise the pressure and for storing the gases when they are produced more rapidly than they are required for soldering purposes. In the Tudor works such a system is employed, and by the arrangement of the apparatus it is quite impossible for the gases to mix until they meet in the blow-pipe flame, and the blow-pipe is so constructed that the proportion of each of the gases passing into the flame can be regulated. The advantage of this is that an economy in the consumption of oxygen, which is the more expensive gas, can be effected, for, as Dr. Schmidt points out, one-fifth part by volume of atmospheric air *is* oxygen, and therefore it is not necessary to supply the theoretical proportion of this gas to the flame. The quantity of gas consumed per hour by the blow-pipe in the works amounts on an average to 100 litres of hydrogen and 88 litres of oxygen. Where soldering has to be effected outside the works portable steel bottles are used for the conveyance of the gases, which are compressed into them under a pressure of from 120 atmospheres to 150 atmospheres. A description is given of taps for regulating the pressure of the gas on its release from the bottles, and also for the management of the blow-pipe flame.

Earthing Distribution Networks.—At the recent meeting of the National Electric Light Association, a report by a committee appointed to consider the question of "grounded circuits" was read. The report was signed by Messrs. W. Brophy and J. I. Ayer, the late Lieut. S. Dana Greene having been the third member. "Some very eminent professors, nearly all fire insurance offices and inspectors, and some prominent workers in the electrical field" in America, argued against the practice of earthing the middle wire, characterising it as extremely dangerous. Others, less prominent perhaps, says the report, but having more practical experience with the actual operation of three-wire systems, took the opposite view. Although nearly all fire insurance boards issued their edict against earthing the middle wire, this custom has become almost universal in America, experience having shown that it has not increased the fire hazard or losses by fire, but perhaps decreased them. The committee, therefore, recommends earthing the middle wire, being of the opinion that as long as high-grade insulation is maintained in house wiring, little danger need be apprehended. The committee also reports on the question of earthing one side of secondary circuits in transformer systems. Some deaths and fires have occurred from the passage of the primary current into the secondary circuits, and in each case which the committee have investigated no evidence of the leakage had been previously given by an increase of the candle-power of the lamps or otherwise. The report continues:—

> Various plans have been proposed and devices tried to prevent accidents from this cause, the most effective step being the improvement of the insulation of the transformer. The "grounding of the outer case," connecting the middle of the secondary coil to "ground," and a "grounded" magnetic shield have all been tried to some extent and with varying degrees of success. Where transformers are placed in manholes and connected to underground lead-covered cables the case can be securely grounded to the lead covering of such conductors; but when they are placed on poles, structures, roofs, and walls of houses, it is very difficult, if not impossible, to connect either coils or case to a good and secure "ground." Could this end be gained the liability of breaking the ground wire would be very great, and when broken such wires would be a source of danger. No magnetic electric device for automatically grounding the secondary in case the high-potential current passes over the same known to your committee has thus far proved reliable. That type that is constantly in circuit, owing to its almost constant consumption of energy, is objectionable, while those that depend on a sudden increase of voltage are unreliable.

It concludes with the expression of opinion that, although permanent "grounding" of one side of secondary circuits is not an absolute preventative of accidents to person and property, yet the committee firmly believes it to be a step in the right direction.

Electrical Power Transmission in Workshops.—An interesting report on the relative advantages of electric and shafting driving in workshops was presented by a committee of the Master Mechanics' Association at a recent convention at Saratoga. The report enters into details of the various advantages and disadvantages of methods of driving, and finishes up with the following "Conclusions":—

> 1. In a small shop, consisting of practically one building, having an equipment of small tools for light work only, electric transmission will not be found a paying investment. In such a shop, however, an electric lighting dynamo will be a convenience, and may be utilised to run a few labour-saving electric tools, such as a cylinder-boring outfit, a turn-table motor, &c.
>
> 2. In an extensive railway shop plant the installation of a central power station and electric transmission will always be found advisable, as it will not only result in the most economical system in respect to operation, but will make possible far more important shop economies, namely, an increase in quantity and quality of output and a reduction in cost of handling the same.

In the course of the report an interesting table is given, prepared from tests made of the power required to drive typical railway shop tools both for iron and wood working. The greater number of these figures are taken from tests at the Baldwin locomotive works and the Pennsylvania Railroad Co.'s works. It is also stated that, as a rough guide in laying down power plants in workshops, the horse-power of the generating station per man for railway shops averages about 0·4. The following is the table referred to:—

Tool.	Nature of work.	Horse-power required. Empty	Lght load.	Full load.	No. of cutters
70in. wheel lathe	Wheel centre[1]	...	4·4	7·9	2
	32in. wheel centre[2]	...	4·7	5·8	2
	56in. wheel centre	1·5	5·2	6·2	2
Horizontal lathe	56in. wheel centre[3]	...	4·3	7·1	1
Large d'bl. frame planer	Two frames[3]	11·0	...	21·6	2
Slotter, 18in. stroke	Frames[3]	2·3	5·0	10·3	1
Slotter, 12in. stroke	Wrought iron, 6in. thick	1·5	2·1	6·5	1
36in. planer	Frames	3·4	4·2	7·4	1
		3·4	...	11·3	2
Drill press	1in. drill, wrought iron	0·97	1·94	2·9	1
	1½in. drill, wrought iron	0·97	1·92	2·2	1
	2¼in. drill, wrought iron	0·97	1·94	2·85	1
Boiler-plate shears	⅝in. plate steel	3·5	6·0	19 0	1
Boiler-plate rolls	⅜in. by 10ft. 6in. long, steel	4·5	14·4	19·8	...
Jib crane, 10 ton, 10 H.P. motor	Lifting 10 tons	1·2	...	13·0	...
	Lifting 7 tons	1·2	...	11·0	...
Jib crane, 6 ton, 8 H.P. motor	Lifting 6 tons	1·2	...	11·6	...
Travelling crane, 5-ton	Lifting & carrying 4 tons	11·9	...	19·3	...
Planer	Empty	3·4	...	...	...
	1 tool	...	...	7·4	...
	2 tools	...	...	14·0	...
Shafting	Empty	15·0	...	...	...
	6 planers	...	...	20·0	...
	4 milling machines	...	...	26·0	...
	2 lathes	...	...	30·0	...
	1 buff wheel	...	...	34·0	...
Planer & siding machine	6in. oak flooring[4]	8·0	...	32·0	...
24in. planer	12in. yellow pine[5]	2·5	...	11·0	...
Moulding machine	6½in. yellow pine carlin[6]	1·5	...	8·5	...
Daniel 30in. head planer	Oak tender end sill[7]	3·7	...	8·8	...
3-spindle boring mill	Oak, 2in. bitts	0·5	...	2·5	...
Large tenoning machine	Oak end sills[8]	3·0	...	7·0	...
Circ. rip saw, 28in diam.	Oak, 9½in. by ¼in. cut	1·5	...	20·0	...
Band saw blade, 1½in. wide	Oak, 12in. thick	1·5	...	6·0	...

[1] Light cut. [2] ½in. deep cut. [3] Heavy cut. [4] Top and sides planed. [5] Top only. [6] Four sides. [7] Cut $\frac{3}{16}$in. off top. [8] 3½in. by 5in. by 10in. cut.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Continuous Discharges in Air.—When a battery of cells is used as a source of electric energy, the constant element in the circuit is the E.M.F., while the current depends upon a variety of external conditions. The case is reversed on using an influence machine driven at a constant speed, for then the mean current is the constant element, while the E.M.F. is a dependent variable. This fact has been utilised by M. Toepler for investigating the continuous discharge in air at atmospheric pressure as dependent upon the current. This continuous discharge may appear in four different forms—viz., glow, brush, brush arc, and flame arc. All of these may appear both at the positive and negative electrodes, but to simplify matters the author takes care nearly to suppress the effects at one electrode by covering it with a flat bad conductor such as a slate. He is thus enabled to study the effects at the two electrodes independently. As a general rule an increase in the current strength brings about a transition from the glow to the brush, and finally to the brush arc. But this transition is not continuous unless the capacity in the circuit is negligible. Otherwise the three continuous stages are separated by stages of discontinuous spark discharge, and as the capacity increases the discontinuous stages encroach until the brush arc is almost entirely eliminated. Finally, the author deals at length with two forms of natural continuous discharge—viz., St. Elmo's fire and globular lightning.

[M. Toepler, *Ann. der Physik*, No. 7, 1900.]

Electrostatic Lines of Force.—In designing an instrument for plotting electric lines of force, analogous to the magnetic needle, the difficulties are encountered that the forces are small and the charge is not permanent. F. J. Rogers has, however, designed two kinds of "electrostatic needles" which answer very well. The first consists of an aluminium needle bearing at its ends two gilt pithballs. The needle is perforated in the centre and mounted on a horizontal pin stuck into an ebonite rod. With this simple contrivance it can be shown to the student that the lines of force are normal to the surface of a charged conductor, and not normal to the surface of an ebonite rod, and that in the case of two oppositely charged conductors placed near each other the lines of force issue from one conductor, curve over, and end on the other. The second form of needle is even more useful. It consists of a little ebonite rod in place of an aluminium needle, and the pithballs are charged positively and negatively respectively. Thus we have a complete analogue of the magnetic needle. If the neutralising rod of a Voss machine is removed while the machine is running, the inductors change the sign of their charge every few seconds. This change of sign is promptly indicated by the electrostatic needle described.

[F. J. Rogers, *Phys. Review*, July, 1900.]

Continuously-Adjustable Condenser.—L. J. Briggs has designed an adjustable condenser on a modern plan. It is of the mica type, but the usual tinfoil is replaced by slightly curved elastic brass sheets. The effect of this is that the condenser tends to expand, and has to be kept pressed down by a screw press. The process of screwing down and thus flattening the sheets is to increase the capacity of the condenser, and when they are quite flat the capacity in one such instrument is four times the original capacity. The curvature given to the sheet brass by the manufacturer in rolling it for shipment is found to answer very well. The range of capacity may be greatly increased by dividing the condenser into three or four sections, so arranged as to permit their being thrown in multiple by a suitable switch. By dividing the condenser into three sections, the first of which contains three-fourths of the condenser sheets, the second three-fourths of the remainder, and the third section the remainder of the sheets, the range of capacity can be increased 16 times, or the minimum capacity obtainable will be one-sixty-fourth of the maximum. The adjustment will, moreover, be perfectly continuous throughout this range. On account of the double dielectric used (mica and air or oil) the change of capacity is most rapid when the plates are nearly flat.

[L. J. Briggs, *Phys. Review*, July, 1900.]

Uranium Rays.—H. Becquerel has not yet succeeded in obtaining "inactive" uranium. When uranium chloride is mixed with barium chloride, and the barium is precipitated as sulphate, the latter takes down with it the greater part of the radio-activity of the uranium. The question remains as to whether a further application of the same process would eventually result in the uranium being made entirely inactive. Becquerel has therefore applied the same process 18 times over to the same specimen. He found that the barium sulphate precipitated was less and less active, and that correspondingly the loss of activity of the uranium became less and less in proportion to its initial activity. Between the eighth and twelfth operation the variations in activity were sometimes positive and sometimes negative, and could possibly be due to the presence of more or less water, as the salt is hygroscopic. In the case of the unpurified product, aluminium is more transparent for the rays than glass, but the case is reversed in the purified uranium, whose rays obey rather the rules of light than those of Röntgen rays in the matter of absorption. After the fifteenth operation, another decided diminution of activity sets in, bringing it down to one-sixth of the original activity. What happens after the eighteenth operation is not yet known.

[H. Becquerel, *Comptes Rendus*, July 16, 1900.]

Effect of Temperature upon Magnetism.—According to Ewing, the magnetising process of magnetic metals may be divided into three stages. During the first stage the permeability is small, and there is practically no retentiveness. In the second stage the curve of magnetisation rises rapidly, and the permeability is high. In the third stage the permeability decreases and the specimen approaches saturation. The effect of heat is regarded as making the transition from one stage to another occur at lower values of the magnetising force, owing to the vibrations set up and the weakening of the inter-molecular forces. R. L. Wills has investigated the effect of heat on the magnetic properties of certain alloys of iron which at the ordinary temperature had been previously found to give very different magnetic results when in different physical conditions. In wrought iron the permeability increases slightly as the temperature is raised to about 500deg. With fairly strong fields, such that the third stage of the magnetising process is brought on before any heat is applied, there is no appreciable increase in permeability as the temperature rises. But in an alloy containing 2·6 per cent. of aluminium there is not only no increase, but a decrease as the temperature is raised from 360deg. to 489deg. This confirms the impression as to the exceptional character of the influence of aluminium upon iron.

[R. L. Wills, *Phil. Mag.*, July, 1900.

THE SYDENHAM BOILER EXPLOSION.

The four photographs on the opposite page give the history of the disastrous boiler explosion which wrecked the works of the Crystal Palace District Electric Supply Co. on July 25, and was briefly referred to in our issue of July 27. In the boiler-house were five boilers of the locomotive type and one new Hornsby boiler, the locomotive boilers having been put in at the time the station was built in 1893. It is one of these locomotive boilers that exploded, the crown remaining in the boiler-house, and the boiler itself breaking through the wall of the engine-room at the roof level, passing through the opposite wall of the engine-room and settling down in a private garden on the other side. It is premature at present to suggest the cause of the disaster, as the Board of Trade inquiry is still to be held. Fig. 1 is from a photograph of the boiler taken after the explosion; it is seen that the roof was blown away and that the force of the explosion pushed back the adjacent locomotive boiler. Fig. 2 shows the two gaps made in the walls of the engine room, Fig. 3 is from a photograph of the boiler in its present position, and the crown of the boiler that remained in the boiler house is illustrated in Fig. 4. The photographs were taken by Mr. H. Hallier, of High-street, Upper Sydenham. As can be gathered by a study of these, the works will not be in a condition to supply current for some time to come.

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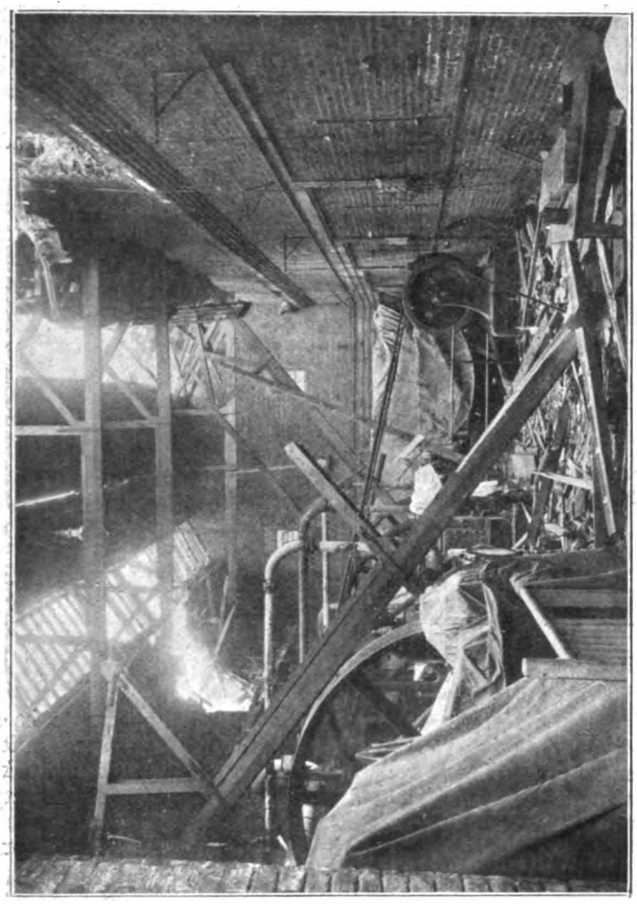


FIG. 2.—ENGINE HOUSE, SHOWING THE GAPS MADE BY THE BOILER.

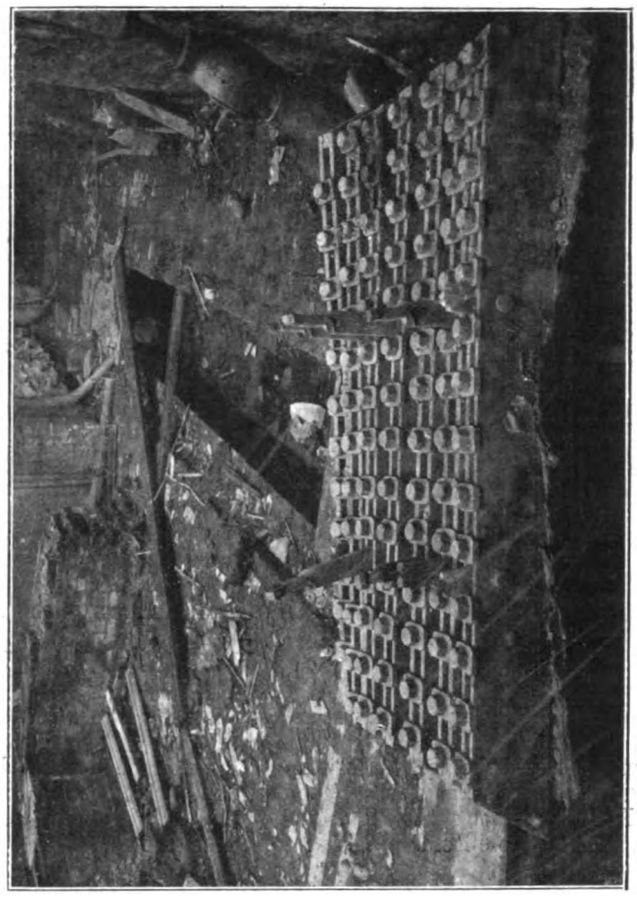


FIG. 4.—CROWN OF THE BOILER REMAINING IN THE BOILER HOUSE.

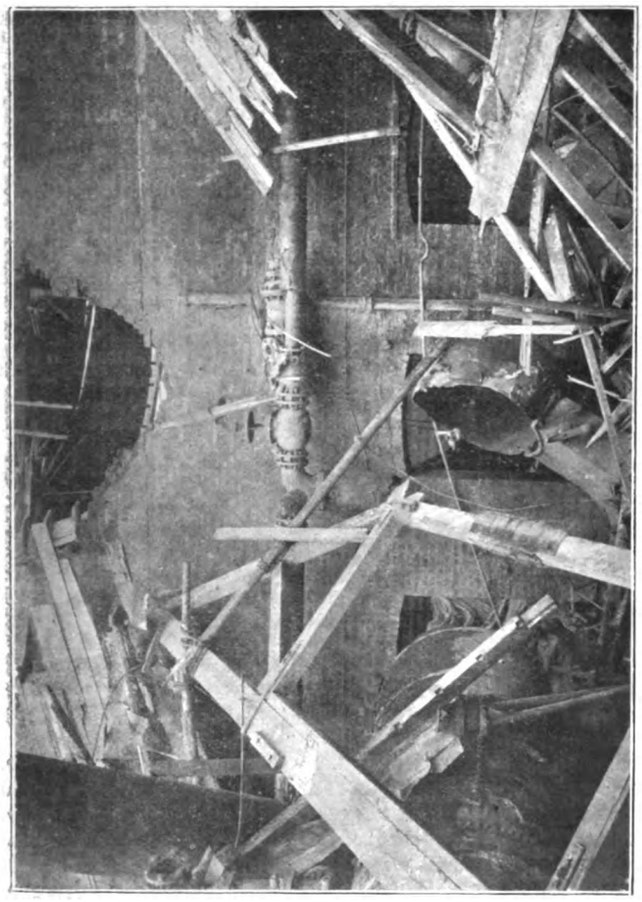
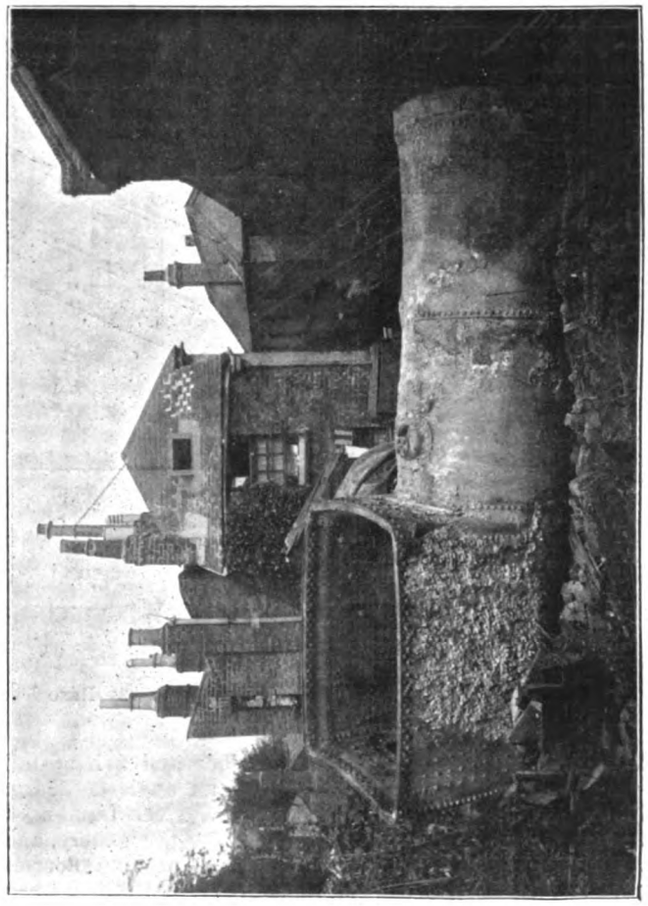


FIG. 1.—BOILER HOUSE AFTER THE EXPLOSION.



IG. 3.—PRESENT POSITION OF THE BOILER.

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THE RENO INCLINED ELEVATOR.

A new attraction has been added at the Crystal Palace (Sydenham) in the form of an "inclined elevator." This, the directors of the Crystal Palace hope, will entice a greater number of people to the gallery of their large building, for it appears that the exhibition of pictures there is much neglected by the public. Elevators of this type have been in operation some years in the United States, and in Harrod's stores in London a somewhat similar one has long been in use, but the "Reno" elevator exhibited at the Crystal Palace is different in some respects from the latter.

FIG. 1.—RENO INCLINED ELEVATOR AT THE PARIS EXHIBITION.

These slats are 3ft. 6in. in length (*i.e.*, in the direction perpendicular to the chain), and are only a few inches in width, corresponding of course to the length of a link of the chain. They have fastened to them a series of rubber-covered longitudinal ridges, each being ¾in. wide and 1in. high, to serve as a comfortable footing for the passengers. Beneath each wooden slat are attached, one at each end, small wheels made of a material termed "Hemacite" which appears to be a compound having rubber and several other substances in its composition. These rollers travel upon angle-iron tracks both on their upward and downward paths, and ensure easy and noiseless running.

The upper sprocket wheel is driven through a belt and spur gearing by a 9 H.P. electric motor of American manufacture, supported on the same framework as the elevator. The speed of the motor is 650 revs. per min., which is reduced to 14 revs. per min. for the sprocket wheel, and the inclined floor moves at about 90ft. per min.

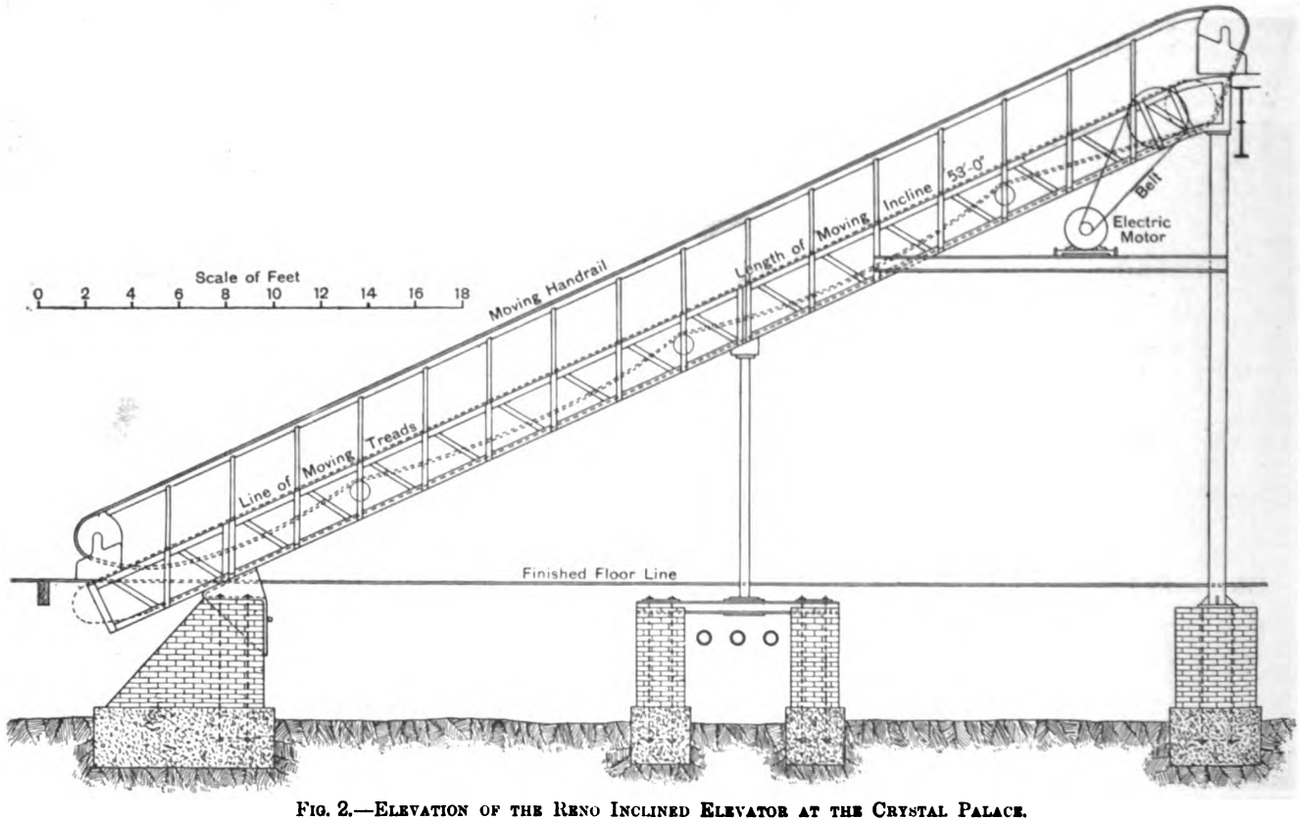

FIG. 2.—ELEVATION OF THE RENO INCLINED ELEVATOR AT THE CRYSTAL PALACE.

The elevator consists of a moving floor and a hand-rail moving at the same speed, inclined at an angle of 25deg. with the horizontal. It is carried on a steel framework bolted at the top to the girders supporting the gallery, and secured in a similar manner below. The moving floor is formed of a series of transverse slats or treads attached to an endless chain which passes over a sprocket wheel at each end.

At the top end of the incline is a cast-iron plate which serves as a landing stage, and forming part of this is a sort of comb

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the prongs of which are curved to follow closely the contour of the chain of slats as it arrives on the sprocket wheel. These prongs are so proportioned that they fit in exactly between the longitudinal ridges on the slats already mentioned, and in this way the feet of the passengers are moved off smoothly on to the landing stage. So perfect is this action that a handkerchief or paper dropped on the incline is not carried round beyond the top but remains on this comb until it is picked up.

In order to prevent the machine from running back if it stops while passengers are on it—for instance, by the motor fuse blowing—a ratchet wheel and pawl are fitted to the lower sprocket wheel, and another simple pawl rests on the under part of the chain at its centre.

The moving handrail is formed of an endless steel chain, covered with a flexible rubber covering, passing over sprocket wheels much in the same way as the inclined track itself, and moving with the same peripheral velocity. In this case, however, it is necessary to provide against the chain being pulled out of its course too much by the passengers, and this is done by the use of links, the under side of which have little cross pieces which slide in groves cut in the fixed bannister which this moving hand-rail covers. At the upper end the moving rail passes down over its sprocket wheel and thus the passenger is obliged to release it.

We are informed that no less than 10,000 people paid a penny to make use of the elevator on Whit Monday, when it was opened to the public.

Although constructed exactly in accordance with the American design, the elevator has been made in this country by Messrs. G. Aston & Son for the Reno Inclined Elevator Syndicate, who are the owners of the British patents. Five of the inclined elevators at the Paris Exhibition are also of the "Reno" construction, and one of these is illustrated in Fig. 1. Fig. 2 shows the general arrangement of the elevator at the Crystal Palace.

The following are the makers' estimates of the horse-power required for working an inclined elevator 19ft. high:—

1·2	H.P.	Elevator free.			
2·36	do.	do.	carrying up	600	passengers per hour.
2·8	do.	do.	do.	1,200	do.
2·95	do.	do.	do.	1,500	do.
5·15	do.	do.	do.	2,250	do.

An interesting modification of this elevator is one specially suitable for docks, &c., in which goods have to be transported from one level to another, the difference in level being not, however, a fixed quantity. One end only can therefore be fixed, and the apparatus consists of a trussed steel framework which carries an endless travelling platform. This passes around suitable wheels at each end, those at the upper end being driven by an electric motor. The machine is mounted on swivelled wheels, and can be moved easily to any position on the dock or in the warehouse; being on a self-adjusting base, it can then be raised to the required position by pulley and tackle. Such an elevator, 38ft. in length, weighs about 45 cwt. This appliance should prove even more useful than the fixed pattern.

FRENCH CABLE PROJECTS.

The report of the Commission appointed to examine the question of the establishment of a system of submarine telegraph lines to connect certain French colonies with the mother country has been recently published. The document is accompanied by a map, a reproduction of which, with translation where necessary, is given in the present issue, showing the cables which it is proposed to lay. After setting out the desirability of the projected connections from a French political point of view, and the position of other Governments in regard to the subject of submarine cables, the following principles are laid down as necessary in dealing with the matter: (1) Submarine telegraph lines between France and her colonies should, where no absolute material impossibility exists, be direct and without landing on foreign soil. Such landings, where indispensable, should be as few as possible, and should be by preference upon the territory of friendly nations deemed the most capable of making their neutrality respected. The lines should be as numerous as possible, so that dependence need not be placed upon the goodwill of a single foreign power. Lines in deep water should be preferred on account of their relative security. Landing places, which are the most vulnerable points of a line, should be as far as possible at fortified ports, and preferentially naval bases. (2) Isolated cables connecting with a foreign system, which benefits by the transit, have little commercial value or political importance, their working being expensive and the service indifferent. Complete and logical systems should be established able to tap commerce and meet the competition of rival lines. The landing places should be concentrated at as few points as possible, so as to form "telegraphic knots" favourable to good working.

A summary of the existing communications available is then given, with the following *résumé* as to the submarine telegraph system "indispensable to the security of our Colonial Empire," that part considered capable of immediate realisation being shown in italic.

Description of lines.		Length in marine miles.	Approximate cost.
Mediterranean System—*Oran-Tanjier*		290	£32,000
Atlantic System.	*Brest-St. Louis* (or *Dakar*)	2,500	680,000
	St. Louis-Pernambuco (or *Cayenne*)	2,500	400,000
	Aerial line—*St. Louis to Kotonou*	2,500	40,000
	Kotonou-Libreville	660	96,000
	St. Louis-Libreville (direct)	660	720,000
Indian Ocean System.	Libreville-Madagascar	4,730	1,480,000
	Madagascar-Reunion	455	72,000
	Reunion-Indo-China	455	1,520,000
Indo-Chinese System—*Hue-Amoy*		1,000	220,000
		15,760	£5,260,000

From the point of view of length of cable, it may be pointed out that cables of 2,500 miles will be slow, even with a heavy core, as well as costly; while the section from Libreville to Madagascar would form the altogether unparalleled span of 4,730 nautical miles. With the largest core which could be safely handled, say 650/400, the speed on such a section would not be more than about two words a minute, and only patriotism run mad could recommend the laying of a line one-third of the way down the west side of Africa, round the Cape of Good Hope, and up past Natal to the southern end of Madagascar. To call such a line strategic is an abuse of language, seeing that it would pass within, perhaps, 100 miles of Cape Town, and would be vulnerable throughout its enormous length.

Then the maintenance of such a cable would certainly be excessively costly. A glance at any telegraph map will show that the English companies have no lines between Cape Town and Durban, round the South of Africa; the fact of the matter being that they have always recognised the unsuitability from a submarine cable point of view of that stretch of coast, on account of the dreaded Agulhas current, which frequently raises dangerous seas and causes heavy rollers to break upon the shore. This current is known to exist at least 120 miles from land, and to lay a submarine line such as the French have projected, beyond its influence would considerably lengthen an already impracticable cable.

From a commercial point of view, there would be no traffic worth speaking of between the French possessions on the West Coast of Africa and Madagascar, while business between France and her colonies could not possibly be sufficient to support such great lengths of cable as are projected. Indeed, if a paying traffic existed, it could not be got through the system proposed. It is significant, however, that no attempt is made in the report to estimate the traffic which would pass over the lines when laid, and with hardly an exception the cables would not touch at points where any business of importance could be expected. Single lines of cable of great length are notoriously unreliable, and in competition with triplicated and duplicated routes, with sections of reasonable lengths, would have no chance at all of building up a traffic which would justify duplication. The fact of the matter is, of course, that there are not a sufficient number of inter-

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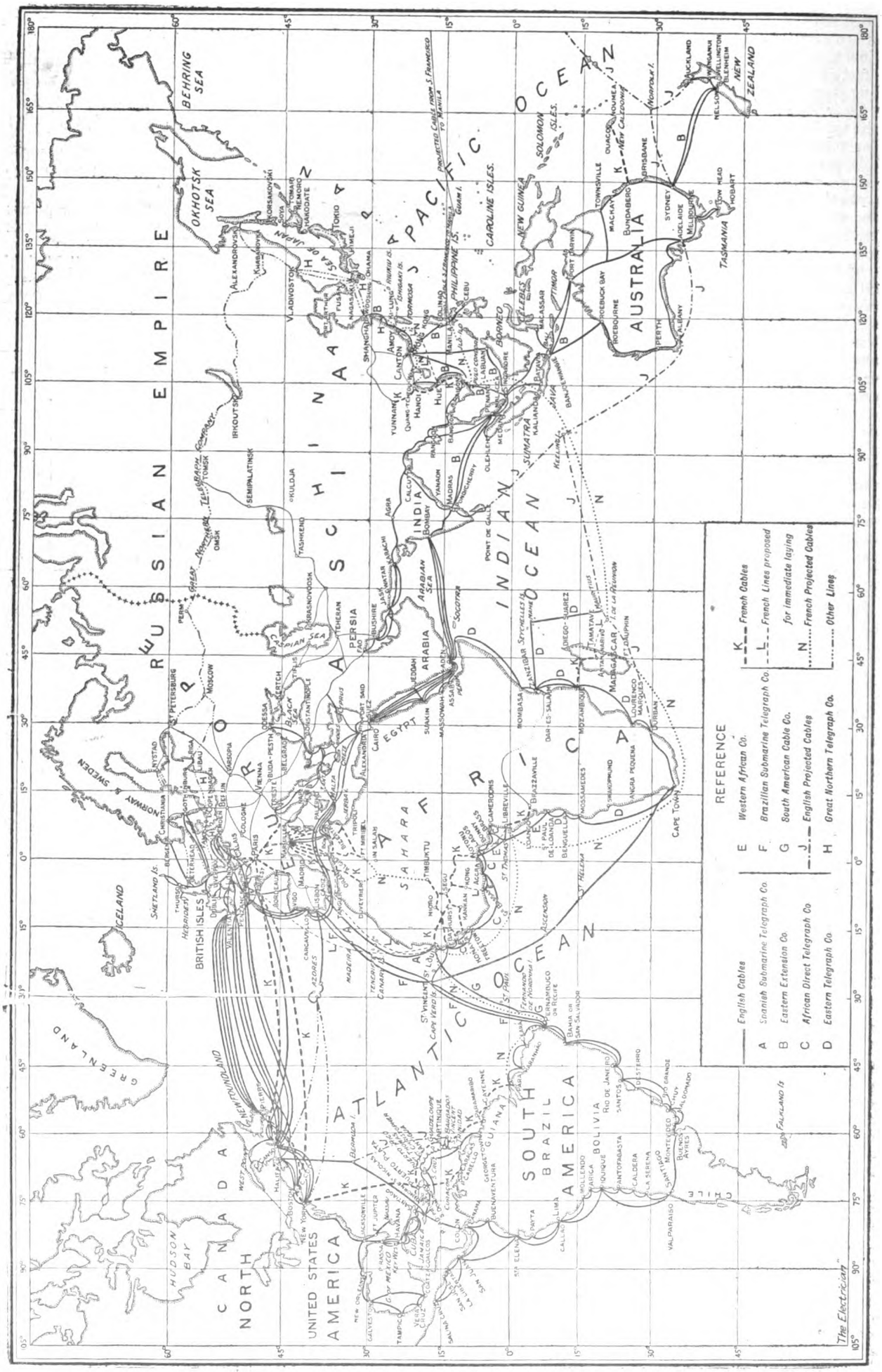

MAP SHOWING EXISTING AND PROJECTED CABLE ROUTES.

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mediate points belonging to our neighbours to permit of a practicable all-French system of cables being established, and that Government pecuniary support of such lines would only be a stupid waste of the money of the taxpayers. Nevertheless, as the word "patriotism" has been invoked, it is by no means certain that an attempt will not be made to carry out the programme indicated.

In considering the capacity for manufacturing telegraph cables in France the report points out that the State has no facilities for work of this kind on a large scale, and recalls that there are two French undertakings for the construction of submarine lines: The Société Industrielle des Telephones has factories at Bezons and Calais, owns the cable ship "Arago," of 3,406 tons (able to carry 1,315 miles of deep sea cable), and can manufacture on the average 80 knots *per diem* of heavy cable and 50 knots of deep sea. In six months time it could increase its production to 45 miles of heavy cable daily, and would then provide a second ship of 5,000 to 6,000 tons. The Grammont establishment at Pont-de-Cherui and St. Tropez could turn out 15 marine miles of cable per day and double its production in three months.

After considering the question of construction and working by the State it is pointed out that the Government project recommends that the work be carried out by private French industry under the direction of the State, and that the working of the lines be entrusted to companies to be formed for the purpose. This is regarded as only a provisional measure to be followed by direct concessions, under State guarantee or annual subsidy, so that the Treasury would only have to bear a diminishing annual charge which might eventually be extinguished by the development of the traffic.

As to the provision of the amount shown above as the estimate for carrying out the programme in question it will be well to quote the report:—

"Of this total of 130 million francs (say £5,200,000) the Government proposes to expend in 1900-1901 a sum of 17 millions (£680,000), which does not include the annual budget credits to cover the deficit on working and maintaining the system.

"If the sum of about 25 millions (£1,000,000) proposed by your Commission be adopted it will require from five to six years at least before the Colonies possess the means of communication at present lacking. This delay would not be unreasonable, and would probably even be imposed by the technical necessities of construction. But modest as is the sum, relative at least to the enormous outlay of England upon its cables, would it not throw too great a burden upon our budgets, weighted already by the new programme of Colonial military defence, with which the cable system has such close relations? The credit of 17 millions (£680,000) proposed by the Government does not appear, one observes with surprise, in the Budget project for 1901. This is certainly an omission which is not of happy augury for the prompt completion of the cables, if the State Budget alone is to bear the charge."

After pointing out that the management of the French cable companies has not inspired public confidence, the Commission remarks that whether it is possible to institute a better state of things either in regard to existing companies, under fresh guarantees, or by forming new companies, the Government alone can say, and concludes by recommending that the project of law submitted to it be approved, with the modifications indicated in its report.

It will be seen that the projected extension of French cable enterprise is of an ambitious and far-reaching character, but that there is altogether lacking in the scheme any real element of soundness, financial or otherwise; and that it is not, even in conformity with the above-quoted principles laid down by the Commission as necessary in dealing with the matter. From the political point of view, the French people may be gratified by the consideration of proposals on so great a scale, but the outlay involved would be out of all proportion to the advantages immediate and prospective, commercial and strategic. One is inclined to adapt the words of one of their own generals: "C'est magnifique mais ce n'est pas la télégraphie."

FALL OF POTENTIAL ALONG TRAMWAY RAILS.

BY E. PARRY.

Assuming an ordinary tramway line construction, consisting of rails laid on a bed of concrete, grouted, and filled in with sets, it is reasonable to conclude that given the conductivity of the rail and the surface conductivity between the rail and the earth, the fall of potential along a line, given the potential difference between the far and near end, may be predicted, and consequently the current in the rail at any point can be ascertained from the potential gradient. The problem is similar to that of a heat conductor exposed to the air, heated at one end and cooled at the other, and other kindred phenomena. The equation which expresses the temperature at any point in a bar subject to the conditions mentioned, and assuming that the temperature is constant throughout a section, is given by Fourier in his "Theory of Heat," chapter I., page 60.

$$v = Ae^{-x\sqrt{\frac{2h}{kl}}} + Be^{+x\sqrt{\frac{2h}{kl}}};$$

where v is the temperature at distance x from the end of the bar,
h is the external conductivity,
k is the conductivity of the material of the bar for heat,
$2l$ is the side of a square bar, and
A and B are arbitrary constants.

By substituting for the above constants the corresponding electrical constants, the same equation expresses fall of potential along an ordinary tramway track, and is the main fact or basis of any phenomena connected with current distribution in the earthed sections of an electrical circuit, subject to disturbing influences due to want of continuity at rail joints, the variation in current density throughout the cross-section of the rail, variation of surface conduction along the rails, and perhaps to a slight extent to electrolytic action; the main disturbing factor, however, as regards a particular line worked electrically is the action of the contact surface of the rest of the track system to which it is metallically connected.

In order to establish a basis for actual cases let us assume in the first place a single rail, laid in earth, which is continuous and isolated from any other rail or system of rails. If an electric current is passed in at one end and taken out at the other end by insulated conductors, a proportion of the current will flow out of the rail between one end and the middle of the rail, and will flow in again along the section between the middle of the rail and the other end. The distribution being symmetrical, the current-density in the rail, under the conditions assumed, will diminish from a maximum at the distant end to a minimum at the middle, and will increase again and attain a maximum at the home end; the point of minimum density in the rail is therefore the point which is at the same potential as the earth, assumed for convenience to be zero in the following investigation:—

Let X = The total length of the rail from end to end.
A = The cross-sectional area of the rail.
L = The surface area of the rail per unit length in contact with the ground.
k = Conductivity of material of rail.
h = External conductivity between rail and earth, *i.e.*, the reciprocal of the specific contact resistance.

Let v be the difference of potential between rail and earth at distance x from one end of the rail.

Consider a lamina whose thickness is dx.

The contact surface is Ldx.

Conductance is $Lhdx$.

Quantity of electricity passing across the contact surface in unit time is $vLhdx$.

This loss must equal the difference between the quantity which during unit time enters the lamina at one face and leaves it at the other face.

The area of the lamina is A.

Conductance is kA.

Quantity of electricity entering the surface at x per unit time is $-k\mathrm{A}\frac{dv}{dx}$.

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The quantity of electricity passing through the surface at $x+dx$ is

$$-kA\frac{dv}{dx}-kAd\left(\frac{dv}{dx}\right)dx,$$

using two terms of the series.

The difference between the quantities entering and leaving the lamina is

$$kA\frac{d^2v}{dx}dx,$$

which is numerically equal to $vLhdx$; therefore

$$\frac{d^2v}{dx}=\frac{Lh}{Ak}v,$$

the solution of which is

$$v=Ae^{-x\sqrt{\frac{Lh}{Ak}}}+Be^{+x\sqrt{\frac{Lh}{Ak}}}.$$

The distribution being symmetrical the point of zero difference of potential as regards the earth is at a distance X/2 from one end. We have therefore the relation

$$0=Ae^{-\frac{X}{2}\sqrt{\frac{Lh}{Ak}}}+Be^{+\frac{X}{2}\sqrt{\frac{Lh}{Ak}}}$$

whence $$B=-Ae^{-X\sqrt{\frac{Lh}{Ak}}}$$

If $$A+B=V$$

$$V=A\left(1-e^{-X\sqrt{\frac{Lh}{Ak}}}\right)$$

and $$v=\frac{V}{\left(1-e^{-X\sqrt{\frac{Lh}{Ak}}}\right)}\left[e^{-x\sqrt{\frac{Lh}{Ak}}}-e^{-(X-x)\sqrt{\frac{Lh}{Ak}}}\right]. \quad . \quad (1)$$

Referring to equation (1)

$v=V$ for $x=0$,
$v=-V$ for $x=X$,
$v=0$ for $x=X/2$.

V is therefore the maximum difference of potential between rail and earth.

Equation (1) is the law of potential differences along a rail under the conditions specified. From this it follows that the current density γ at any point x is $-k\frac{dv}{dx}$ and the current is $kA\frac{dv}{dx}$, the law of current density along the rail is therefore

$$\gamma=-k\frac{dv}{dx}=\frac{kV\sqrt{\frac{Lh}{Ak}}}{1-e^{-X\sqrt{\frac{Lh}{Ak}}}}\left[e^{-x\sqrt{\frac{Lh}{Ak}}}+e^{-(X-x)\sqrt{\frac{Lh}{Ak}}}\right]$$

by placing $x=0$ or $x=X$, we have

$$\gamma=\frac{kV\sqrt{\frac{Lh}{Ak}}}{1-e^{-X\sqrt{\frac{Lh}{Ak}}}}\left(1+e^{-X\sqrt{\frac{Lh}{Ak}}}\right),$$

which gives the maximum current density for any value of V which may be assumed. The minimum current density by our hypothesis is obtained by placing $x=X/2$ and its value is therefore

$$\gamma_{x=\frac{X}{2}}=2\frac{kV\sqrt{\frac{Lh}{Ak}}}{1-e^{-X\sqrt{\frac{Lh}{Ak}}}}Xe^{-\frac{X}{2}\sqrt{\frac{Lh}{Ak}}}$$

Dealing with the practical constants h and k, it will be seen by reference to a Paper on "Earth Returns for Electric Tramways," by Mr. H. F. Parshall,* that the specific resistance of the material of modern steel rails may be taken as 11 times that of copper at 60°F. The specific resistance of high conductivity copper is defined by the recent report of the "Committee on Copper Conductors" to be 6·6788 by 10^{-7} ohms per cubic inch at 60°F., and accordingly the specific resistance of the material of steel rails averages about $7{\cdot}35\times10^{-6}$ ohms per cubic inch. The value of k is therefore taken as $10^6/7{\cdot}35$.

* *The Electrician*, 1898, Vol. XLI., p. 54.

The value of h is not so determinate. Tests carried out between iron plates buried in the earth show considerable variation in resistance. We have, however, to deal in practice with rails laid under particular conditions; the important point is to get an average value measured over long lengths of track, so as to eliminate any resistance due to the earth. As a result of experiments measured over a length of 4 miles and 7 miles of double track, the contact resistance per square inch appears to be about 737,000 ohms per square inch.

The value of h is therefore 1/737,000.

As the construction of tramway lines in Great Britain is practically identical, it is not anticipated that results will vary much from the above, and the method of construction minimises to a large extent any variation which would result from differences in the nature of the soil.

Assuming any particular type of girder rail the value of L/A is approximately constant, and in the following curves it is taken as 3·15 as a result of measurements upon a modern type of girder rail. The value of $\sqrt{\frac{Lh}{Ak}}$ is therefore 1/180,000. In order to construct the voltage and current curves, it is necessary to assume either a maximum value of potential difference between the two ends or the current density at either end; for instance, the Board of Trade limit may be assumed for the maximum potential difference. However, it is found more convenient for the purpose of this Paper to assume a value for the maximum current density, and in the following curves the value of the current density is assumed to be 2·5. Referring to the curves in Figs. 1, 2, 3, and 4, the curve marked γ is the current density curve, and the curve marked v is the potential curve.

With reference to Fig. 1: The total distance is 2 miles, and the ratio of the current midway between the two ends to the current entering is $2{\cdot}36/2{\cdot}5=0{\cdot}945$, and the stray current is, therefore, about 5·6 per cent. of the current entering the rail. The potential difference required on the basis assumed for these curves is 2·24 volts.

With reference to Fig. 2: The distance is 4 miles, the ratio of the two current densities is $1{\cdot}96/2{\cdot}5=0{\cdot}784$, the percentage of stray current is 22 per cent., and total potential difference corresponding to the current density assumed is 4 volts.

Fig. 3 is plotted for a total distance of 6 miles, the ratio of current densities is $1{\cdot}54/2{\cdot}5=0{\cdot}616$, the stray current is 38 per cent., and the total potential difference is 5·2 volts.

Fig. 4 is plotted for a distance of 8 miles. Here the ratio of the current densities is $1{\cdot}145/2{\cdot}5=45{\cdot}8$, the stray current is 54 per cent., and the total potential difference is 7·8 volts.

Fig. 5 shows a curve plotted with the abscissa representing the total distance in miles, and ordinates representing the ratio of the current midway between the two ends and the current entering or leaving the ends. It will be seen that whilst this value is never zero it is less than 1 per cent. for distances greater than 18 miles.

Fig. 6 is a comparison between the voltage required for the same current in the case of a continuous length of rail with no leakage (curve v^1) and the voltage required for the same length of rail under the conditions assumed (curve v), the curve v^1 being of course a straight line. The peculiarity of the curve v is that for distances exceeding 10 miles the value of v increases very slowly.

With regard to the curves generally, it should be noted that they hold good for a particular type of rail, irrespective of the weight of the rail, the curve γ being a curve of current density. The total current is proportional to the weight of the rail used, and the curve of potential holds good for any number of rails in parallel, provided that the current is increased in the same proportion.

The curves form the basis of actual conditions, and, as a first approximation, if a correction is made for the resistance of the joints, the total potential difference for any given current will be found to agree closely with actual conditions. Take the case of 6 miles of rail of 76lb. weight per yard laid in 30ft. lengths:—

The number of joints per mile is 176.
Total number of joints = 1,056.

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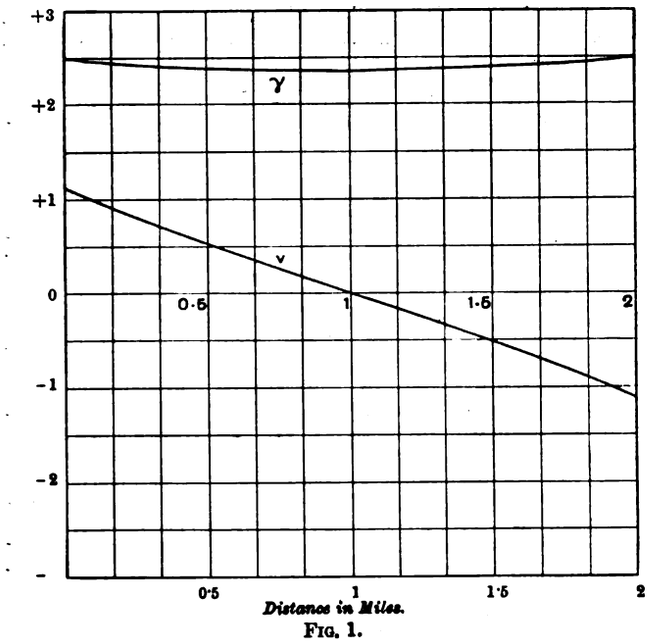

FIG. 1.

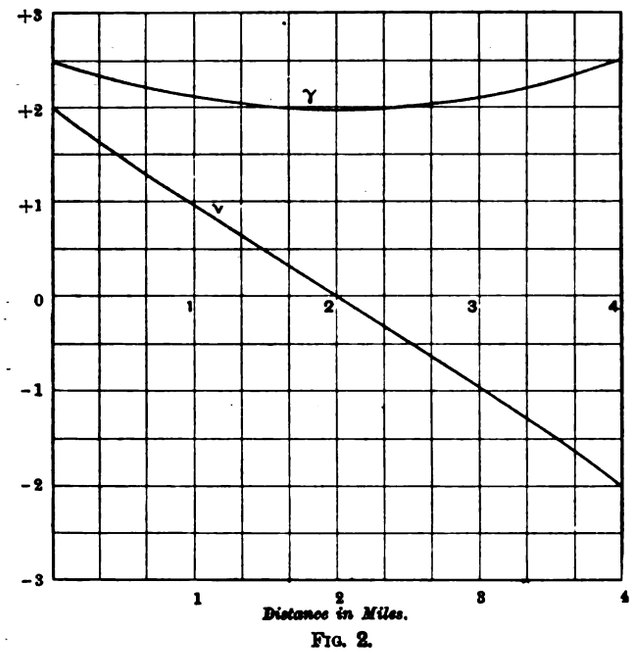

FIG. 2.

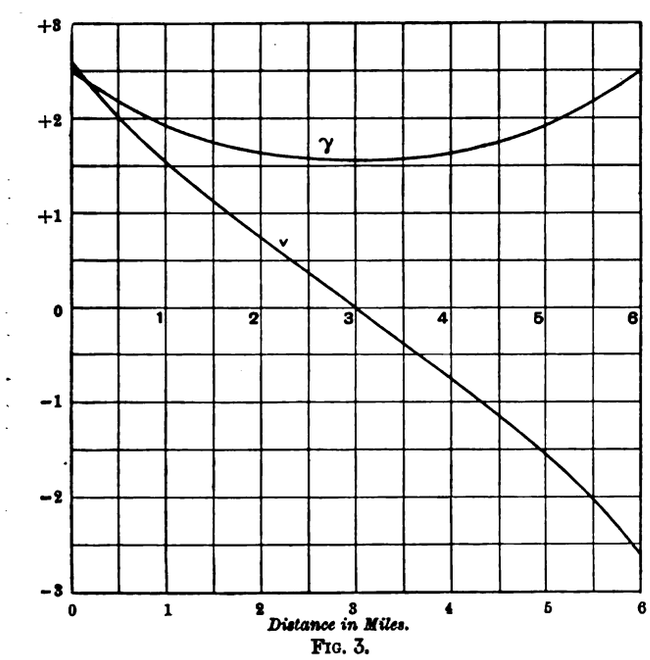

FIG. 3.

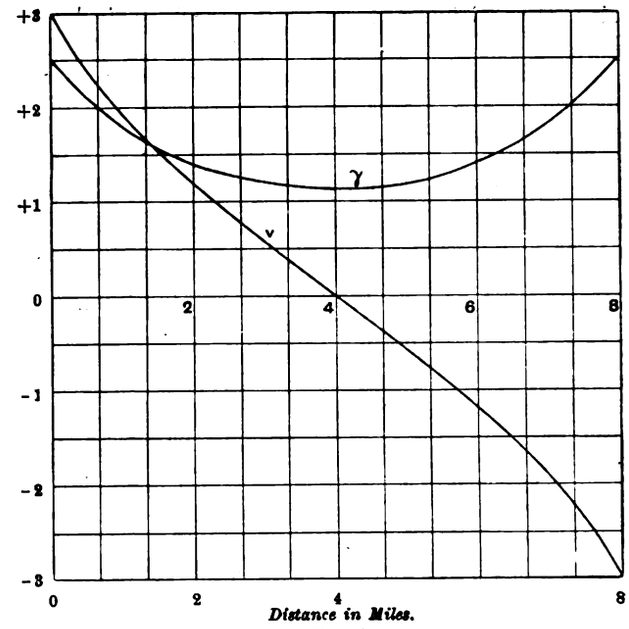

FIG. 4.

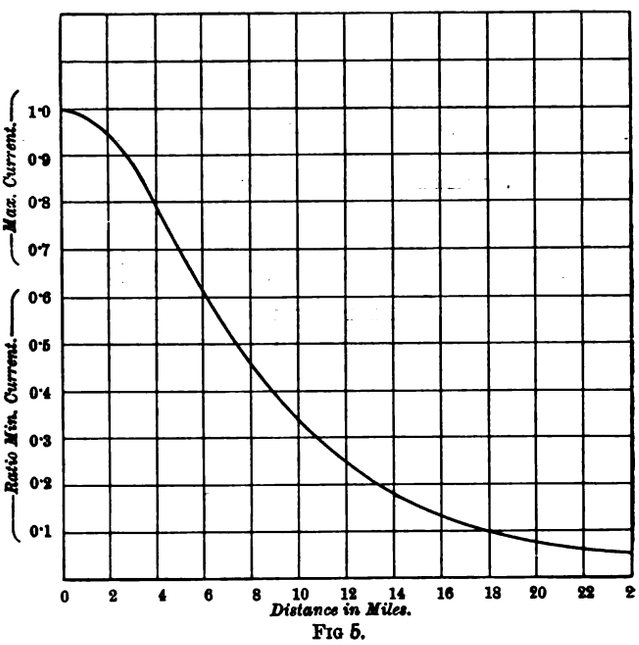

FIG 5.

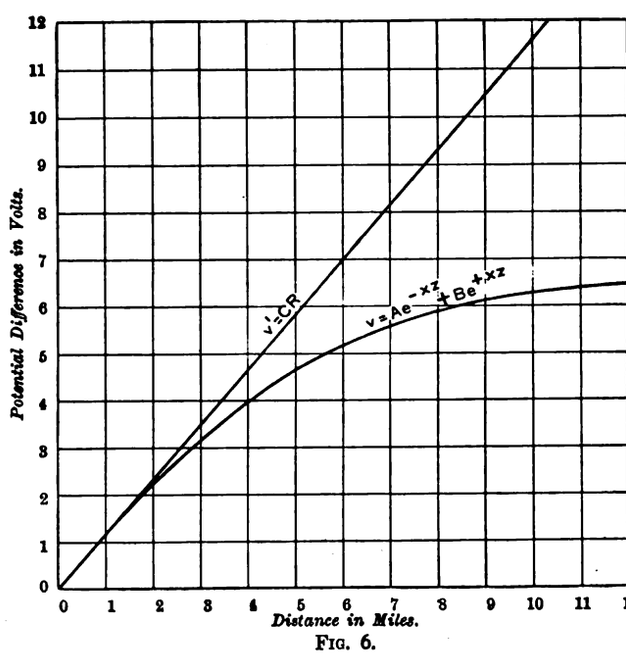

FIG. 6.

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Resistance per joint with one 0000 bond is equivalent to, say, 30in. of rail (Mr. Parshall on "Earth Returns for Electric Tramways." *Proceedings* I.E.E., Vol. XXVII.*).

Resistance of 76lb. rail = 0·0637 ohms per mile.

$$\text{Total resistance of joints} = \frac{0{\cdot}0637 \times 1{,}056 \times 30}{63{,}360} = 0{\cdot}0318 \text{ ohms.}$$

Current density = 2·5 amperes per square inch.

C.R. drop due to joints = 18·25 × 0·0318 = 0·58 volt.

Potential difference for a length of 6 miles from Fig. 6 is 5·2 volts.

Total potential difference = 5·2 + 0·58 = 5·78 volts, a result which is sufficiently near to justify the process.

It should also be noted that the whole of the resistance to leakage is assumed to be at the contact of rail and earth; the equations are therefore more correct for long lengths than for short ones, as in the latter case the resistance of the earth itself will affect the result.

In the next place the conditions assumed result in symmetry as regards the current distribution. If, for instance, the line under test forms part of a larger system of rails, the zero point will be shifted on to that side on which there is a preponderance of metal, and the curves will not be symmetrical with regard to the section under test. Moreover, a proportion of the current will be dispersed on the one side and collected on the other by means of the rail surfaces in contact with the ground if connected to the rails of the electrical system, so that for the same total current the potential difference will be less than the values given. The corrections for these cases are easily applied on the assumption that the furthest limit of the rail system is at the same potential as the earth.

WAVE TRANSMISSION OVER NON-UNIFORM CABLES AND LONG-DISTANCE AIR-LINES.†

BY M. I. PUPIN, PH.D.

This Paper describes an experimental investigation of a method of constructing cables and long-distance air-lines for long-distance telephony and telegraphy. Transmission of electrical energy over conducting wires is a *wave transmission* when the distance between the transmitting and the receiving apparatus is sufficiently long to permit the development of electrical waves. Such a transmission exists in long-distance telegraphy and telephony. It does not exist to any practically appreciable extent in ordinary transmissions of electrical power by alternating currents over distances which up to the present time have been bridged over by electrical power transmission lines. In cases of wave transmission considered here the conductors will be called *wave conductors.*

Wave-length.—The velocity of propagation of electrical waves of telephonic frequencies over conducting wires may be anything, from the velocity of light down to a few inches, or even less than an inch per second, depending on the inductance, resistance, and capacity of the line. The smaller the velocity the shorter, of course, will be the wave-length for a given frequency. The *wave-length*, as will be seen presently, plays a very important part in this investigation. It is considered here as one of the characteristic constants of wave propagation. I am not aware that previous investigators of the propagation of long electrical waves have devoted any serious attention to this characteristic constant.

Attenuation Constant.—There remains another constant which with the wave-length completely defines electrical wave propagation. It is called here the *attenuation constant.* To bring out its physical meaning consider two consecutive half wave-lengths of any moment. The one nearest to the transmitting apparatus shall be denoted by A and the other by B. The wave energy stored up in the medium surrounding A is greater than that stored up in the medium surrounding B. Hence wave energy is gradually dissipated during its propagation from the transmitting to the receiving apparatus, and therefore the amplitude of both current and potential become smaller as the energy progresses along the transmission line. Let U be the amplitude of the current at the transmitting end, and U_s be the amplitude at a distance, s, then if the line be considered infinitely long

$$\frac{U_s}{U} = e^{-\beta s}$$

where e is the base of Naperian logarithms. The constant β is called here the attenuation constant. The mathematical expression for β is well known—

$$\beta = \sqrt{\tfrac{1}{2}pC[\sqrt{p^2L^2 + R^2} - pL]}$$

where L, R, C are the inductance, resistance, and capacity respectively of the wave-conductor per unit length, and p is the frequency speed. Much confusion exists in the minds of physicists as to the real significance of this constant, and as to the true cause of current attenuation. It is usually stated that the capacity of the line, acting, as it does, somewhat like a shunt, is the cause of all the trouble experienced in electrical wave transmission. This statement contains a small part of the truth only, and for that reason may and actually has become misleading. The fact that a conductor possesses inductance and capacity shows that the medium surrounding it is capable of storing up energy, which, indeed, is a blessing; it cannot possibly signify that energy propagated along it will be dissipated; and if capacity cannot cause a loss of energy, how can it possibly cause an attenuation of current? The dissipation is due to imperfect conductivity of the wire, and to that alone. Inductance and capacity regulate it, they do not cause it.

Consider now the manner in which this regulation is effected. The dissipation of the energy transmitted occurs at the time when it is stored up in the medium as magnetic energy; for if the medium surrounding an element ds of the transmission wire contains a quantity, dW, of magnetic energy, then a current, x, must flow in that element such that

$$dW = \tfrac{1}{2}Lx^2ds.$$

Let dH be the rate of dissipation in that element, then

$$dH = Rx^2ds.$$

Suppose now that by some means we increase L to n^2L, the medium surrounding the elements ds will store up the same amount dW of magnetic with one nth of the current, for

$$dW = \tfrac{1}{2}n^2L(x/n)^2ds.$$

Let dH_1 be the rate of dissipation in this case then

$$dH_1 = R(x/n)^2 ds = dH/n^2.$$

It follows, therefore, that during the transmission of a given quantity of energy over a conducting wire the dissipation will be diminished by increasing the inductance of the wire, for if the wire have high inductance then small currents are required to transmit a given quantity of energy, and small currents incur small ohmic resistance losses. By increasing the inductance the efficiency of transmission is increased just as effectively as by increasing the conductivity of the transmission wire.

Distortionless Wave Conductors.—Another important advantage is gained by increasing the inductance. The expression for β given above shows that attenuation depends on frequency; it increases with it. Hence, in telephonic transmission where waves of complex harmonic frequencies are propagated over the line there will be distortion of the waves, because upper harmonics will be attenuated more vigorously than the lower frequencies. This results in a distortion of speech, which is noticed in long-distance telephonic transmission as defective articulation. Some instructive experiments bearing upon this point will be described presently. High inductance obviates this difficulty. To illustrate: Suppose that the inductance is large in comparison to the resistance, the expression for β will reduce to

$$\beta = R/2\sqrt{C/L}$$

It is independent of the frequency. All frequencies are attenuated alike, so that high inductance not only diminishes attenuation but also renders the circuit distortionless. Such a circuit is the ideal circuit for telephonic and telegraphic wave transmission.

Mr. Oliver Heaviside, of England, to whose profound researches most of the existing mathematical theory of electrical wave propagation is due, was the originator and most ardent advocate of wave conductors of high inductance. His counsel did not seem to prevail as much as it deserved, certainly not in his own country. I trust that the physical view of attenuation described above in the terms of the dissipation of energy which is transmitted over the wire will help to elucidate Mr. Heaviside's theory of high inductance wave conductors.

Wave Propagation over Non-Uniform Conductors.—But Mr. Heaviside's proposition to employ wave conductors of high inductance contained a serious difficulty which his mathematical theory was not capable of overcoming. The difficulty is this: How can a wave conductor be constructed so as to have a high inductance? Ordinary circuits can be endowed by as much inductance as may be required by simply introducing a coil of proper dimensions, with or without an iron core, into it. But this will never do in the case of a wave conductor; for a coil introduced that way will act by reflection as a barrier to electrical waves. Acting on a suggestion made by Mr. O. Heaviside* in 1893, wave propagation experiments

* *The Electrician*, 1898, Vol. XLI., p. 54.

† Abstract of a Paper read before the American Institute of Electrical Engineers, May, 19, 1900.

* O. Heaviside, "Electromagnetic Theory," Vol. I., p. 435.

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over long wave conductors containing a certain number of coils in series at periodically recurring points have actually been tried by telephone engineers; the results obtained have invariably proved most disappointing. I shall return to this point later on in connection with the description of experiments given further below. Suffice it to state here that all attempts to increase the inductance of a wave conductor by the introduction of inductance coils at periodically recurring points failed, because they had no mathematical theory to guide them, so as to avoid the difficulties of wave reflection by inductance coils introduced that way. It is hardly worth while to enter here into a discussion of the many other attempts at increasing the inductance of a wave conductor by devices which had neither theory nor experiment to recommend them. In fact, most of them were absurd on the face of it.

The first mathematical theory dealing with wave propagation over conductors of this kind was presented by me before this Institute on March 22, 1899.* A more complete theory is given in the second part of this paper.† The main object of this theory is, find an answer to the question: *Under what conditions are the non-uniform conductors described equivalent to their corresponding uniform conductors?* The answer which the mathematical theory gives to the question just proposed is definite. To formulate it introduce here a convenient technical term. Consider the distance between two consecutive inductance points, that is, the points at which the inductance coils are introduced. Denote it by l, and let the wave-length which is to be transmitted be λ. Now introduce an angle ϕ such that

$$\phi/2\pi = l/\lambda.$$

The angle ϕ shall be called the *angular distance* between the inductance points, or inductance sources. The angular distance 2π corresponds to the wave-length. The law which determines the degree of equivalence between a non-uniform conductor and its corresponding uniform conductor can now be stated as follows: A non-uniform conductor is as nearly equivalent to its corresponding uniform conductor as $\sin\phi/2$ is to $\phi/2$.

It is evident that ϕ is inversely proportional to the wave-length, so that for a given distance between the reactance points the degree of equivalence diminishes as the wave-length diminishes. If a wave of complex harmonic frequency, such as occur in telephony, be transmitted over a non-uniform conductor, then the action of the conductor will be different for the different components of this complex harmonic wave. If, however, the non-uniform conductor acts with sufficient approximation as a uniform conductor toward the highest important frequency of this complex wave then its approximation to a uniform conductor will be even higher for the lower frequencies and thus for all the frequencies of the wave. A numerical example will illustrate this point more clearly. It is well, however, to state more fully the meaning of the expression "equivalence between a non-uniform conductor and its corresponding uniform conductor." All that we can predicate of a wave of a given frequency is that it has a certain wave-length and a certain attenuation constant. Hence, if a wave of a given frequency has the same wave-length and the same attenuation constant on a non-uniform conductor as it has on the corresponding uniform conductor then the two conductors are equivalent to each other. If these two quantities differ by, say, 3 per cent., then an approximate equivalence up to within 3 per cent. exists.

Consider now the following numerical example: A twin conductor, such as employed for telephone cables, has a length of 250 miles. Let its constants have the following values per mile:—

Inductance = 0.
Resistance = 9 ohms.
Mutual capacity = 0·074 microfarads.

According to the high but definite standard which the New York Telephone Co. employs the limiting distance of telephony over such a cable is 39 miles. According to the lower standard which is maintained in long-distance telephone work the limit would be 78 miles. The results obtained by me experimentally seem to verify these figures. I find that at a distance of 100 miles telephony over such a cable is very poor—in fact, impracticable—and at a distance of 125 miles impossible. It is proposed now to decrease attenuation and distortion over such a cable by the insertion of inductance coils at periodically recurring points. The attenuation constant β in this case is given by the formula‡

$$\beta = \frac{R}{\sqrt{2}}\sqrt{\frac{C}{L}}.$$

Say that it is required to have $\beta = 0{\cdot}015$. Assume that the introduction of the inductance coils adds 9 ohms per mile, so that R = 8 ohms. These values of R and C require L = 0·056 henrys. The attenuation factor at a distance of 250 miles would be $e^{-250\beta} = \frac{1}{40}$ (roughly). That is, 2½ per cent. of the current leaving the transmitting end will reach the receiving end. This is quite sufficient for telephonic purposes; but it should be observed that better efficiency of transmission could be obtained by making L larger. Notice now that the attenuation factor for this cable without the coils would be, for a frequency of 600 P.P.S., roughly, $\frac{1}{25\times10^4}$, that is, with a given initial current, the current at the receiving end would be 6,000 times larger with the coils than without them.

The next step is to find the wave-length for the highest important frequency in telephony over a *uniform wave conductor* having L = 0·056 henrys, R = 18 ohms, C = 0·074 microfarads. The best telephone practice assumes that 750 ∿ per sec. is the highest frequency of any importance. The wave-length corresponding to this frequency over a *uniform conductor* of this description is obtained from the formula:*

$$\lambda = \frac{0{\cdot}2\pi}{p\sqrt{2LC}} = 14{\cdot}6 \text{ miles},$$

approximately.

Suppose now that at each mile we place a coil of inductance L = 0·056 henry and a resistance R = 9 ohms. The angular distance ϕ for frequency 750 P.P.S. of the non-uniform conductor thus obtained will be $2\pi/14{\cdot}6$. The degree of equivalence of this non-uniform conductor to its corresponding uniform conductor is measured by the degree of equivalence of $\sin\pi/14{\cdot}6$ and $\pi/14{\cdot}6$. Now $\sin\pi/14{\cdot}6$ differs from $\pi/14{\cdot}6$ by less than 1 per cent. of the value of $\pi/14{\cdot}6$; hence for a frequency of 750 P.P.S. the wave-length and the attenuation constant on the non-uniform conductor will differ from the wave-length and attenuation constant on the corresponding uniform conductor by less than 1 per cent. of the values of these constants. Such a difference cannot be detected by any of the experimental methods which are at present available for investigating wave propagation. In telephonic transmission the ear could not detect it. For lower frequencies the differences will be even considerably smaller. Hence the non-uniform conductor thus obtained will represent a uniform, non-attenuating, distortionless conductor for telephonic transmission.

It should be observed here that in the case of a submarine cable of, say, 2,000 miles the attenuation constant should be much smaller than the value of β given above, in order to have a sufficiently small attenuation factor. Now the capacity per mile of a submarine cable is about four times as large as the capacity of the telephone cable just described. Hence, both on account of the long distance and also on account of the much increased capacity, the inductance per mile will have to be much larger than in the case just discussed. But high inductance and large capacity will give a very short wave-length. For instance, if in the case of the submarine cable having six times the capacity we employ an inductance six times as large as in the case of the telephone cable we shall obtain for the frequency of 750 ∿ per sec. a wave-length of only 14·6 ÷ 6 = 2·43 miles. Hence, since the inductance coils will have to be placed apart at one-sixth of the distance employed in the case of the telephone cable, the distance between them will be about 880ft. The distance between the inductance coils depends entirely on the circumstances of each particular case. But in all cases the rule given above contains the necessary and sufficient directions.

This rule and the method based upon it are recommended by the mathematical theory developed in Part II. of this Paper for the construction of distortionless wave conductors of high efficiency of transmission. It will be shown now in how far this theory is confirmed by experiment.

Description of the Experimental Cable.—A so-called artificial cable possessing the above constants was constructed by me for the purpose of testing experimentally the mathematical theory developed in Section III. of Part II. Previous experiments in this line will be found in the author's Paper of March 22, 1899, cited above.

The cable has 250 sections. One of these sections is represented in Fig. 1. It consists of a sheet, A, of paraffined paper. On each side of this sheet is a strip of tinfoil *ab*. The resistance of this strip is approximately 9 ohms. The capacity of the condenser formed by the two strips is 0·074 microfarads approximately; 250 sections of this kind connected in series represent a cable of 250 miles in length having a resistance of 9 ohms and a capacity of 0·074 microfarads per mile. That such is actually the case was verified experimentally, as will be shown presently. In Fig. 3 the straight lines A, B, C, D, A_1, B_1, C_1, D_1 represent these sections. The upper lines represent one side of the cable and the lower lines represent the other side. When the plugs are out, then the consecutive sections of the cable are connected to each other by the inserted coils. The plugs being in the coils are short-circuited. In this case we have a uniform cable; in the former case we have a non-uniform cable of

* M. I. Pupin, "Propagation of Long Electrical Waves"; *Transactions* of the American Institute of Electrical Engineers, Vol. XVI., p. 93, 1899.

† *Transactions* of the American Institute of Electrical Engineers, Vol. XVII., No. 4, p. 275; or *Transactions* of the American Mathematical Society, Vol. I.

‡ For the proof of these equations, the reader is referred to the complete Paper: *Transactions* of the American Institute of Electrical Engineers, 1900, Vol. XVII., No. 4.

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250 miles length, with inductance coils inserted at each mile. The coils are wound as represented in Fig. 2. The twin coils aa_1, bb_1, cc_1, of Fig. 3 are represented in Fig. 2 by coils *aa* and *bb*. These two coils are wound on one spool, and are separated by a sheet of cardboard indicated by a black line in Fig. 2 which is $\frac{1}{64}$in. thick. The coil when finished is boiled in beeswax at a temperature of about 280° F., in order to drive all the moisture out and ensure good insulation. Each coil had 580 turns of No. 20 wire B. and S. The average inductance of one of these coils is 0·030 henry, and the mutual inductance 0·028 henry. Each coil, therefore, when connected into the line, as indicated in Fig. 3, has an effective inductance of 0·058 henry. This method of bringing the corresponding coils of the two sides of the cable into close relation by mutual induction is not necessary; it is a matter of convenience and economy.

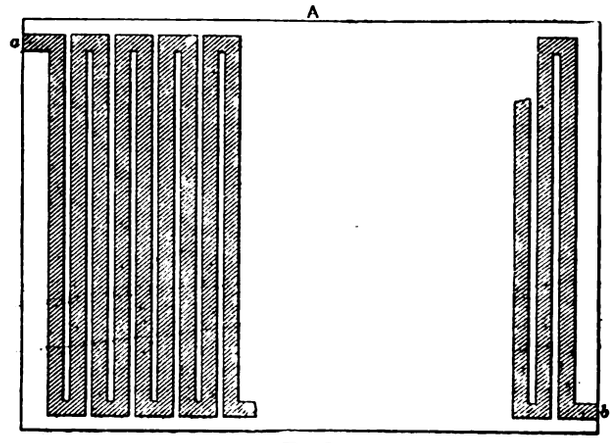

FIG. 1.

The cable sections are divided in five groups of 50 each, and each of these groups is enclosed in a separate box. Each box represents, therefore, 50 miles of the cable. Fig. 4 is a reproduction from the photograph of one of these boxes. The box marked A is the cable box. On two opposite sides are five rows B . . . . of binding posts, each row having 10 pairs. They are the terminals of the condenser sections. From these binding posts double cotton-covered wires which have been boiled in beeswax lead to the row of brass-plate couplers indicated in the picture by letters *a*, *b*, *c*, ... These boxes were made by the well-known mechanician, Mr. E. V.

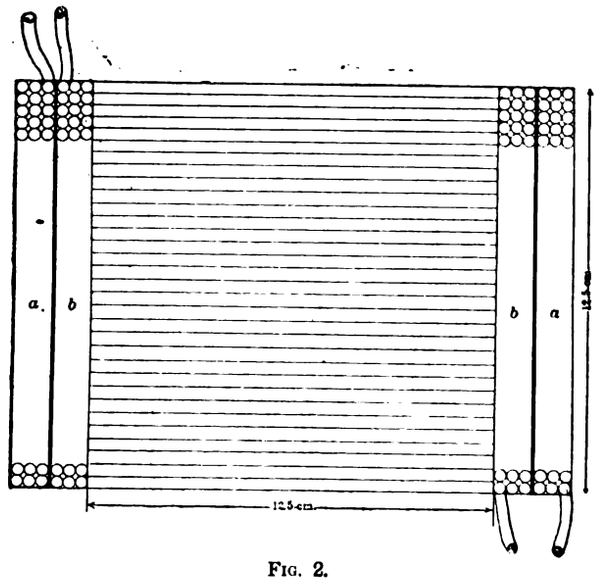

FIG. 2.

Baillard, to whom my sincere thanks are due for the keen interest which he took in this exceedingly laborious work. The rest of the work on the cable was done in the Columbia University laboratory for electro-mechanics. The insulation per section was about 50 megohms.

Telephony Over the Non-Uniform Cable.—Actual experimental tests with transmitters and receivers, which were kindly put at my disposal by the New York Telephone Co, for which I feel very grateful to them, verified my predictions completely. Telephonic communication over the whole of the cable was carried on with perfect ease. Both the volume and the articulation of the transmitted sound were all that could be desired. If, however, the inductance coils were cut out and the cable used as a uniform cable, then the transmission was good up to 50 miles, fair up to 75 miles, impracticable at 100 miles, impossible at distances over 112 miles. Increased distance interferes with the transmission over the uniform cable, not only on account of the diminished volume of the sound transmitted, but also on account of the rapid loss of articulation. This manifests itself at first as an apparent lowering of the pitch of the voice just as the theory demands it. My assistant's voice is of an ordinary pitch, if anything, a little above the pitch of the average man's voice. When it was transmitted over 75 miles of the uniform cable (that is, the coils being disconnected from it) it sounded like a strong baritone. Over a distance of 100 miles it

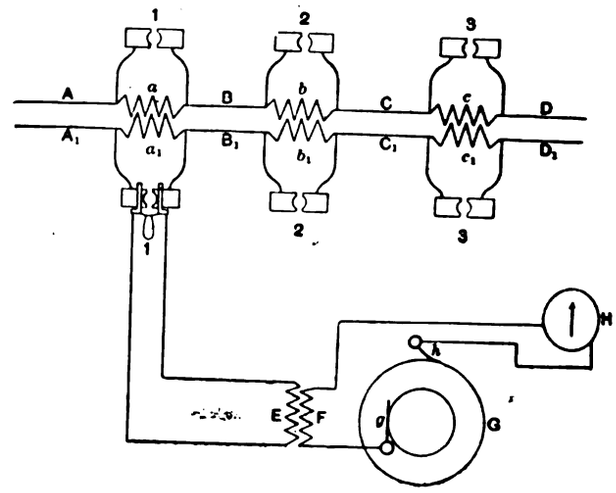

FIG. 3.

became so drummy—this is an expression borrowed from telephone engineers—that it was difficult to understand it, unless nothing but ordinary conversation was carried on, and then very slowly, and the speaker had to put his mouth as close to the transmitter as possible, and speak out as if he were addressing a big audience. At distances over 112 miles nothing but the lowest notes of the voice could be heard; the articulation was entirely gone. When the coils were all in, then no drumminess in the voice was noticed, and the conversation could be carried on as rapidly as one chose to do. I understand that in long-distance work three galvanic cells of the same type, of which I had two only, were formerly employed by the American Telegraph and Telephone Co., when they employed the old system of transmission.

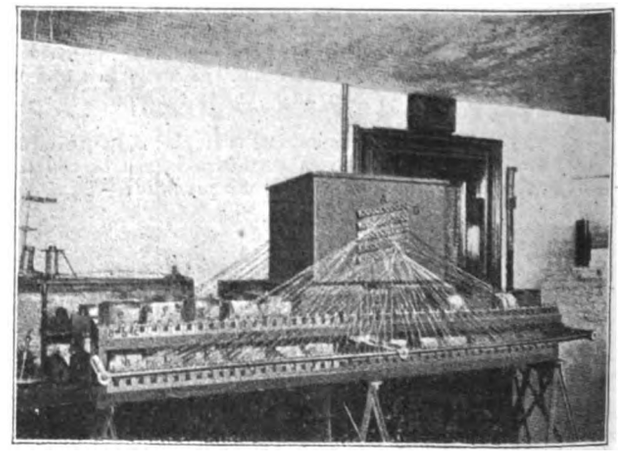

FIG. 4.

Effect of Internal Reflections upon Telephonic Transmission.—For this purpose the inductance coils were connected in groups of 10; one of these groups was inserted into the cable every 10 miles, so that the total inductance of the cable was now the same as before. The length of cable was therefore 100 miles. Telephonic transmission over this distance was absolutely impossible, although the lowest note in the voice was transmitted quite vigorously, and sounded like the muffled beating of a big drum. Another distribution of the coils was now tried. The coils were divided into groups of five, and these groups were put into the cable at points 5 miles apart. Transmission over a distance of 100 miles became intelligible, though with much difficulty; but it was not as good as over the cable

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without the coils. The drumminess was even more excessive in the former case than in the latter. One had to put his mouth very close to the transmitter, speak very slowly, very loud, and about very ordinary things, otherwise the meaning of the transmitted intelligence would not be caught at all. But if the same distance of cable was employed with the inductance coils placed 1 mile apart, as the mathematical theory suggests, then the voice of the sender sounded just as if he stood right before the receiving operator. It was not necessary to stand near the transmitter at all, in order to be heard at the other end. There was no difficulty in making the receiving operator understand even if the transmitting operator stood anywhere in the room at a distance of 20ft. or more from the transmitting instrument. The effect of the inductance coils properly distributed over the cable upon the efficiency of transmission astonishes even one like myself, who have now worked for years upon and made myself perfectly familiar with this fascinating problem of electro-mechanics.

The inductance coils which I have so far described contain no iron. Coils with iron cores to be used for this purpose will have, of course, to be constructed in a perfectly definite way to work satisfactorily. I expect to bring this matter before the Institute at some future time. Suffice it to state now that such coils would be required in the construction of non-uniform submarine and underground telephone cables on account of the much smaller volume per unit of inductance. For long-distance air lines inductance coils without iron cores would be in many respects preferable.

In conclusion, I wish to thank my assistant, Mr. Cushman, and my students, Mr. Frank and Mr. Koscherak, for the very faithful and persevering way in which they have assisted me throughout these experimental researches.

It is of interest to add the following extract, taken from the *Electrical Review* of New York, of two American patents recently issued to Dr. M. I. Pupin for the "Art of Reducing Attenuation of Electrical Waves and Apparatus therefor."

Suppose it be required to transmit speech telephonically over a submarine cable 2,000 miles long. In this case inductance coils of small volume are preferable on account of considerations of mechanical construction. To secure high inductance with small volume, steel or iron cores should be used to avoid excessive ohmic resistance. Coils having iron cores are a source of three kinds of losses—viz., those due to Foucault currents, hysteresis and ohmic resistance. Each one of these losses has to be very small if the coil is to be efficient. I have found that this can be accomplished, at any rate, when it is required to transmit only small quantities of energy. If the core is finely subdivided, Foucault currents are negligible, especially for exceptionally weak magnetisations, such as will be employed in the case before us. It will now be shown that hysteresis also can be made negligibly small. Let the wire have a resistance of 5 ohms per mile. According to present cable construction the capacity per mile with wires of such size is very nearly three-tenths microfarad. Introduce inductance coils at proper distances, so as to make the inductance three-tenths henry per mile, and suppose that these coils add 1 ohm per mile, thus increasing the ohmic resistance to 6 ohms per mile. The wave-length for a frequency of 1,500 periods per second will be 2 miles, approximately.

To secure a close approximation to the rule, it will be necessary to introduce 16 coils per wave length or eight coils per mile. The inductance of each coil will then be 0·0375 henry. The resistance of each coil will be 0·0125 ohm. Employing cores of iron, or well-annealed steel, coils of this inductance can be readily made which will be small enough to go within the sheathing of a submarine cable as these are constructed to-day and at the same time show negligibly small Foucault current and hysteresis losses.

In Fig. 6 X′ is a ring-shaped disc. Its internal diameter is 2·5cm. and its external diameter is 6·5cm. Its thickness is 0·002cm., or about 0 005in. It has a narrow slit, *pq*. A core is built up by piling together a sufficient number of such discs to give the required length, which we will assume is 10cm. In Fig. 5 a transverse section of such core is represented. Wind this core with two layers of wire having 8·5 ohms resistance per mile. Let each layer have 48 turns. The length of the wire will be 80ft., and its ohmic resistance will therefore be little more than 0·125 ohm. Eight coils per mile will therefore add 1 ohm per mile to the resistance, making the total resistance 6 ohms per mile. To calculate the inductance, the permeability of the iron must be known. In telephony the maximum value of the current at the sending station is generally less than 0 0001 ampere, or 0·00001 unit of current in the centimetre-gramme second system. The magneto-motive force of the magnetic circuit is for this value of the magnetising current

$$M = 4\pi sC = 4\pi \times 96 \times 10^{-5}.$$

The intensity H of the magnetising force will be

$$\frac{M}{l} = H,$$

where l is the mean length of the magnetic circuit equal to 10cm., roughly. Hence

$$H = \frac{4\pi \times 96}{10^{6}} = 0{\cdot}0012.$$

For excessively feeble magnetising forces of this kind the magnetic permeability of first-class iron is about 180. The intensity of magnetic induction will be $B = 180 \times 0{\cdot}0012 = 22$ lines of induction per square centimetre. At this excessively low induction there is no hysteresis. The inductance of the coil can now be easily calculated. The formula is

$$L = \frac{4\pi s^2 q\mu}{l \times 10^{9}},$$

where

s = number of turns = 96.
q = cross-section of core in square centimetres = 20.
μ = permeability × 180.

Hence $L = 0{\cdot}042$ henry.

The diameter of the coil, when finished, will be less than 2·5in. and its length 4·25in. Such a coil can be placed conveniently within the sheathing of a submarine cable. Its diameter can very easily be reduced by increasing its length.

It should be observed here as a warning that unless inductance coils with iron cores are constructed in such a way as to keep down the magnetisation, hysteresis, Foucault current losses and distortion of current by the varying value of the magnetic permeability at each cycle of magnetisation will work disastrously. The limit of magnetisation permissible will not, however, be passed even if the magnetising current is 30 times as large as is assumed above—that is, the magnetising current can be as high as 3 milliamperes—a strength of current which is capable of operating telegraphic apparatus. It should also be observed that the iron core

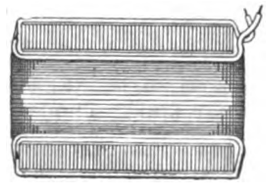

Fig. 5.

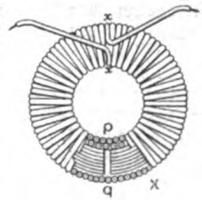

Fig. 6.

represented in Figs. 5 and 6 can be made by winding very fine iron wire, the plane of the windings being perpendicular to the axis of the cylindrical tube which constitutes the core. The advantage of this core is that it still further reduces the Foucault current losses, and also prevents magnetic creeping. The cross-section of the wire core would have to be made larger than that of the plate core to allow for the more imperfect filling up of the available space by the substance of the wire.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"The Law and Practice Relating to Letters Patent for Inventions." By R. W. Wallace, Q.C., and J. B. Williamson. (London: W. Clowes & Sons.) £2.

"*Journal* of the Institution of Electrical Engineers." No. 146, Vol. XXIX., with Index to Vol. XXIX. (London: E. & F. N. Spon.) 5s.

"List of Officers and Members of the Institution of Electrical Engineers." Corrected to June 30, 1900. (London: E. & F. N. Spon.)

"*Transactions* of the American Institute of Electrical Engineers." Vol. XVI. (New York: The Institute.)

"La Telegrafia Senza Fili E La Canalizzazione Dell'Elettricità Senza Fili." By Emilio Guarini. (Rome: G. Bertero.)

"The Application of Electric-Motors to Machine-Driving." By A. Stewart. (London: S. Rentell & Co.). 1s.

"*Proceedings* of the Royal Society." No. 433. Vol. LXVI. (London: Harrison & Sons.) 1s. 6d.

"Calendar of the Glasgow and West of Scotland Technical College for the Session 1090—1901. (Glasgow: R. Anderson). 1s.

Electric Tramway in Astrachan.—The Astrachan electric tramway was opened to the public on June 11 last. It is a single-track network connecting the most important points of the town and harbour and some of the suburbs, its total length being 12½ miles. The electrical and mechanical equipment has been carried out by the St. Petersburg branch of Messrs. Siemens & Halske, and includes three 200 kw. sets consisting of internal pole machines running at 200 revs. per min., driven through belting by compound steam engines. There is also a 50 kw. set for the station lighting. The tramway pressure is 500 volts. A feature of the station is that the three boilers, each of 2,150 sq. ft. heating surface, are constructed for naphtha fuel. The ordinary Siemens' sliding-bar system is employed on the line, there being two trolley wires of 8·2mm. diameter.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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A DIGEST OF THE LAW OF ELECTRIC LIGHTING, ELECTRIC TRACTION, TELEGRAPHS, TELEPHONES, &c. A. C. Curtis-Hayward, B.A. To January, 1900. Price 3s. 6d., post free.

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RIVAL DISTRIBUTION SYSTEMS.

When the Council of the Municipal Electrical Association arranged the programme of the recent convention of this Society they cannot have made themselves acquainted with the contents of the various Papers sent in. If they had done so they would hardly have set down two Papers on entirely different subjects for discussion at the same time, while one of these Papers dealt with the same problem as a Paper which had been read and discussed on the previous day. Mr. L. Andrews' Paper on "The Distribution of Electricity to Scattered Areas" was a polemic devoted to the alternating *versus* continuous controversy, while Mr. Boor's Paper, read the day before, dealt with the most important problem in connection with it, viz., the reduction of all-day losses on alternating-current systems. Mr. Wilkinson's Paper, on the other hand, was on the details of distributing systems, such as the methods of laying cables, the choice of junction boxes, and similar matters. It was most interesting and would probably have led to a highly instructive and technical discussion, had it been taken separately; but in the discussion that did take place it was overshadowed by the greater importance of the problem raised in Mr. Andrews' Paper. Mr. Andrews is a staunch champion of alternating-current distribution, so much so that he considers Hastings and St. Leonards to be still a "scattered" area, and is of opinion that for this district a continuous-current system would be less economical. Some of Mr. Andrews' items in his comparison of the estimated costs of the two systems were severely criticised by Mr. J. F. C. Snell, who was supported by Mr. Wordingham, but we think that, even after Mr. Snell's taxation, the costs of the continuous-current system were allowed to remain too high. For instance, those engineers who have had experience with both low and high-pressure mains will agree that, for the same district, the cost of repairs and maintenance of feeders is higher with high-pressure than with low-pressure systems, whereas Mr. Andrews' figures assume merely a higher percentage on the outlay, which works out to a lower sum for high pressure than for low pressure. And then he also includes in this figure the repairs and maintenance of the sub-stations, and of their equipment, which,

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even without the complicated switch gear he proposes to employ, will probably alone be quite as great as the maintenance of the feeder system of a continuous-current network. Then, to judge by the table in Mr. Boot's Paper, referred to in our last issue, the possibility of a reduction of the light load losses from 540 units to 40 units a day in 17 sub-stations is by no means certain, even with the ingenious devices proposed by Mr. Andrews. A sum must also be put down to the high-pressure account for a proportion of the wages of the switcher-off. What is probably more important than all is the loss, which is not so easily calculable, accruing from the diminished load factor owing to the relatively few motors that will be attracted to an alternating-current system. A supply area tends to become more concentrated as time goes on, and, consequently, we are of opinion that, with the methods at present at the disposal of the electrical engineer, an alternating-current system should only be recommended for *distribution* in an area much more "scattered" than the typical one chosen by Mr. Andrews, and even then a two-phase or three-phase system would probably be preferable to one on the old single-phase lines.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Magnetic Induction in Iron and other Metals. By Prof J. A. Ewing. 3rd edition. "The Electrician" Printing & Publishing Co 1900. 10s. 6d. net.

Not quite nine years have passed since Prof. Ewing first published his work on Magnetic Induction, and the fact that he is now called upon to issue a third edition is satisfactory evidence that it still maintains the position which it rapidly gained for itself on its first appearance as a leading text book on the subject.

Good in all respects as the earlier editions were, this new edition should be still more popular. For not only is the work brought up to date by the incorporation of the results of the many valuable investigations made on the subject during the intervening period, but in addition there is a new chapter on "Practical Magnetic Testing" which will prove most acceptable to all practical electrical engineers. No one has done more than Prof. Ewing in applying theory to practice, and his success is seen in the series of beautiful testing instruments which he has devised, and which are fully described in this chapter.

His "permeability bridge" is especially neat and simple. In its action it is analogous to the Wheatstone bridge for measuring electrical resistances. The bar to be tested is compared with a standard bar whose B-H curve is known. The same current passes in series through the magnetising coils of both bars; but while the number of turns on the coil round the standard bar is fixed, the number on that round the test-bar is adjustable. The bars are connected together at each end by a short yoke, and a detector shows any inequality in the induction in the two bars in this circuit. The adjustment of coils to obtain exact equality is made by moving a switch over contacts on a dial, compensating resistances being thrown in or cut out by this single movement as the number of coils is decreased or increased. The usual arrangement is that a current of one ampere gives a force of 10 units in the standard bar; so that for any given induction, the force necessary to produce that induction in the standard is first read off from its B-H curve, the current is adjusted accordingly to the proper amount to give this force, and when equality between the bars has been established by adjusting the coils, the magnetic force required to produce the given induction in the test-bar is at once known by multiplying the magnetic force in the standard by the ratio between the number of coils on the test-bar to that on the standard. This latter is usually 100, but it may be changed to 50, in which case the magnetic force in the standard bar will be 5 units per ampere.

Descriptions are also given of the author's magnetic balance and his hysteresis tester, and of Du Bois' magnetic balance. These descriptions will certainly make the book still more attractive to practical men, and the student of theory will find a careful perusal of them to be an excellent means of fixing the theory in his memory.

The other chapters of the book, as already indicated, are brought up to date by the inclusion of the results of the most recent investigations. Perhaps the most interesting addition of this kind is found in the chapter on "Molecular Theory," giving an account of Prof. Baily's experiments on hysteresis of iron in a rotating magnetic field. We may quote the author's own words: "The conclusion that hysteresis should vanish when iron is rotated in a very strong field seemed at first so improbable that it was advanced by way of criticism of the author's molecular theory. Mr. Baily's demonstration that hysteresis does, in fact, nearly vanish may be claimed as going far to prove its fundamental soundness." In applying his molecular theory to account for the loss of magnetic quality in iron when the temperature is high, the author makes a "plausible conjecture" that the oscillation of the molecules is then so violent as to amount to *rotation*. It may be of interest however to mention that, on the other hand, Mr. J. S. Townsend ("On Magnetisation of Liquids," *Phil. Trans.*, 1896, second half-year) has suggested the same idea of rotating molecular magnets to account not for absence of magnetic quality, but for diamagnetism. For "if we take the simple case of a magnet rotating rapidly in the horizontal field of the earth the effect of the applied force H will be to make the north-seeking pole move more slowly when it is south of the axis of suspension than when it is north, so that its mean position is south of the axis of suspension, thus causing the magnet to act like a diamagnetic body."

The book is very clearly printed and very few printers' errors appear. The references to Papers are very complete. It is too often considered sufficient by writers, in referring to a scientific journal or to the publications of one of the learned societies, to give only the number of the *volume*, whereas the really important point is the *year*, not only as fixing the date of publication, but also for convenience in reference. Both volume and year should be given, and except in a few instances Prof. Ewing has been careful to do this.

W. C. H.

Die Sicherungen von Schwach- und Starkstrom-Anlagen gegen die Gefahren der Atmosphärischen Elektricität. By Dr. Friedrich Niessen. (Braunschweig: F. Vieweg and Son. 1899). 5M.

As it deals with no other subject than the protection of electrical installations from damage by atmospheric electricity, this little work may be cited as an excellent example of the present tendency towards extreme specialisation in electro-technical literature. On the question whether the lightning discharge is oscillatory or not the author takes up a somewhat unstable position upon the proverbial fence:—

> What we know of condenser discharge certainly speaks against oscillation of the actual lightning spark. The clouds which hold one part of the charge do not form short metallic circuits, and just as little does the earth do so. But one has to do with water resistance in the discharge circuit, and so it follows from theory and experiment, that the discharge is always in one or several strokes following shortly after one another without oscillations. If, however, the conception that the actual lightning stroke between cloud and earth has an oscillatory discharge is to be put aside, it must yet be allowed that in the conductor to which the lightning conductor is connected, or in the actual material of the latter, electrical oscillations can ensue, particularly as soon as a stemming of the discharge of electricity,—perhaps in consequence of discontinuities—occurs. The whole conductor is charged by the electricity of the cloud; the one kind of electricity cancels itself with the electricity of the cloud, the other must be led away harmlessly by the lightning conductor. For this latter, a state of oscillation can very well occur.

However, whether we have to consider an oscillating discharge, a sharp fall of potential from a high value to zero, or several discharges of the latter nature following one another in succession, the effects of resistance, capacity, and self-induction are in the same direction, and the design of lightning guards is hardly affected by these considerations. The above therefore detracts nothing from the

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conscientious descriptions of a large number of well-known and also of less familiar patterns of lightning protectors which follow. In the remainder of the book a few pages are devoted respectively to a catalogue of cases of damage done by lightning to electrical installations, an account of experience obtained with some of the apparatus described in the book and of some miscellaneous experiments, and lastly, an enumeration of some points to be considered in choosing and fixing lightning protectors. In the last chapter, however, the recommendation attributed to Dr. Görges, that the frames of machines should be insulated and not earthed, cannot be endorsed.

Elektrometallurgie und Galvanotechnik. By Dr. Franz Peters 4 Vols. (Hartleben: Vienna, Pesth, Leipzig.)

Dr. Peters's object in bringing out these volumes has been to give as complete a *résumé* as possible of what has been published up to date in the journal and patent literature of all countries, on the recovery and working of metals by electrical processes. The need of some such work has been felt both by electro-chemists and metallurgists, and also by inventors when they have desired to ascertain the novelty or otherwise of processes which they may wish to patent. The present book forms a convenient illustrated handbook to the literature in question, and should save much of the time which is often wasted in hunting through specifications in the Patent Office. In the case of the patent literature the author claims that no material omissions have been made, and that the list is substantially complete. A claim of this sort it is of course for a reviewer impossible to verify, but it appears to be justified so far as those patents are concerned which have led to marked industrial developments. In the case of the more important German patents, only unnecessary diffuseness has been omitted, because the author feels justified in giving them more or less in full when they contain important observations or comments on the process, even though these latter may not form the subject of claims. The German patent claims have been given verbatim in all cases, and in many instances criticism is appended. With regard to the journal literature also, every care has been taken to make it complete, but it is naturally only in a condensed form, and often only the reference is given.

The work is comprised in four volumes, which appear simultaneously, and the first volume deals with the metalloids and the light metals. The alkalies and alkaline earth metals are not included, as they have less interest for metallurgists than for chemists, and they have already been dealt with by the author in his work on "Applied Electro-chemistry." More than half of the volume is devoted to aluminium, and the remainder to antimony, tin, bismuth, beryllium, and magnesium. The second volume is entirely taken up with copper, and begins with a short history of electro-metallurgy, from which we find that electro-plating with copper was apparently understood by the ancient Egyptians, as a number of clay figures have been found in the graves at Thebes and Memphis which appear to have received an electrolytic coating of copper. In the fifth century Zosimus recorded that iron would separate copper from a solution of copper sulphate, and in the fifteenth century Paracelsus mentioned that a copper plate might be silvered by dipping it into a solution of silver. After this the references to similar facts become more frequent, but it was not until 1837 that Jacobi succeeded in depositing copper by the aid of the electric current. The various improvements which have been effected, since the early days of Elkington and De la Rive down to the latest processes for simultaneously depositing and burnishing copper on revolving cathodes, have each received their due share of notice. The third volume deals with silver and gold, and the chapter on the latter metal is especially valuable at present in view of the efforts which are being made to devise processes for working poor ores and for working up residues. Zinc, lead, nickel, and cobalt occupy the fourth volume, which also contains the subject-matter and authors' name index for all four volumes.

Manuel de Télégraphie et de Téléphonie. By J. Pierart. New edition. (Brussels: Hayez. 1899.)

This is a small book on electricity in its applications to telegraphy and telephony. Half of the 320-page volume being devoted to quite elementary instruction, the remainder cannot deal exhaustively and in detail with all the technical parts of the subject. Thus, although a large number of instruments are described, including the Hughes type-printing telegraph and the Wheatstone automatic, and a chapter is devoted to simultaneous telegraphy and telephony, extremely small space is given on the other hand to line construction, submarine telegraphy, multiplex telegraphy, fault localisation and multiple telephone switchboards, and they are dealt with quite inadequately. The book is presumably intended to teach the ordinary telegraph or telephone clerk something of the technical side of the subject, and if it does not aim higher than this, it should be successful. As a book of reference, it is handicapped by the absence of an alphabetical index.

Les Arbres à Gutta Percha: Leur Culture. Mission relative à l'Acclimatation de ces Arbres aux Antilles et à la Guyane. By Henri Lecomte. (Paris: Georges Carré et C. Naud. 1899.) 2fr.

The first part of this pamphlet is devoted to a botanical description of the various gutta percha plants, a brief summary of the methods employed for extracting the gum, and some interesting historical and statistical information. The second part is a detailed report (presented to the French Colonial Minister) of the author's introduction of the gutta percha plant into Guadeloupe, Martinique, and French Guiana. In all cases the plants were from a consignment brought to Marseilles by the late M. Raoul from the Dutch Indies and Sumatra. Up to the date of the report, all have been doing well; but the time is as yet too short for a definite opinion to be formed as to the probability of the acclimatisation of the gutta percha plant in the localities chosen.

Résistance Electrique et Fluidité. By Gouré de Villemontée (Paris: Gauthier-Villars.) Boards, 3Fr.; paper, 2Fr. 50c.

The author gives in this little volume a *resumé* of the experimental work done to show the connection between electric resistance and the internal friction in liquids. Although the book is in the main devoted to the work of others, the author is evidently thoroughly at home in his subject, and shows considerable ability in its exposition. A valuable feature of the book is the completeness of the references to the original articles of the various investigators.

DIRT MARKS AND ELECTRICAL CONDUCTORS.

BY PROF. F. G. BAILY.

In connection with a recent article by Mr. Campbell Swinton (*The Electrician*, April 27, 1900) on the subject of the accumulation of dirt by electrical conductors, I venture to bring forward some further remarks on the subject, as I have had the phenomenon under observation for some time on a large scale with varied conditions, and the results are therefore fuller and more conclusive. While agreeing fully with Mr. Campbell Swinton that the effect is due to electrostatic action, I may point out that he makes an error (though perhaps only a verbal one) in talking of positive and negative. The following observations show that the sign of the potential with regard to the earth is without or almost without influence on the result.

The system in Edinburgh is three-wire continuous current, with the middle wire earthed at the station and 230 volts on each side. Therefore the line wires are positive or negative to earth according as the circuit is connected to the positive and middle or negative and middle. An examination of several hundred lamps in various supports that have been erected for about 18 months, showed that the deposit of dust round fittings or conductors was very small in all cases in which the switch was on the live side, though a certain amount of dirt had collected when the conductor passed very close to the ceiling or wall, as for example where flexible passed through eyes. When the switch was on the earthed side the deposit was always large and extended several inches from the conductor. Ceiling roses flexible, and the lamp holders were the most usual obvious cases, but even metal fittings produced the same effect if insulated from the wall. Two movable metal brackets mounted on wooden stands which hung from hooks on the wall showed the same dust marks round the base, and even a piece of string which hung

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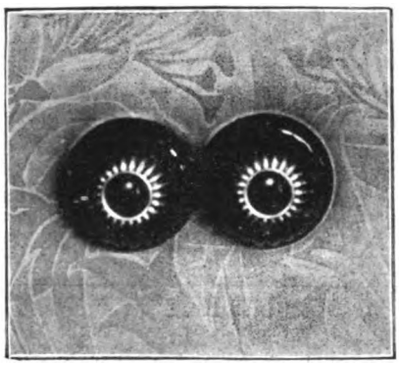
from one of them had a line of dust opposite to it on the wall. These were both on the live side, and the effect is clearly due to leakage from the terminals of the lamp holder over the porcelain insulator to the metal part of the bracket, as there was no direct contact between them. The base of the bracket was of very well seasoned wood polished on all parts, and the room was a particularly dry one, so the conditions were favourable to the retention of electricity on the bracket.

No regular difference could be definitely observed in positive and negative circuits, but there was an indication that the deposit was more on the walls on the negative side, while on the positive side the fitting seemed more covered. This would indicate that the positive charge attracted the dust more than the negative charge, but the difference was not great.

Owing to the difference of potential between the live body and the earth there will be an electrostatic field between them, a charge of electricity positive or negative on the body, and a corresponding negative or positive charge on the earth in the immediate neighbourhood. Any small light objects in the surrounding air will therefore be attracted to the charged surfaces. As Mr. Swinton points out, it can be almost completely stopped by putting the switches on the live side (not necessarily the *positive*, however), for when the lamps are burning the live and earthed conductors are very close together, and the earthed conductor forms the nearest earth for the opposite charge. When the conductors pass very close to the ceiling some of the charge is on the ceiling itself, and hence a small amount of deposit is formed there.

The rapid collection of dust on flexible that is on the live side is due to the fact that, when the switch is off, the whole of the flexible is charged with one charge, and the lines of force



radiate into the air, drawing dust to the body from a large area, while with the switch on the live side, not only is the current on for a small portion of the day, but the two wires are oppositely charged and the lines of force are concentrated between the two, as in two parallel cylinders close together, and hence the area of dust-laden space that is acted upon by an appreciable field is very small. Dust does collect on these, but to a very much smaller extent.

The effect is extremely well shown with switches which are fixed to the wall without projecting back blocks of wood. Round all of these there is a very marked ring of dirt on the wall paper, with a thin line of clean paper close to the porcelain base, as shown in the accompanying photograph. There is evidently slow leakage from the live parts to the metal cover, which is highly insulated from earth by the porcelain base, and also slow creeping of the charge down the base, so that the whole surface is electrified. The thin line of clean surface, which seems to be always present, is possibly caused by the field being very intense where the charges are so close together, causing the charged particles to be shot off again by electric repulsion.* That the marks were not due to the housemaid's duster was clearly shown by the fact that electric bell pushes and gas brackets on the same walls showed no signs of dust marks. Where a switch is near to a side wall the mark appears at the place nearest to the cover, and where the switch is fixed on to narrow casing without any back block the dust appears under the projecting base. The effect is much less marked where polished wood blocks are used, since the dust does not stick to the polished surface and is blown off, or perhaps is repelled off again, and the wall beyond is almost out of reach. Glazed paper and varnished wood wainscotting are almost free from marks.

Since the switch must necessarily be alive, it is a matter of some practical importance, for switches are frequently placed straight on to the wall paper in drawing rooms and other carefully decorated places, and a wall paper is spoilt in a few months. The switch cover should therefore be earthed by being brought down outside the base, so as to enclose it completely. No electrostatic effect can then take place, for the charge will leak away to the wall as fast as it leaks over the insulation inside. It is true that this will lower the insulation of the system, since the insulation in most patterns of tumler switch between the handle and the live parts is somewhat thin. The following test on a small house of 34 lights shows this very clearly. Testing to earth with all wires connected and lamps in, the insulation came out at 50 megohms with a pressure of about 450 volts. The handles of 10 switches were connected by a wire to a good earth, and the insulation dropped to 15 megohms. With a different set of eight switches earthed it fell to 9 megohms, and with 21 switches earthed it fell to 5 megohms. None of the switches were faulty, and they were nearly new and two of the best patterns in the market. They form, however, an undoubtedly weak part in the installation, which is otherwise excellent.

Now that 230 volts is a common pressure I think there is a real need for improvement in the tumler switch; for with the earthed return, which is also becoming usual, a person with delicate hands who is sensitive to shocks may easily receive very unpleasant information that a switch is poorly insulated. The insulation afforded by the base is a bogus and illegitimate once, since it is outside of a part which is intended to be dead, and I trust that some manufacturer will supply a switch that will not give shocks nor make dust marks, one that has an earthed cover and sound ample insulation inside. If the dust question is not heeded, electric lighting will lose some of its claim to be the cleanest form of illuminant.

* Since writing the above I find a reference to this clean space in the "Electrical Researches" of Cavendish, Art. 308, wherein he mentions that on repeatedly charging and discharging a glass plate covered with tin foil a fringe of deposit is formed on the glass with a clean interspace of $\frac{1}{16}$in. He concludes that this is the distance to which electricity spreads instantaneously—a step in his theory to account for his observation that the capacity of flat plates is not strictly proportional to the surface. I think, however, that, though the results are singularly similar, the causes are different. The marks he observed would be caused by the brush discharge from the edge of the foil tearing off particles of metal, which would be repelled beyond the space electrified by the brush discharge. In the case of the switchbases the cause may be that given above, or possibly there may be a discharge of electricity between wall and switchbase where they are very close together, the discharged part not collecting dust.—F.G.B.

THE DISTRIBUTION OF ELECTRICITY TO SCATTERED AREAS.*

BY L. ANDREWS.
(Borough Electrical Engineer, Hastings.)

A few years ago if a scattered area was mentioned in connection with the distribution of electricity, everyone would have known, without further explanation, that reference was made to a district covering an area of a few square miles but very sparsely populated. At the present time, however, a scattered area to many electrical engineers means a district containing a number of towns, several miles apart, all supplied from one generating station. This Paper will, however, be confined to the question of supplying electricity to the old-fashioned scattered area. It will also be old-fashioned in another respect, for it will deal with the old and many-times discussed question of alternating currents *versus* continuous. Until comparatively recently the advocates of the respective systems have each been willing to admit that neither system was altogether best; that the system best for one town was quite unsuitable for another. But with the successful introduction of high-voltage lamps, many of the continuous-current advocates are again attempting to claim that there is not a town in the country that could not be more advantageously supplied by continuous currents than by alternating. Others, on the contrary, still contend that a large and scattered district can be fed more economically by high-tension alternating currents than by the extreme limit of low-pressure supply yet sanctioned by the Board of Trade. To compare the merits of the two systems, it is necessary to consider: (*a*) The

* Paper read before the Municipal Electrical Association, at Leeds, June 23.

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relative capital outlay involved; (*b*) the relative annual cost of upkeep; (*c*) the comparative reliability of each system.

Instead of taking a hypothetical case for these comparisons, it is proposed to consider the relative merits of the respective systems for the purpose of supplying current to a definite area, viz., that of the borough of Hastings. The cost of the distributing networks will not be taken into consideration, as it is assumed that it would be the same for either system. The positions of the feeding points on the distributing networks would also be approximately the same in either case. To provide for the immediate future requirements 17 feeding points are required; these are generally from 800 yards to 900 yards apart. The generating station is in the centre of the borough and about 4,000 yards from the furthest feeding points. It is estimated that the average maximum demand on each feeder will be about 100 kw. The daily load factor will probably be about 10 per cent., or equivalent to 2½ hours' daily use of the maximum demand. For the low-pressure scheme it is assumed that a single independent triple concentric feeder would be run direct from the generating station to each of the feeding points; that all feeders in which the drop was less than 10 per cent. would be connected direct to the generating 'bus-bars, which would be maintained at a pressure 10 per cent. above the declared pressure of 250 volts across each side of the three-wire system; that all feeders in which the drop exceeded 10 per cent. would be supplied from other 'bus-bars boosted up to compensate for the increased drop, and that in all feeders in which the pressure at the feeding points exceeded the declared pressure by more than 2 per cent., a resistance would be inserted to compensate for the excess of pressure.

The following table gives the actual length of the feeders required for lighting the district referred to, and other particulars *re* same. For the high-pressure scheme it is assumed that a sub-station would be erected at each of the feeding points and equipped with transformers, to transform from 2,000 volts down to 500 volts or 250 volts; that instead of running independent feeders to each sub-station, a pair of feeders in duplicate would feed five or six sub-stations as shown diagrammatically in Fig. 1.

Table I.

Length of feeder.	Sectional area.	Max. drop per 100 yds. run.	Drop at full load		Full load pressure.	Full load loss.	B'ost'd volts.
			In feeder.	In resistance.			
Yards.	Sq. in.	Volts.	Volts.	Volts.	Volts.	Kw.	Volts.
20	0·2	4·8	1	43	504	8·8	...
700	0·2	4·8	34	10	504	8·8	...
1,000	0 2	4·8	48	...	500	9·6	...
1,000	0·2	4·8	48	...	500	9·6	...
1,000	0·2	4·8	48	...	500	9·6	...
1,700	0 4	2 4	41	...	507	8·2	...
1,800	0·4	2·4	44	...	504	8 8	...
2,000	0·4	2·4	48	...	500	9 6	...
2,300	0·3	3·6	83	7	506	18 0	48
2,500	0·3	3·6	90	...	506	18·0	48
2,500	0·3	3·6	90	...	506	18·0	48
2,900	0·4	2·4	70	...	510	14·0	32
3,000	0·4	2·4	72	...	508	14·4	32
3,100	0·4	2·4	75	..	505	15·0	32
3,300	0·4	2·4	80	...	500	16·0	32
3,800	0·4	2·4	91	...	505	18·2	48
4,000	0·4	2·4	96	...	500	19·2	48
						223·8	

Table II. gives the size and length of feeders required for this purpose, and other particulars *re* same:—

Table II.

Designating letter, Fig. 1.	Distance of sub-stations from works or next sub-station.	Maximum kilowatts transmitted through feeders.	Sectional area of each feeder.	Current density, amperes per sq. inch.	Max. drop per 100 yds run.	Drop at full load.	Full load loss in feeders.
	Yards.	Kw.	Sq. in.		Volts.	Volts.	Kw.
A	20	100	0·0358	700	3·43	0·7	0·035
B	700	100	0·0358	700	3·43	24·0	1·2
C	1,000	500	0·2	625	3·0	34·0	8·5
D	1,000	400	0·1550	650	3·06	31·0	6·2
E	1,000	100	0·0358	700	3·43	34·0	1·7
F	1,700	100	0·0358	700	3·43	58·0	2·9
G	1,800	400	0·1550	650	3·18	57·0	11·4
H	1,000	400	0·1550	650	3·18	32·0	6·4
I	1,300	300	0·1550	500	2·45	32·0	4·8
J	700	100	0·0358	700	3·43	24·0	1·2
K	700	200	0 0624	800	3·92	28·0	2·8
L	900	100	0 0358	700	3·43	31·0	1·5
M	700	200	0 0624	800	3·92	28·0	2·8
N	1,100	200	0·0624	800	3·92	44·0	4·4
O	800	100	0·0358	700	3·43	28·0	1·4
P	800	100	0·0358	700	3·43	28·0	1·4
Q	900	100	0·0358	700	3·43	31·0	1·6
							60·235

(*a*) *Capital Outlay.*—It is estimated that the capital outlay necessary to carry out the respective schemes referred to above would be as follows:—

To cost of laying and jointing the undermentioned cables, complete with necessary trench work, troughing, and pilot wires, &c.:—	L.T.		H.T.
7,420 yards of 0·036 H.T. concentric in duplicate, at 14*s.* per yard	—	...	£5,200
2,700 yards of 0·062 H.T. concentric in duplicate, at 18*s* per yard	—	...	2,250
5,100 yards of 0·15 H.T. concentric in duplicate, at 23*s.* per yard	—	...	5,870
1,000 yards of 0·2 H.T. concentric in duplicate, at 25*s.* per yard	—	...	1,250
3,720 yards of 0·2, 0·1, 0·2 triple concentric at 14*s.* per yard	£2,600	...	—
7,300 yards of 0·3, 0·15, 0·3 triple concentric, at 18*s.* per yard	6,560	...	—
25,600 yards of 0·4, 0·2, 0·4 triple concentric, at 22*s.* per yard	28,180	...	—
To cost of building 17 sub-stations	—	...	1,700
To cost of 68 30kw. transformers	—	...	5,100
To cost of sub-station switchgear	—	...	3,400
To cost of feeder switch panels at generating station	1,700	...	300
To cost of continuous-current boosters	1,950	...	—
Balance in favour of H.T. scheme	—	...	15,920
	£40,990	...	£40,990

(*b*) *Annual Cost of Upkeep.*—Under this heading the following items should be considered: 1. The interest and sinking fund on the capital outlay. 2. The cost of repairs and attendance to mains and distributing apparatus. 3. The cost of energy wasted in distribution. It is assumed that the interest and sinking fund would amount to about 7 per cent. per annum on the capital expended. The cost of repairs, &c., to mains is taken at 3 per cent. per annum

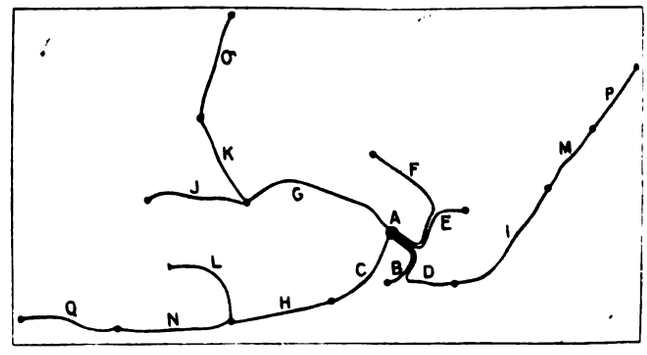

FIG. 1.

in the case of the H.T. scheme, and 2 per cent. per annum for the L.T. scheme. In considering the third item, the energy wasted in distributing networks, meters, &c., is not taken into account, as it is assumed that these losses would be practically the same for either system. The C^2R losses in feeders are obtained from Tables I. and II. The transformer losses and capacity losses in connection with the H.T. scheme, are based upon recent tests. The above losses for the district and output referred to may be summarised as follows:—

	L.T. kw.	H.T. kw.
Full Load Losses.—C^2R losses in feeders	224	60
Capacity current and transformer losses	...	60
Total full load losses	224	120
⅓rd *Full Load Losses.*—C^2R losses in feeders	25	7
Capacity and transformer losses	...	38
	25	45
10th *Full Load Losses.*—C^2R losses in feeders	2	30·0
Capacity and transformer losses	—	0·6
	2	30·6
No load losses	0	30
	L.T. B.T. units	H.T. B.T. units
Daily Losses.—Full load 1 hour per day	224	120
⅓rd load 4 hours per day	100	180
10th load 1 hour per day	2	30
30th load 18 hours per day	0	540
Total daily losses	326	870

It will be seen that in spite of the very great improvements in modern transformers, the all-day losses in connection with the H.T. scheme are still very high. These may be reduced by turning off a number of the transformers during the hours of light load. But

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even if they are all turned off, the losses through capacity current in the feeders will still be very high. It is suggested that, in some districts where the day load is always likely to be a very light one, and where, as at Hastings, it is chiefly confined within a radius of about 1,000 yards of the generating station, it would pay to disconnect the whole of the H.T. feeders, &c., during the hours of light load, and supply all current required through the distributing networks. If this can be done, it is estimated that the H.T. losses during the hours of light load will be reduced from 540 units per day to about 40 units per day. The relative annual losses of the respective systems would then be as follows :—

L.T. 326 units per day × 365 = 118,800
H.T. 370 units per day × 365 = 134,500

The cost of generating the above wasted units, will be as follows :—

	L.T.	H.T.
To standby charges :—		
224kw. at £5 per kilowatt	£1,120	...
120kw. at £5 per kilowatt	...	£600
To running charges :—		
118,800 units at 1½d	618	—
134,500 units at 1½d	—	700
	£1,738	£1,300

The total annual cost of upkeep will therefore be as follows :—

	L.T.	H.T.
To interest and sinking :—		
7% on £40,990	£2,866	—
7% on £25,070	—	£1,754
To repairs and attendance to feeders and other apparatus :—		
2% on £40,990	820	—
3% on £25,070	—	752
Rent of sites for sub-stations	—	30
To cost of current wasted	1,738	1,300
Balance in favour of H.T. scheme	—	1,588
	£5,424	£5,424

(*c*) *Comparative Reliability.*—Doubtless continuous-current advocates will say that, on this score at any rate, the advantages are entirely with their system. It must certainly be admitted that, in

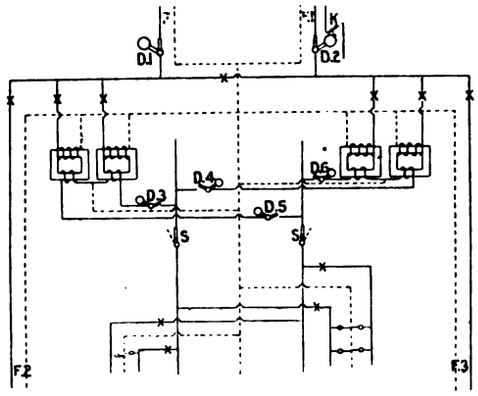

FIG. 2.

the past, low-tension schemes have not suffered from breakdowns to quite the same extent as high-tension schemes; but greater liability to breakdown does not necessarily mean a greater number of interruptions to the supply. If H.T. apparatus and feeders are efficiently duplicated throughout, a failure in any portion of the system will not cause an interruption to the supply in any district. It may very reasonably be objected that duplication costs money, but it has already been shown that an H.T. scheme duplicated throughout costs considerably less than an unduplicated L.T. scheme. It is not, however, sufficient to merely provide duplicate apparatus to be switched into use if necessary. The duplicate feeders, &c., must be connected in such a manner that in the event of a failure the faulty section will be automatically disconnected from the system, the duplicate feeder being left to maintain the supply. A satisfactory method of effecting this object is described in the author's I.E.E. Paper "The Prevention of Interruption to Electricity Supply."* Figs. 1, 2, 3, and 4, illustrate the manner in which this special system of duplication is being applied at Hastings. Fig. 1 shows the general arrangement of the H.T. circuits. Fig. 2 is a diagram of the connections, both primary and secondary, in the sub-stations. In this diagram F and F 1 represent the duplicate H.T. feeders entering the sub-station from the generating station. F 2 and F 3 are similar feeders leaving to supply other sub-stations. D 1 and D 2 are H.T. discriminating cut-outs connected to the end of each feeder to prevent a heavy current from returning *viâ* the sub-station to supply current to a faulty feeder. D 3, D 4, &c., are similar cut-outs on the secondaries of transformers. These serve to disconnect a faulty transformer from the secondary 'bus-bar, and so prevent it from short-circuiting the remaining healthy transformers. S S is a double-pole switch inserted in series with the secondary 'bus-bar. By opening this switch the secondaries of all transformers are disconnected from the distributing network. Fig. 3 shows the general arrangement of the distributing networks throughout the town. It will be seen that each distributor with its branches runs from one sub-station to another, and as all distributors are heavily fused at each end, it follows that a very heavy short-circuit on any section of the network will cut the distributor affected free from the rest of the system. The district supplied is divided into four distinct secondary networks. Each distributor is connected, either directly or *viâ* other distributors and sub-stations, to the generating station. One object of this arrangement is to enable the entire district to be supplied during the hours of light load by means of the secondary network only. Reference was made to the saving effected by this earlier in this Paper. To derive the greatest benefit from the turning off of transformers and feeders, it is necessary that this should be

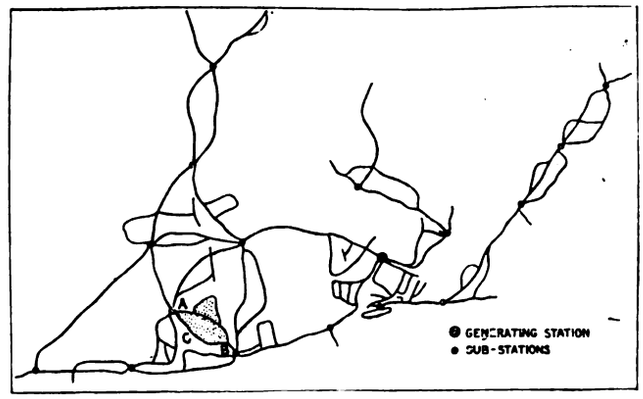

FIG. 3.

done as soon as the load falls below a certain point every night, and they should not be turned on again until the load begins to rise. The former it is comparatively easy to arrange, as turning off time will occur approximately the same time every night. But the time at which the transformers, &c., will need to be turned on, will vary from day to day, and will also depend to a great extent upon the weather; it will often, too, need to be done at a moment's notice. It is advisable therefore that the turning on should be done from the generating station. The way in which this will be affected at Hastings is shown in Fig. 4. From each sub-station a pilot wire P will be run direct to the generating station. This pilot wire will be used for the following purposes: (*a*) To indicate on a voltmeter at the generating station the pressure at the sub-station to which it is connected;

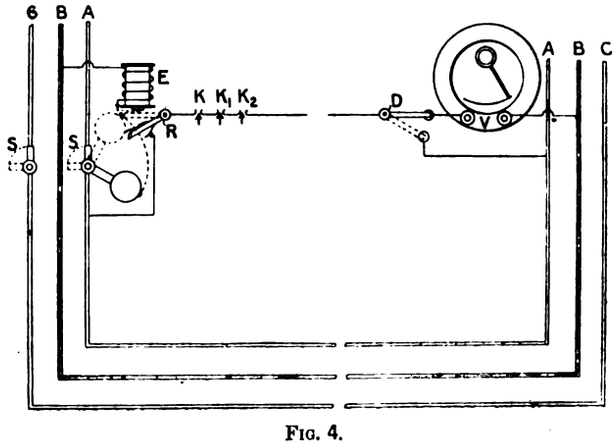

FIG. 4.

(*b*) to indicate at the generating station the position of any fault in a transformer or feeder; (*c*) to indicate at the generating station when the secondaries of the transformers have been disconnected at the respective sub-stations; (*d*) to enable the secondaries of transformers at the sub-stations to be switched on to the distributors from the generating station.

(*a*) *Pressure Indication.*—The pilot wire is connected to one of the outer wires of the three-wire system at the sub-station, and the circuit is completed through the pilot wire P, a two-way switch, D, and voltmeter, V, to the neutral or middle wire B at the generating station.

(*b*) *Fault Indication.*—A small auxiliary switch is attached to each of the discriminating cut-outs in such a manner that it is opened or

* See *The Electrician*, Vol. XLI., pp. 40 and 77.—ED. *E.*

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closed by the opening or closing of the cutouts. These auxiliary switches KK 1 and K 2 are all connected in series with the pilot wire. Should, therefore, a fault occur in any H.T. feeder or in a transformer, the cutout directly connected to it will be opened thereby, and since this will open one of the auxiliary switches in series with the pilot wire, the position of the fault will be signalled to the works by the needle of the voltmeter, connected to the sub-station affected by the fault, falling to zero.

(c) *Indication of the Cutting off of Transformers.*—Between 11 p.m. and 12 p.m. it is intended to send one or two of the running staff who can conveniently be spared at this time round to the various sub-stations to switch off the transformers. This will be done by means of the double-pole switch SS Fig. 2 and Fig. 4. This switch is weighted in such a manner that it tends to stay closed. By lifting the weight the switch is opened, and it may be kept opened by means of a small catch R. The action of lifting the weight to open the switch S S lifts the catch R, and so interrupts the pilot-wire circuit, and the voltmeter needle falling to zero indicates that the transformers at the particular sub-station have been disconnected from the distributing network. When the whole of the secondaries at all the sub-stations supplied by a feeder have been disconnected, the feeder is itself disconnected at the generating station, thus cutting off all the primaries.

(d) *Switching on Transformers.*—When it is desired to switch the transformers on to the distributing network. The switch D at the generating station is placed over to make contact with the wire A. As the pilot wire at the sub-station end is connected to the neutral wire B through the catch R and coil E, a current will now pass through the coil E, and release the catch R, allowing the weight to fall and close the switch S. If the switch D is now replaced so that the pilot wire is connected to the voltmeter V, this instrument should then indicate the pressure at the transformer station. The reading of the voltmeter will be a reliable indication that the switch SS has operated satisfactorily.

THE DISTRIBUTION OF ELECTRICITY.*

BY G. WILKINSON.
(Borough Electrical Engineer, Harrogate.)

The subject of the distribution of electrical energy is such a wide one that I cannot hope to treat it exhaustively in a Paper of the required dimensions for this Association. The question of size of conductors, types of insulation, methods of laying, regulation of pressure, methods of testing and kindred subjects would each form an ample and appropriate theme for a Paper under the above general heading, but the object of this Paper is to bring before the members of this Association certain practical difficulties and suggestions upon this important branch of the electric supply business which has hitherto been somewhat neglected in favour of more interesting but possibly less important engineering and electrical details. If the responsibility of an electrical engineer ceased at the 'bus-bars in the works, his lot in life would be a happier one than it is at present; given good design of plant, sufficient boilers, engine and dynamo power, average care and intelligent supervision at the generating station, a steady electrical pressure and a constant supply of current is assured. It is undoubtedly in the distribution of the electrical energy from the generating station to the consumers' premises that the greatest risks of failure of supply occur, and it is this department of the undertaking which is fraught with most risk; here failures of a more or less serious nature are liable to occur at any moment often without the slightest warning, occurring at widely varying periods of time, usually during wet and unfavourable weather, and possibly at a time of night or early morning when it is desirable to be in bed, or at any rate free from the cares and worries of business. It is not comfortable for any engineer to feel that notwithstanding the exercise of due care and forethought, a bad fault may develop upon the mains at any moment, and effectually stop the supply of electricity to a large proportion of the consumers. Such interruptions of supply serve to destroy public confidence, cause a large amount of loss and inconvenience, and reflect more or less upon the ability of the engineer.

Against faults on mains, the possession of accumulators provides no remedy, and assuming a proper subdivision of plant with an adequate reserve of power at the generating station, accumulators are not regarded as such an important adjunct to a station as they used to be, nor are they likely to assume an important place in large undertakings until they are much improved, reduced in price, less troublesome in upkeep and of higher efficiency. It should be one of the prime motives of an engineer to make his distribution system safe and reliable under every possible condition that can arise; no spirit of parsimony on the part of those in authority should prevent him obtaining and putting down the very best cables and joint boxes money can buy. So far as experience has hitherto shown there is no difficulty in obtaining a variety of types of reliable cables; there are at least half a dozen good makers in this country, and there are as many systems of laying mains to select from, while the types and varieties of joints, joint boxes and accessories thereto in use are far too numerous. For low-tension direct-current distribution, recent practice has led to the almost universal use of three conductors laid side by side in the same trench, and they usually fall under one or other of the following types: (1) Bare conductors carried on earthenware or glass insulators within concrete, brick or iron conduits; (2) three insulated single conductors laid in troughs, and run up solid with bitumen; (3) concentric cables, armoured and laid directly in the ground; (4) single cables drawn into stoneware, concrete or bitumen conduits; (5) three-core "clover leaf" cable armoured and laid directly in the ground. No. 1 is a method of distribution which is unsurpassed for durability and simplicity, and for low-tension currents it appears to be perfectly reliable provided the conduits are kept clear of water. It can be highly commended on account of the ease and small cost of connecting consumers' installations with the mains, the service mains can be soldered to the supply mains at any point, and no joint box is required. Notwithstanding these substantial advantages this system appears to be making little if any headway owing to the difficulty of finding room for it under the street pavement, besides which, owing to the cost of the conduits and supports, it is probably not economical in first cost for conductors of less than 0·1 sq. in. section, which is too large a conductor for the less important streets.

I believe there are few engineers more favourably impressed by this system than Mr. Wordingham, but according to the returns published in his Paper on "The Distribution of Electrical Energy" read before the Northern Society of Electrical Engineers he has less than 6½ miles of this class of mains laid down in Manchester out of a total length of nearly 32 miles of distributing mains. The St. James' and Pall Mall Co. at the commencement of their works used bare conductors laid in iron conduits very largely indeed, but there have been no extensions thereto during the last seven years, bare conductors having been discarded in favour of armoured insulated cables laid directly in the ground. Method No. 2 appears to be the most widely used system for the distribution of low-tension direct current, and possesses the important quality of durability with facility and cheapness of jointing service cables. No mechanical joint boxes for service mains are necessary, the service cables can be soldered directly to the distributors at any point, the joints being insulated and the trough refilled with the waterproof bitumen. The troughs should in every case be covered with cast-iron covers to afford protection at the top and sides against mechanical injury, and the services used in connection with this system should also be enclosed in troughs and run up solid with bitumen, the whole being protected by metal covers. Experience in many towns appears to show that a carefully laid network upon the solid system is remarkably free from faults. Methods Nos. 3 and 5 have been largely used, but they do not appear to possess the qualities of durability and permanence equal to methods Nos. 1 and 2, as the steel sheathing is liable to rapid corrosion in wet ground, but given freedom from mechanical injury the life of these cables is probably measured by the life of the lead covering in which they are enclosed: what length of time this represents there is as yet no experience to show. The recent practice of putting lead sheathing cables into earthenware ducts, and covering them with a continuous coating of bitumen, will doubtless increase the durability and life of the cables.

Method No. 4 the writer regards as only suitable for feeders from the station to the various distributing centres. A good method is to draw feeders into some form of conduits, from which they can readily be withdrawn in case of a fault or for the substitution of a larger main to meet an increasing demand. The feeders should be laid in the longest lengths possible, so as to reduce the number of joints to a minimum. These joints in all cases should be readily accessible for examination, testing or repairs. For alternating currents armoured concentric cables are most frequently used as low-tension distributing mains, and give the most satisfactory results. Clover leaf three-core and triple concentric cables, armoured and laid directly in the ground, are also largely used. The three-core cable is somewhat more expensive in first cost than the triple cable, probably because it is not manufactured in such large quantities; it has, however, the advantage that the service joint boxes and connections are much cheaper. A service joint box for a triple main costs from £2 to £3. 5s., as against half the cost for a service joint-box and connections for three-core cable of the same size; in addition to this, the triple concentric box costs more in labour to joint. This means an average saving with three-core distributors of over 25s. for each service connected, or where two services are taken from the same box 12s. 6d. per service, which is a very substantial saving, especially in the total cost of connecting up small consumers. With triple concentric distributors, it is necessary at every other service connection to cut through the outer and middle conductors to make joints on the inner and outer conductors, the alternate joints being made to the outer and middle, leaving the inner conductor intact; in many triple service joint boxes, it is necessary to cut all three

* Paper read before the Municipal Electrical Association, at Leeds, June 23.

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conductors at every joint, and this constant cutting and the frequent insertion of mechanical junctions, doubtless tends to impair the conductivity of the main. In some towns to avoid cutting the middle conductor the triple concentric distributors have been divided up into sections, each section being connected by a junction box, which changes the polarity of the inner and middle conductors, so that the middle will be + on one section and − in the next; all joints are made upon the middle and outer conductors only while the balance of load is thus kept approximately equal on the two sides of the neutral or outer conductor.

Probably the advent of higher voltage lamps and the consequent raising of the electrical pressure upon the distributors will lead to simple concentric mains entirely superseding both the three-core and triple mains for alternating-current distribution purposes. For high-tension distribution, concentric mains have demonstrated their superiority over side-by-side cables, both in point of efficiency and safety. For high-tension currents it is difficult to conceive a safer method of distribution than by concentric mains with the outer conductor earthed at the station, and the writer has known numerous instances where 2,000-volt mains have been sawn asunder by careless jointers with the current on, always with disastrous result to the saw, but with no inconvenience to the jointer beyond a blinding flash when the saw has reached the inner conductor. As a dielectric for high-pressure mains, paper impregnated with oil appears to be the most satisfactory; it possesses great resistance to electrical stresses, has sufficient flexibility if the cable is carefully handled, and the conductors can be heated to a considerable temperature before any damage is done to the insulation, which is a great advantage when sweating joints, or in case of having to overload a cable for the purpose of burning out a fault. Owing to the hygroscopic nature of the dielectric it is necessary that the cable be enclosed in a continuous metallic envelope to keep out moisture, and this appears to be the one weak point in paper-insulated cables, though the writer has only had two instances during a long experience in which paper-insulated mains have failed owing to blow holes in the lead covering.

Joints and Jointing Boxes.—Probably in no branch of electricity supply undertakings is more variety of design manifested than in the matter of joint boxes. Many engineers design their own joint boxes, and will employ no other type; some of these boxes are of good and reliable design, and a fair proportion of them are faulty and unreliable. Owing to the almost numberless designs of boxes used in the country and the consequent limited demand for each pattern, the cost of joint boxes must necessarily remain high, and in the writer's opinion it is time an effort was made to secure standard types of joint boxes and connections for all classes of cables, which shall be recognised as most suitable and reliable for the particular purpose for which they are designed. Until there is more uniformity of design and standardisation in joint boxes, disconnecting boxes, house service boxes, terminal boxes, and their accessories, the cost of connecting consumers' premises to the supply must remain high, and we cannot hope to be free from interruptions of supply, which, though happily in most cases occurring only at long intervals, constitute a continual source of anxiety to the engineer, and in the past have served to confirm a general impression in the mind of the public that electricity supply is unreliable, and should not be entirely depended upon either as a source of power or illumination. In the case of low-pressure supply network employing single cables the question of joints is not serious or difficult, and probably the best form of joint is an ordinary "married" and soldered joint well lapped with insulating strip, enclosed in a substantial iron case, and run up solid with a waterproof bituminous compound, or, in the case of rubber insulated cables, covered and vulcanised. For economical reasons the joints on low-pressure mains are buried beneath the pavements, and any faults which may develop are difficult to find; for this reason at every street corner an accessible distributing box should be provided at which the network can readily be disconnected and divided up into short lengths, enabling faults to be quickly located and repaired before they became serious. The pillar distributor designed by Mr. Wordingham for Manchester is admirably adapted for this purpose. The apparatus consists of a central iron pillar within the junction box, supported upon insulators. This pillar carries an iron plate for each pole; on each plate is fixed a ring-shaped porcelain insulator, carrying a gun-metal ring having projecting studs to which the cables can be clamped by means of nuts, the ends of the cable being sweated into lugs. A large funnel is slipped on to the top of the pillar, and serves to collect any water that may drip into the junction box, and so prevent it from falling upon the connections. Owing to experience obtained with fuses on mains, which were always put in too light, there appears to be a wide and well-founded prejudice against the use of underground fuses, especially in big undertakings, where, owing to the development of a fault upon a main, such a heavy flow of current will take place through the main as to permanently damage the insulating covering thereon from excessive heat. Under such conditions the conductor of smaller section would be fused before damage were done to the insulation of the main, and at the same time the faulty circuit would be isolated from the remainder of the network and prevent failure of supply on other mains in the immediate district. This is simpler, cheaper, and more reliable than employing automatic devices to break circuit with excess of current; and such automatic devices are subject to rapid deterioration when put underground, are liable to stick at the critical moment, or to open the circuit when it is not desired or necessary.

In joint-boxes for concentric cables the prevalent method of clamping up the outer conductors upon the insulation of the inner conductors should be condemned, as no permanently good connection can be made upon a more or less soft and elastic substance forming the insulation. The unsatisfactory makeshift of slipping a split ferrule in between the outer conductors and the inner insulation should also be abandoned, as seldom is a sound metallic contact upon all and every outer strand of the outer conductor secured by this method, the outer conductors often being hard bound in one diameter and loose in the diameter at right angles; thus in course of time, when the main becomes loaded to its full working density, heating is likely to take place at these contacts, the joint becoming impaired and the resistance of the main increased. In every case the "outers" of concentric or triple concentric mains should be bent out at right angles, radiating from the centre of the cable, and be securely clamped between two discs of metal, which also form the necessary connections in the joint. By this means a good contact is maintained between each and every strand of the outer conductor. If these discs of metal are made whole the centre conductor requires to be cut in order to get the discs into position, which is not good practice, although often resorted to. To avoid this, the discs should be made in halves, the division line of the front disc being set at right angles to that of the back disc, thus securing rigidity and good conductivity when fixed. For the same reason all joint boxes for mains should be made in halves, *i.e.*, divided horizontally in the plane of the cable, otherwise the mains have to be cut to get the joint boxes on, which is a common though bad method.

The writer wishes to enter a protest against the far too lavish use of compound in joint boxes. Waterproof bituminous insulating compound is a very useful and necessary article to the jointer, but it is a mistake to run up a mechanical joint box solid with this substance; the connections within the box should be enclosed in a light internal box preferably of incombustible material to keep the compound off the connections, and the compound should be run in solid between this internal box and the outer box. The difficulties of clearing the connections of this compound when once they are run up solid in it are very great; the compound is seldom brittle enough to chip out with hammer and chisel, consequently it has generally to be melted out with a blow lamp. As everybody of any experience knows this is a very tedious process, and unless great care and judgment are exercised the insulation of the incoming cables is damaged by the heat; such work as this has generally to be done when there is a fault on the main, and it makes it impossible to effect an expeditious repair, whereas if the compound simply formed a shell round the joint between the outer joint box and a fragile inner box the joint could be quickly cleared and the connections readily exposed for the necessary examination, alteration or repairs.

The author would like to see the prevailing custom of using wood or fibre boards in joint boxes superseded by the use of earthenware or other incombustible material having satisfactory insulating qualities; combustible material in house switches, fuses and distribution boxes has long been superseded by the use of porcelain, and possibly the same improvement will take place in underground joint boxes when a serious effort at standardisation has been made. Experience has demonstrated to the writer that in many instances substantial improvements can be effected in joint boxes if the cable ends to be joined are turned into a vertical position and enter the joint-box from the bottom. This method, which was a radical departure from the prevailing practice of that day, was probably first introduced by Mr. J. S. Raworth in 1892 on the high-pressure concentric mains laid in Huddersfield; in this case the mains are brought through glands in the bottom of a circular cast-iron base, the glands being made watertight round the cables by means of wax, thence through a disc of porcelain fixed on the said iron base and carrying the connections for the "outer" conductors; the "inners" being carried up still higher in the box by their own rigidity support the "inner" connections which are fixed by suitable screwed clamps to the ends of the "inner" conductors, the said clamp connections being covered by an inverted cup insulator formed of woodite. The whole joint box is covered by a dome-shaped cast-iron cover, the lower edge of which dips into a fossit, cast round the circular iron base, where it is made air and watertight by a filling of wax. This joint box was a great advance upon many of those in use at that time for the following reasons: (1) it is easily accessible; (2) the removal of the dome-shaped cover immediately exposes all the connections for examination or manipulation; (3) the insulation of the joint is high; (4) little, if any, combustible material is used in the construction of the box; (5) the joint box is cheap and the parts interchangeable. Joint boxes of this type are used by Prof. Kennedy upon the low-pressure mains in Sunderland and Edinburgh in which the ends of the single cables are turned into a vertical position and

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fitted with metal cone-shaped connectors; these connectors are screwed up to a heavy horizontal connecting bar, the whole being covered by a dome-shaped cover of porcelain. Four, five or six-way boxes are also used of similar construction. There may be other towns in which this class of joint is used, and probably its use will become more general in the near future for many classes of cable owing to the simplicity of the method and the considerable advantages obtained thereby. At all points where the Raworth high-tension joint box is used it is necessary that the cable ends be left long enough to overlap each other so as to allow enough spare cable to enter the box and reach the connecting bars, also the connections within the box are so close together that the joint is practically useless as a disconnecting box during period when the cables are carrying current. The writer is using a reliable and inexpensive high-tension box of this type with very satisfactory results. This joint box is cast "coffin-shaped," viz., long in one diameter and narrow in the other, in order that it may be placed upon any cable which is already laid; and by reason of the centres being wide apart in one diameter, any cable is long enough to reach up to the box terminals, provided the cable is cut at point mid-way between the two centres. This coffin box is supported with the outer metal pavement box just below the pavement level by means of brackets which not only carry the joint box, but also grip the outer lead covering of the cables, thus effectually earthing both the inner and outer boxes, and maintaining the cable ends in a vertical position at the proper centres and attitude for entering the taper glands in the bottom of the joint box; the joint box lid which is shrouded round the rim, is secured by means of swivelled bolts and wing nuts, and is made watertight by compressing an india-rubber ring between the lid and box rim. It will thus be evident that the joint box is in the best possible position for accessibility—it is above the plane of the conduits and cables, and forms no obstructions to the drawing in or manipulation of additional mains; also the joint is well above any lodgment or flow of water in the conduits and joint pits; this latter is a valuable feature in view of the number of faults which so frequently arise through water getting into joint boxes. The box carcase is cast so that it may be used either as a straight through, or three or four-way box as desired. The outer conductors, after the cables are brought through the bottom of the joint box, are spread out radially and clipped in between contact discs, the said discs being connected together by suitable connecting links, and upon each upper half of the contact disc bosses are cast, into which externally fluted hollow earthenware insulators are screwed; through these insulators the inner conductors with their insulating coverings are brought, and the inner conductors are attached to the metal terminal discs fixed on the top of these earthenware insulators. These "inner" terminals are made in various designs according to the particular use for which the box is required, and in due form an "inner" connecting bar is used forming a first-rate quick-break switch which may be pulled out or replaced with perfect safety at full load should such an operation be necessary. A watertight compound is used only for luting up the conical cable glands in the bottom of the box, the whole of the internal connections being thus left exposed for examination, testing or repairs. These boxes in any size up to 300kw. size (viz., 150 amperes at 2,000 volts) complete with all accessories, including outer box, fixing in the pavement, jointing up, jointer's time and all labour, cost less than £5. 5s. each, while the cost of brick pit and pavement cover alone for many types of boxes exceeds this figure. In the writer's experience previous to the introducion of this type of high-tension box the cost of brick pit, pavement frame, cover, and internal joint box for concentric cables, including labour, fixing and jointing up was never less than £7. 7s. 6d. Doubtless in the near future triple mains of the "Clover Leaf" type will be extensively used for power transmission through long distances by means of multiphase currents at extra high pressure; for these mains joint boxes of the type just described possess valuable features, as they may be depended upon to stand any practical working pressure with safety, all the internal parts can be formed entirely of incombustible and durable material, and all inflammable compound may be entirely dispensed with. Another form of joint on concentric mains which should be mentioned is the simple soldered and wrapped joint, which is protected from moisture by covering lead sleeve of larger diameter than the lead tube covering the cable, and to which it is united by plumbers' wiped joints; this form of joint when carefully made appears to be reliable, but no engineer would entertain the idea of using this class of joint exclusively on a distributing network.

A fruitful source of trouble and failure on high-tension alternating current networks laid in residential neighbourhoods arises in the connections made between the concentric mains and the terminals of the small transformers installed in the houses. Usually the concentric mains are taken into a small joint box, and united therein to "side-by-side" rubber-covered mains which in turn are taken to the primary terminals of the transformers. In cases of this kind the writer has, by means of a special cable terminal end and cover, always concentric mains directly to the terminals of the transformer without the intervention of a joint box, and in no single instance has a fault ever developed,

Below is an abstract of the discussion which followed the reading of the foregoing two Papers by Mr. L. Andrews, of Hastings, and Mr. G. Wilkinson, of Harrogate, before the Municipal Electrical Association.

Mr. J. F. C. SNELL (Sunderland) felt that Mr. Andrews' Paper was a challenge to direct-current men. He would like to place before them some figures based upon Mr. Andrews' own calculations which would show a different case for the direct-current stations. There were, however, towns where obviously nothing but alternating current would suffice. He observed in Mr. Andrews' Paper that the total plant installed in the station was 1,700kw. Instead of 17 feeders allowed for he (Mr. Snell) would say that 12 feeders would suffice for the purpose. In that case there would be very much less trench work to provide. Mr. Andrews put down a triple concentric or three-core cable for each of his feeders, but a two-wire feeder would suffice amply. The feeders would then cost £24,750 instead of £37,340. The feeder panels would be covered by £1,050 instead of £1,700, making a total cost of £25,800 for the feeder system. Turning to the high-tension scheme, he had never been able to construct a sub-station yet for £100, and he thought that the £1,700 was much under-estimated for the 17 sub-stations. Instead of there being a balance in favour of the high-tension system of £15,920 there would only be about £730. He considered also that when making comparisons the transformers should be taken as part of the feeder system, and the loss on these would be 870 units per day instead of 370 as quoted. Turning to the annual cost and upkeep the figures would now be materially altered. The repairs on feeders for direct current stations taken at 2 per cent. was much too high. His experience over 12 years proved to him that one per cent. was ample for direct current work. This would reduce the figure of £850 to £258, and the total expenses would be £3,802 instead of £5,424. He believed the two schemes would work out practically the same. His point was, that if two schemes of 1,700kw. each were compared in any particular district which was not scattered, he did not think there would be £100 difference in the two schemes.

Mr. E. W. COWAN (Salford) said there were two ways in which to reduce the day losses—one within the station and the other outside. He considered the relative advantages of continuous and alternating current in relation to any particular area was a difficult subject to discuss. He thought it was best to disconnect the high-tension feeders from the network in order to save losses. Mr. Boot had indicated the ways for doing this, and Mr. Andrews had a complete scheme. Unless they knew that the switches were absolutely to be depended upon it would never do to give them such an important function to perform as automatically connecting and disconnecting transformers. The method suggested for a member of the staff to go round and switch on and off the transformers was hopeless in practice. A sudden demand from any cause would absolutely produce disaster, as there would be no time to send a runner round to switch on the different transformers. Switching feeders on and off abruptly ought not to be done in connection with any high-tension station, especially in a station with a scattered area and long feeders of any capacity. Dr. Fleming and others have pointed out that in a 2,000-volt distribution system by abruptly opening a switch you may get 100,000 volts on your feeder, and he had experienced so much trouble from this increase of the pressure that he would not allow it to be done at any station with which he was connected. The simplest way would be to connect the switch on to a 'bus-bar and run down the machine slowly. If automatic switches could be got which were reliable that was the right thing to do.

Mr. C. H. WORDINGHAM (Manchester) said that Mr. Snell had already stated what he would have liked to have said himself upon Mr. Andrews' Paper. He would have been pleased to see some mention of the high-tension continuous current work, as he thought that would have afforded a better discussion than the other two systems of high-tension single-phase and low-tension direct current. With reference to bare copper mains he looked upon ¼ sq. in. as the lowest limit of size for running bare copper conductors; he would never think of putting in a main of this kind less than ¼ sq. in. diameter. In some of the outlying districts all the large mains were bare copper in work which he had recently done. He thought the thick pitch pine cover was the best one could have, even better than cast-iron. Mr. Wilkinson mentioned that the hydroscopic nature of the dielectric necessitated the cable being enclosed in a metallic envelope. It seems to him (Mr. Wordingham) that this metallic envelope was dangerous where trams were about.

Mr. H. FARADAY PROCTOR (Bristol) pointed out that in Bristol the cost of building sub-stations, with walls 21 in. thick, and built in the most perfect manner, did not exceed £70 each. With regard to switching off the high and low pressure from the mains the proper way was to switch off first the high-tension leaving the pressure on the cable fed from the low-pressure transformer. It seemed to him the only danger from the rise of pressure would be in the continuous current station, as there were no transformers to take the pressure off gradually.

Mr. W. A. CHAMEN (Glasgow) said that owing to extraordinary conditions existing at Glasgow they had had to give up the use of bare copper conductors altogether. In Glasgow they could not retain any right for their mains under the footpaths, and they were obliged to keep taking the mains from the footpath and putting them under the street, and he believed it was very dangerous to have electric lighting culverts under the street with bare copper mains. They started in Glasgow with two systems—one using cast-iron troughing and the other earthenware troughing—both run in with bitumen or pitch. The cast-iron seems the best; but if the lead was made alive through a fault it gradually run on the lead until it could find its way through the bitumen, and then serious trouble followed. Whenever they opened any of these troughs with lead-sheathed cable in they made a point of connecting the lead metallically with the trough. With regard to the earthenware troughing, it was impossible to make good joints between the ends of the troughs, and the result would no doubt be in time that if the lead got alive electrolysis

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would occur there. The result of this was that they have decided to go back to wood troughing, and they were trying now to use cables without lead sheathing.

Mr. A. S. BARNARD (Hull) would like to draw attention to the point Mr. Wordingham had raised, *i.e.*, high-tension continuous current for a town of that size. It had one or two great advantages over alternating stations on the lines suggested by Mr. Andrews; they could cut out the whole of the high-tension mains and transformers and so save the loss through the high-tension mains. In Hull they were able to control the whole of the high-tension feeders from the generating station, which saved the expense of sending a man round to switch off the transformers, &c. They had four sub-stations with 13 large transformers in them, and they send a man round during the day to attend to the lubrication. They could at any time switch on or off the transformers as desired from the generating station.

Mr. G. M. HARRIS (Bray) differed with Mr. Wilkinson on the question of jointing; he thought of all the forms of jointing concentric cables two plates clamped together was the worst. They had had great trouble from that and he considered that the proper way was to bring the outer to one side and joint them round, using solder and putting them in a proper box. He was much interested in Mr. Chamen's remarks about troughing, but there was one form he had not mentioned which he (Mr. Harris) had tried, and that was the concrete form. He thought the proper thing to put on the top of the cables was a board.

Mr. J. E. EDGCOME (Kingston-on-Thames) said the conclusions they seemed to have come to were that the low-tension men *thought* they were right, but the high-tension men *knew* they were right. He agreed with Mr. Barnard that the high tension continuous current had its advantages, but unfortunately for that particular theory there was such a large capital expenditure involved.

Mr. R. TURNBULL (Tynemouth) thought the difficulty of regulating the pressure on mains might be got over by having transformers giving different voltages on the secondaries, some 100 and others 101, &c., according to the load which they had to carry.

Mr. H. R. BURNETT (Barrow-in-Furness) said Mr. Andrews' calculations were based upon 10 per cent. drop at full load, but he thought it would be more economical to work with 15 per cent. drop at full load. The average loss of 10 per cent. at full load would probably mean not more than 5 per cent. of the average loss throughout the 24 hours.

Mr. H. L. P. BOOT (Tunbridge Wells) stated that the cost of a distributing system on low tension was considerably more than on the high tension because it was a difficult matter to run another feeder on the low-tension system to the point where the load increased rapidly, but it was an easy matter on the high-tension system to add another transformer. He did not favour automatic disconnection of transformers as they were liable to go wrong.

Mr. L. ANDREWS (Hastings) replying to Mr. Snell, said he mentioned 17 feeders because this made an average length of 900 yards to 1,000 yards, and it seemed to him that if only 12 were used they would have very poor lights at certain points. He thought it was necessary to have boosters or resistances to equalise the pressure, otherwise in some parts the voltage would vary considerably. He knew continuous-current men liked to talk about the simplicity of their system, but he preferred a high-tension alternating-current transformer to the running machinery necessary with continuous current. He mentioned £100 as the cost of a sub-station, as he wished to be on the top side; as a matter of fact, he had constructed many, with glazed bricks inside, at a cost of £80 each.

Mr. G. WILKINSON (Harrogate), in replying, said most people considered they were entitled to have the light whether they were in the outer districts or in the centre of the town. The outer districts could not be supplied on a low-tension network as these mains could not be run to all the outer districts; the capital outlay would be too heavy to make the undertaking a success. He was glad to see Mr. Wordingham agreed with him that bare copper conductors should not be used for sizes less than 250 amperes.

THE PROTECTION OF TELEGRAPH AND TELEPHONE WIRES IN CONNECTION WITH OVERHEAD TRACTION.*

BY R. C. QUIN.

(Borough Electrical and Tramway Engineer, Blackpool.)

This question at the present time is of special importance in view of the number of traction systems now being installed throughout the Kingdom, and in view also of the fact that there is such a divergence of opinion and practice. This latter is most marked in connection with the two Government Departments concerned, the Board of Trade and the Post Office. That overhead telegraph and telephone wires need protection will be admitted, but how shall this protection be best given? To the author the best method appears, and he thinks his readers will agree with him, to be the placing of these telegraph and telephone wires underground where they cross the line of tramway route. He believes the Telephone Company are not averse to this course being adopted; but we are met with the absolute refusal of the Post Office to consider any such proposition. Under these circumstances we must recognise the existence of crossing overhead wires.

The most usual practice until a comparatively recent date was to place guard wires above the overhead trolley line at a distance of about 18in., these wires being of galvanised steel and supported by insulators. There is a question which the author has often asked, and to which he has not, as yet, received a satisfactory reply, and therefore he takes the liberty of placing the question before his readers. It is this: "What are the insulators intended for?" Are they to protect the telegraph or telephone wires or the trolley line? Assuming that we adopt guard wires, they should be supported on poles 2ft. above the trolley line, but they should not be insulated. If a telegraph or telephone wire break what need is there to insulate from earth? If two guard wires in the same horizontal plane and 18in. apart be placed over the trolley line, the probability is that the broken telegraph or telephone wire would not come in contact with the trolley line or passing trolley; but it might do so. In that event it is better that the guard wire should be efficiently connected to earth, as a short circuit would be the result, and if both lines, telegraph and telephone, and trolley line be properly protected by maximum current apparatus no damage would ensue. The author would, however, point out that it is not sufficient to have these guard wires clamped to a traction post, when the traction post is bedded in concrete. There should in all cases of guard wires be two poles bonded to the rails, and these poles should preferably be the end ones of the guard wire section. The telephone and telegraph wires should be provided with fusible cutouts or other similar device for the protection of the terminal instruments, and this is a matter of no great cost. With these precautions there need be no fear of electrical accidents from overhead telegraph and telephone wires.

There is another system of protection now largely adopted, and which consists of fastening to the trolley line brass clips, and placing vertically over the trolley line a wooden moulding of greater width than the trolley wire. This system, to the author, appears to have several objections. It is more unsightly than the guard wires, and brings the trolley line into greater prominence. There also appears to be difficulty in thoroughly securing these strips, for in most towns in which they are in use many lengths have become detached. Further they do not afford the same protection as guard wires. A telephone wire may break and fall on the strip, but so far no great damage results. A car, however, comes along, and as has happened the driver does not notice the fallen wire, but the cheeks of his trolley wheel touch the wire forming contact between it and the trolley line. We then have a live telephone wire earthed only through its terminal instruments, and a live dangling wire on the car, which is not assuring to the passengers.

There is a third method which is advocated by the Post Office, and that is a system of bunching telegraph wires so as to reduce the number of crossing places, and then forming an insulated cradle or hammock round these wires. The principal objection to this course would be extreme unsightliness. It moreover by no means follows that if a wire breaks it will not fall through the cradle, as the meshes are 2ft. to 3ft. square.

If we are to regard as impossible the laying underground at crossing places of telegraph and telephone wires, then the author suggests the following as the best method to protect telegraph and telephone wires. (1) The erection of two guard wires 18in. apart, at a minimum height of 2ft. above the trolley line. (2) The length of the guard wires to be such that should the crossing telegraph or telephone wire break close up to one span insulator, and be blown horizontally in either direction it could not, when falling, come in contact with an unguarded portion of the line. (3) Each span of guard wires should be separate and distinct from its neighbour, but metallically looped across. (4) No insulators whatever should be used, but guard wire standards be bolted direct to the bracket arms, or to the span wire, as the case may be. (5) The terminal posts of each length of guard wire should be bonded to the tram rails. (6) The trolley line should be divided into sections, and each protected by a maximum current device. These sections should preferably not be of equal length, but proportioned for equal maximum working current. (7) The crossing span of telegraph or telephone wires should be terminated by a disconnecting insulating shackle on each side and the connection across these shackles should be by fusible metal bridge. If these suggestions be carried out, the author considers that all that is humanly possible to protect overhead telegraph and telephone wires will have been done.

The following is an abstract of the brief discussion on the above Paper:—

Mr. A. S. BARNARD (Hull) agreed with Mr. Quin's views upon this subject. There were many different kinds of overhead wires, and they were bound to have some means of keeping them off the overhead trolley wire. He thought the minimum height of 2ft. above the trolley wire was too much, as there was great risk of the loose end swinging round and coming in contact with the trolley. In Hull they had only a difference of 8in. rise above the trolley wire, and since they had exercised great care in drawing the trolley wire tight they had no trouble with these. He said it was very difficult to estimate where the maximum load would be required in the level districts.

Mr. A. E. LE ROSSIGNOL (Newcastle-upon-Tyne) did not agree with all the points mentioned by Mr. Quin. He thought the guard wires should

* Paper read before the Municipal Electrical Association, at Leeds, June 23rd.

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not be earthed, as they would then be very dangerous to men who had to work on the trolley wires. He suggested that the guard wires should be insulated from earth, or a switch should be put in the pillars, so that the earth connection might be cut at any time to prevent men from experiencing a shock if they happened to put their heads against the wires when repairing the trolley wire. The trolley wires should be protected by a maximum current device, and he thought this device should be in the station. With regard to telephone wires, one of the worst troubles arises when one wire has dropped and the guard wires are earthed. It fuses away as it touches the trolley, and the cutout falls out at the works. On the Continent they put up in front of the insulator, carrying a telephone or telegraph wire across a track, a metal stirrup solidly connected to earth, so that when the wire breaks it touches this before it can reach the trolley. He thought the best method was to earth the whole of the guard wires through a switch, and be able to pull that out at any time.

Bailie WILLOCK (Glasgow) said "Prevention was better than cure," and he thought the best way was to put the wires under the streets. The grand secret was to get the telephones into the hands of the municipalities and have the wires put underground. They would then have a good telephone service without these risks.

Mr. R. C. QUIN (Blackpool), in reply, said that when he fixed the minimum distance of 2ft. between the guard wire and the trolley wire he had in his mind the swaying of the trolley line and the jumping of the trolley pole; his experience showed that 2ft. was the limit. The length of a section depended upon the density and the gradients. As regards the maximum current device, there was a great advantage in placing these in the section box. The disadvantage referred to by the telephone wires falling and fusing while replacing the cutouts at the station would be obviated by the section cutout. With regard to having a switch connected with the guard wire, he thought this would be very convenient, but as a general rule, when repairs were going on, the current was not on the trolley wires.

CORRESPONDENCE.

THE SOUTHPORT TRAMWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We regret to have to call your attention to a statement appearing in your article on the Southport Traction system in your issue of August 3rd, in which you state the overhead construction was erected by us, and remark as follows: "Some details in the attachment of the guard wires and anchor wires are open to criticism, as, for instance, making-off the anchor wires on the trolley wire ears and the omission to secure the guard wires (which are also noticeably kinked in places) to the hooks. *The latter is a serious defect, for in the case of a guard wire breaking several hundred yards might come down.*"

While all work is open to fair criticism, to which we cannot object, yet we most strongly object to the last sentence in the above paragraph, and demand that you recall it. In the first place, there are hardly any sections of guard wire in Southport that exceed 200 yards in length; in the second place, your statement is incorrect, as the guard wire is properly secured and tied in to each support, and cannot come down in the manner you state.—Yours, &c.,

MACARTNEY, MCELROY & CO. (LTD.)
J. F. Macartney, Managing Director.

London, August 3, 1900.

[We regret that the word "properly" was omitted in the first sentence quoted above, before the bracket. On the opening day, July 18th, the guard wires were certainly not secured in a workmanlike manner. It is interesting to know that in hardly any case could *more* than 200 yards of guard wire have come down.—ED. *E.*]

THE ENCLOSED ARC LAMP PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the note appearing in your recent issue *re* the discontinuance of our action against William Jones Davy, we must ask you, in justice to The Jandus Arc Lamp and Electric Co., Limited, and to our many licensees, to state that proceedings in the nature of a test action upon the Jandus patents are now pending in which we are advised that (as in the recent Johnson and Phillips action) we shall have a successful issue. We shall then deal with the small infringers as we did with those licensees who, to their own detriment, elected to join hands with Messrs. Johnson and Phillips in disputing our rights under our licenses.—Yours, &c.

For the Jandus Arc Lamp and Electric Co., Ltd.,
London, August 8, 1900. A. A. GILLIES, Secretary.

LEGAL INTELLIGENCE.

Postmaster-General v. Loch.

In the Edinburgh Small Debt Court recently, the Postmaster-General sued Mr. Adam Loch, a contractor, for the recovery of £9. 8s. 1d., damage alleged to have been caused to a telegraph line underneath a public thoroughfare in Leith. It was alleged that the telegraph line was melted by the heat from a tar boiler which defender employed for his business For the defence it was urged that as the defender did not know the telegraph line was there he should not be held liable. Eventually Sheriff Reid gave judgment for the amount claimed.

Charing Cross and Strand Electricity Co. v. Johnson and another.

This case was in Mr. Justice Cozens-Hardy's list yesterday (Thursday), but before the case was called on Mr. Eve, Q.C., stated that it was a right-of-way-case, but he could not ask his lordship to try it on motion. No undertaking would be given, and the motion by consent would stand until the trial of the action.

Burke v. British Blahnik Arc Light Syndicate.

In the Chancery Division on Tuesday, Mr. Justice Kekewich heard an adjourned motion for the appointment of a receiver. It was now explained that the consent of a trustee for the debenture-holders was not obtainable owing to his being away from town. His Lordship made the declaration asked for.

Re London Electrical Cab Co. (Ltd.).

The petition by C. E. Foster and others for the winding-up of this company has been, by consent, ordered to stand over until after the long vacation.

PARLIAMENTARY INTELLIGENCE.

NATIONAL TELEPHONE CO. AND GLASGOW CORPORATION.

In the House of Commons on Monday Mr. Provand asked the Secretary to the Treasury whether the National Telephone Co. had intimated to the Postmaster-General that they agreed in terms of sec. 3 of the Telegraphs Act, 1899, to it being made a condition of their licence that they would not give preference to any person within the area specified in the licence granted by the Postmaster-General to the Corporation of Glasgow, and would not within that area, as a condition of giving a service, require any person to grant any facility except for the purpose of supplying telephonic communication to that person; whether the company had claimed, in respect of coming under this condition, that the permissive powers to open streets in certain burghs within that area now hold good for the whole term of their licence, and, further, that their licence be extended from 1911 to 1913, so as to terminate at the same time as the licence to the Corporation of Glasgow; whether the company had issued a print of an agreement with subscribers in the Glasgow area, dated June 18, 1900, under which the intending subscriber must bind himself as a condition of receiving a connection from the company not to subscribe to any exchange telephone system other than that of the company, or use at any of his premises any telephone instruments in connection with any such other system, and the company thus proposed to give favour of preference to persons in the Glasgow district who did not join the Corporation telephone exchange as against those persons who joined that exchange; and what steps the Postmaster-General was prepared to take to secure that the company should not obtain privileges under last year's Telegraphs Act and at the same time refuse its obligations.

Mr. HANBURY said the National Telephone Co. had stated to the Postmaster-General that they were willing that the conditions mentioned in the question should be made a condition of their licence. They had also undertaken to prove to the satisfaction of the Postmaster-General that they had incurred or contracted to incur material expenditure in laying underground wires in certain burghs in the Glasgow area, and had acquired powers for the purpose under agreements with the local authorities. The Postmaster-General was not aware that the company had at present claimed that the powers given by their agreements with local authorities in the Glasgow area would hold good during the period of the licence granted to the Corporation of Glasgow, and that their licence would be extended for the full period of the Corporation licence; but when the conditions to be observed on the part of the company had been duly complied with they would no doubt claim that they were entitled to the advantages specified in sec. 3 of the Telegraph Act, 1899. The Postmaster-General's attention had been drawn to the form of agreement offered by the company to their subscribers, and there was some doubt whether the condition mentioned could be held to be a breach of the undertaking not to give preference to persons in the Glasgow area; but there was another condition in the agreement—that as to granting wayleaves for the lines of other persons—which would unquestionably be a violation of the undertaking not to require any person to grant any facility except for the purpose of supplying telephonic communication to that person. Any breach of the new conditions which the company were to accept as conditions of their licence would, when those conditions were legally in force, render the company liable to the same penalty as a breach of the original conditions, and that penalty was the termination of their licence.

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LOCAL AUTHORITIES AND TRAMWAYS CONSTRUCTION.

In the House of Lords on Thursday last Lord RIBBLESDALE asked the Chairman of Committees whether he had considered the expediency of proposing an alteration of Standing Order No. 22, the effect of which was to give local authorities a veto upon any proposal for the construction of a new tramway. In the event of the London County Council promoting a tramway bill they had to obtain the consent of the local authorities and accept such conditions as the local authorities desired to impose, not always in the public interest.

In reply, the EARL OF MORLEY said he hoped next session to propose an amendment of the standing order.

MUNICIPAL TRADING.

A report was issued on Saturday by the Joint Select Committee of the House of Lords and the House of Commons on Municipal Trading. Owing to the Committee having been appointed at a comparatively late period in the session the report states the Committee has not been able to bring the inquiry to a satisfactory conclusion before Parliament rises. The report recommends that the Committee be re-appointed next session.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Acts of Parliament.—Royal assent has been given to the following acts :—

Aberdeen Corporation Tramways.
Airdrie and Coatbridge Tramways.
Aston Manor Tramways.
Barnsley Corporation.
Blackpool, St. Anne's and Lytham Tramways.
Bradford Corp. (Tramways, &c.).
Bray and Enniskerry Railway.
Brighton Corporation.
Charing Cross & Strand Elec. Supply Corp. (Ltd.) (Further Powers).
Christchurch & Bournemouth Trams.
Cork Electric Trams. (Extension).
County of Durham Electric Power Supply.
Devonport Corporation.
Edinburgh Corporation.
Electric Lighting Orders, Nos. 6, 7, 8, 9, 10, and 12.
Great Grimsby Street Tramways.
Hamilton, Motherwell and Wishaw Tramways.
Hastings Tramways.
Huddersfield Corporation Tramways
Ipswich Corporation Tramways.
Lancashire Electric Power.
Lancaster Corporation.
Liverpool Corporation.
Liverpool Overhead Railway.
London County Tramways.
London County Tramways (Electrical Power).
London United Tramways.
Mersey Railway.
Newcastle-upon-Tyne Elec. Supply Co.
North Metrop. Elec. Power Supply.
Nottingham Corporation.
Plymouth, Stonehouse and Devonport Tramways.
Preston Corporation.
Rawmarsh Urban District Council Tramways.
Reading Corporation Tramways.
Rochdale Corporation.
South-Eastern Metropolitan Trams.
South Lancashire Tramways.
South Staffordshire Tramways.
South Wales Electrical Power Distribution Co.
Southport and Lytham Tramroad
Vale of Rheidol Light Railway.
Walker and Wallsend Union Gas Co. (Electricity Capital).
Wellingborough & Dist. Tramroads.
Whitechapel and Bow Railway.

Aldershot.—Edmundson's Electricity Corporation have written to the District Council suggesting that as the Council possess a provisional order they should arrange the necessary loan for erecting electricity supply works, and they would undertake to carry out the whole of the works required under the Council's supervision and at prices to be arranged. The company would undertake to manage the works when erected for seven years, taking all profit or loss which might be made, and guaranteeing to the Council the payment of interest and sinking fund due upon their loan. The Council would also have the option of taking over the works at seven years, on paying the company a premium of 15 per cent. upon the capital expended, or at 14 years on payment of 10 per cent. on the capital expenditure. The offer has been referred to the Electricity Lighting committee.

Barnstaple.—It has been decided to engage an electrical engineer to advise on the best means of carrying out the terms of the Council's provisional order.

Belfast.—The Electric committee have included in their report to June 30 the following resolution :—

That a record be made of the committee's appreciation of the able and courteous manner in which Mr. V. A. H. M'Cowen has discharged his duties as chief engineer, which included the designing and establishment of the present electricity works, rendered necessary by the rapid development of the undertaking under his charge.

Bradford Corporation Tramway Contracts.—Messrs. R. W. Blackwell & Co., who carried out the electrical equipment of the Bradford Corporation tramways to Great Horton and Eccleshill, recently addressed a complaint to the Bradford Corporation alleging that, in connection with the tramway extensions now in hand (for which their tender was £13,540), the successful tenderers, Messrs. Macartney, McElroy & Co. (whose tender was £12,064), had been allowed detailed deviations from the specifications, which amount to a saving of £851. This communication was considered at a meeting of the Tramways sub-committee on Wednesday, when a letter on the subject from Messrs. Macartney, McElroy & Co. was read. No resolution was passed, but a report will be submitted to the Tramways committee in due course.

Braintree (Essex).—The Council will oppose the proposed application of the North British Electricity Supply Co. for a provisional order.

Burton-on-Trent.—The surveyor (Mr. Lynham) has submitted a report on the proposal to construct tramways in the district, but before proceeding further the Council have decided to obtain a report from Prof. Kennedy on the matter.

Cardiff.—At the meeting of the Lighting and Electrical committee last Thursday it was announced that the borough electrical engineer (Mr. N. Appelbee) and four members of his staff had sent in applications for increased salaries. At the meeting the chairman (Mr. Hallett) presided. The following is an abstract report of the proceedings culled from the *Western Daily Mail* of the 3rd and 4th inst. :—

Mr. APPELBEE said it might be interesting to know that five of the staff were seeking employment elsewhere.

Mr. GOOD : I am very glad to hear it.

Mr. FOX : When we advertise we have plenty of applicants.

The CHAIRMAN : We shall not be able to do anything with the electric light until we have swept the whole lot out. After what has happened and what Mr. Appelbee has said this is proved conclusively. All they want is to get as much money as they can out of the ratepayers and to do as little as possible.

Mr. MORGAN THOMAS : Everyone is playing off his own bat.

The applications were deferred.

A letter was read from Mr. W. H. Illingworth resigning the post of superintendent of mains, to which he was appointed in June.

Mr. FOX thought before they accepted the resignation they should hear what Mr. Illingworth had to say. It was a most extraordinary thing, and he moved that they decline to accept the resignation until Mr. Illingworth appeared before them.

The CHAIRMAN : You must be careful. Suppose he won't come here ?

Mr. APPELBEE said he was not surprised at the resignation. He did not think Mr. Illingworth had been comfortable at Cardiff, and he had received two offers from elsewhere.

Mr. M. THOMAS said he had heard that the men under Mr. Illingworth were not capable, in his opinion, to carry out the work successfully, and that he had complained repeatedly.

Mr. APPELBEE said he had the highest opinion of Mr. Illingworth's qualifications, and should be sorry to lose him.

The next day Mr. Illingworth appeared before the Committee :—

The CHAIRMAN said they received his resignation with regret, and felt there was something behind it all.

Mr. ILLINGWORTH said, personally, he would have preferred to have his resignation accepted without going into details as to the reason why he had taken the step. He assumed that the committee held him responsible for the efficient distribution of electrical energy in Cardiff. He had heard of their failures in the past, and, as mains superintendent, he feared his reputation might suffer if such failures again occurred. They must look forward to a much larger demand for energy, and he had found on examination that to prevent failures during the approaching winter it would be necessary to make many alterations to the distributing stations, to the tanks and mains, and to the low-tension network. The stations were not in a good condition as to equipment an cleanliness. In many instances the transforming cases were not properly earthed. He had reported matters on a good many occasions to the deputy-engineer (Mr. Teasdel). So far, however, he could not see any great improvement. Having regard to the approach of winter, he felt that, unless something were done, he could not be responsible for the proper and efficient supply and distribution. He had also had some trouble, which he looked for, from the mains. He heard that the department had not been properly handled—he did not know through whose fault—and he found that the men had got into dilatory ways, and were not at all sharp and attentive in the discharge of their duties, though of late an improvement in that respect had been noticeable. He had been superintendent of mains in Salford and Halifax, and had many years' experience in carrying out schemes and estimates. It was necessary to get out of the men's heads the idea that because they worked for a corporation they could do a different day's work than for a private firm, a feeling which certainly had existed, although it was wearing away now, and would probably disappear in time. One matter that had caused friction was the fact that the public works department did a good portion of the work, such as excavating, laying conduits, &c., whilst previously it had always been his custom to take a job in hand and carry it through. These and other matters troubled him, and led him to fear that, unless thing were different, he might later on find himself in an awkward position. Probably they would have breakdowns and then they would be justified in saying he was not fit for the position, and that would be a stain upon his reputation. Regarding these and other personal matters he did not know that he had complained directly to Mr. Appelbee, it being his intention not to trouble him at all. However, he did communicate with Mr. Appelbee before writing his resignation, and he had also stated in his book that he had had trouble with the men. He did not say the men were not efficient, for if they liked they could be efficient. He had conveyed in writing to Mr. Appelbee a great many things he considered it necessary to do. When he came to Cardiff he was handed a list of consumers' premises which he was told had been examined and the work completed, but on inspection he found nothing had been done, and so he had to start to do all the work over again. He was told the free library had been completed, but he had had four or five men employed there every week. He did not complain so

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much of the mains as of the distribution centres, the tanks, and the low-tension network. Undoubtedly, it would be better if he could be in direct communication with Mr. Appelbee.

Mr. APPLEBEE said he took the whole responsibility for the outdoor department—the responsibility which he had from them, and which he accepted. He had received no complaints from Mr. Illingworth, and the first time he heard of any friction was two days before Mr. Illingworth's resignation was received. Mr. Teasdel had not said a word to him. He reminded the committee that it was they who instructed him to make Mr. Teasdel his deputy. He did not make the appointment, and he did not think that Mr. Teasdel was a fit man to be deputy, having regard to his training and qualifications. Moreover, the friction was not limited to Mr. Illingworth.

Mr. GOOD: Why do you allow your deputy to give instructions?

Mr. APPLEBEE: I have carried out your instructions.

Mr. FOX urged that a vast improvement would be affected if Mr. Illingworth were made solely responsible to Mr. Appelbee and the committee.

Mr. M. THOMAS favoured a thorough reorganisation of the department, Mr. Illingworth to be asked to withdraw his notice pending the inquiry.

Mr. ILLINGWORTH, in deference to the committee, consented.

The CHAIRMAN said things were going from bad to worse. If anything happened the committee would be blamed. If anything went wrong, Mr. Appelbee got behind the powers given him, or else he put the blame on somebody else's shoulders. It was Mr. Appelbee's duty to see that Mr. Illingworth did his work, instead of sending for his deputy, and things ought to go on smoothly, as in any large engineering department. They had had nothing but trouble since this department came into existence, and the time had come to ask Mr. Appelbee to resign. That was his view, and he could not express it too strongly.

On the motion of Mr. M. THOMAS, the inquiry was adjourned, Messrs. Appelbee, Teasdel and Illingworth to attend.

Carmarthen.—Owing to a disagreement with the gas company as to quality and price of gas, the Council have decided to engage an electrical expert to report on the question of establishing electricity supply.

Chile.—During 1899 negotiations were in progress for the establishment of electric tramways in Valparaiso, but owing to the opposition of the existing horse tramway company, the project fell through. The owners of these latter lines have a clause in their concession that their tramways shall not at any point be crossed by those of another company, nor shall any new company lay down parallel lines. Considerable extensions to the tramways are being made.

The town of Caleta Buena is supplied with electric light by the Agua Santa Co., whose works also supply the water and ice upon which the town depends.

At Santiago the Chilian Electric Traction and Light Syndicate (Ltd.), with over £1,000,000 subscribed capital (British and German), is making good progress. It has been decided to obtain water power of about 50,000 H.P. from the river Maipu to generate current for the electric lighting of Santiago and a complete service of electric tramways.

Colchester.—The Council have agreed to enter into a seven years agreement for supplying electric current for lighting the Military Hospital, the Goojerat Barracks, the double canteen and married men's quarters, the officers' mess, and recreation rooms of the Sobraon Barracks at the following charges: For the first 50,000 units per annum 4½d. per unit, and for any quantity above this figure 4d. A new main is to be laid over the Abbey Field in the position approved by the War Department at an estimated cost of £1,500.

Consett.—Though the District Council have accepted the tender of the Shotley Bridge and Consett District Gas Co. for lighting the district during the coming session, particulars of the cost of electric lighting are to be obtained.

Dublin.—The Corporation has decided to send a deputation consisting of Councillors Jones and M'Call, the city surveyor (Mr. Spencer Harty), and the electrical engineer (Mr. Mark Ruddle), to inspect and report upon the systems of electric lighting in the leading Continental cities. The deputation will be accompanied by the consulting engineer (Mr. Robert Hammond).

"Duncan's Manual of Tramways, Omnibuses and Electric Railways."—The 23rd edition of this useful manual has just been published and contains a mass of interesting statistics regarding tramways in Great Britain, and also foreign companies originally promoted and controlled in this country. The information includes an analysis of the last published accounts, the directors and chief officials of the companies, and so far as we have been able to test it the information is accurate and up to date. At the end of the book is an alphabetical list of officials, engineers, and others connected with tramway undertakings. The published price is 3s. 6d., and copies of the book can be obtained from Messrs. T. J. Whiting & Sons (Ltd.), 7A, South-place, London, E.C.

Electricity in Mining.—An important announcement as to the electrical transmission of power from the Cauvery Falls, Mysore (India), to the Kolar Field was made last week by the chairman (Lord Ribblesdale) of the Road Block Gold Mining Co. He said that an arrangement had been made with the Mysore Government for the transmission of electric power from the Cauvery Falls to the Kolar Field, which would tend to very much decrease the working expenses of the mines. It will probably take about two years to complete the scheme. The Falls are about 100 miles from the mines. At first about 4,000 H.P. will be available.

Electrical Imports into Argentina.—A recent issue of the *Review of the River Plate* gives the following figures in regard to the import of electrical appliances during the past year:—

	Quantity.	Value.
Galvanised iron wire	26,240 tons	£338,455
Dynamos	658	20,228
Electrical apparatus	6,211 cases	68,207
Wire and cables	1,257 tons	102,341
Fittings, chandeliers, &c.	98 tons	28,671
Phonographs and gramophones	2,752	4,408
Arc-light carbons	139 tons	4,164
Incandescent lamps	33,704 doz.	20,222
Telephone material	416 cases	4,023
Telegraph do.	1,011 cases	7,398

Electric Cargo Cranes.—The Tees Union Shipping Co. have recently erected at their wharf at Middlesbrough three portable electric cargo discharging cranes similar to those which have proved so successful at Southampton (see *The Electrician* for 18 Nov., 1898) The cranes, which are capable of lifting 5 tons, have been constructed by Messrs. Stothert and Pitt, the consulting electrical engineer being Mr. J. G. W. Aldridge, who was responsible for the Southampton installation. The cranes erected for the Tees Company have already given great satisfaction.

Enfield.—Three companies have given notice of intention to apply for provisional orders, but the District Council have decided to co-operate with the Councils of Tottenham, Edmonton, Wood Green, Southgate, Enfield, Finchley, and Friern Barnet in the promotion of a bill for electric lighting powers. Pending the execution of the proposed agreement between these local authorities information is being collected concerning the proposals of the three companies whose proposals are before the Enfield Council.

Exhibition.—The first Ironmongery and Hardware Trades Exhibition will be held at the Agricultural Hall, Islington, London, N., between the 15th and 25th inst.

Fakenham.—Owing to the local gas company having increased the cost of public lighting from £210 to £275 the question of adopting electric lighting is being debated in local circles. The Council have consulted Mr. Mann, electrical engineer, of Norwich, who estimated the cost of purchasing and erecting the lamps, lamp-posts and fittings, cables, &c., at £850, and Messrs Miller, Son & Co. undertake to give a supply of current at £187. 10s. per annum. The subject was discussed at a public meeting last week, and though the prevailing feeling was in favour of electric lighting, a committee of 10 were appointed to deal fully with the matter.

Fire Risk Rules.—The Northern Assurance Co. has just issued a new set of rules for governing electrical installation risks.

Frankfort-on-Main.—This city has taken over the management of its tramways, and has introduced electric traction. As soon as the new organisation is complete the mails will be carried to and from the great central railway station by specially constructed electric cars. This experiment of the Imperial German Post Office in the carriage of mails by electricity is the first of its kind in Germany.

Gloucester.—The Electric Light committee has been instructed to ascertain the cost and report upon the advisability of lighting the whole of the public thoroughfares by arc lamps.

Hammersmith (London).—The plans of the project for obtaining water from the Thames for condensing purposes for the Hammersmith electricity supply station have been approved, and tenders for the work, which is estimated to cost £6,350, are being prepared.

Hawaii.—The Marconi system of wireless telegraphy is being established on the Hawaiian islands with a view of providing prompt communication between the islands for the benefit of planters, merchants, &c.

Hull.—Some time ago the Corporation accepted the tender of Earle's Shipbuilding and Engineering Co. for the supply of two dynamos, but subsequently that firm went into liquidation. Last week the Electric Lighting committee reported that they had received a communication from the legal advisers of the Vulcan Boiler and Insurance Co., who were sureties for the contractors, and it was recommended that the Corporation should agree to Messrs. Thomas Parker supplying the dynamos, but without a spare armature, the Corporation paying £3,725 (the same amount as would be payable under Earle's contract), and the insurance company paying the difference between that sum and the price charged by Messrs. Thomas Parker (between £400 and £500). This course was approved.

Huntingdon.—The Council have resolved to apply for electric lighting powers, and the application of the North British Electricity Supply Co. will, therefore, be opposed.

Infirmary Lighting.—The St. Pancras (London) Guardians have decided to adopt electric lighting at Cook's-terrace Infirmary.

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Current is to be taken from the Vestry's mains and the wiring is to be carried out according to the specification of the chief engineer to the Vestry (Mr. Sydney W. Baynes). The question of lighting the workhouse is postponed.

Kilmarnock.—The Town Council have decided to ask the British Electric Traction Co. to send a representative to explain the company's electric tramway scheme at the next meeting of the Council.

Leicester.—The chairman of the Gas and Electric Light committee (Ald. Lennard) last week presented the report of the electricity department for the June half-year. The output was 489,055 units against 342,327 in the corresponding period last year, an increase of 42·86 per cent. The number of consumers was 827 against 565.

Light Railway.—On Wednesday Sir Courtenay Boyle heard the appeal of the Worcestershire County Council against the confirmation of the Bromsgrove Light Railway Order. The objection was not to the preamble of the order, but the County Council wanted the New-road as well as the High-street and Strand repaired by the promoters. After hearing evidence, the Board of Trade dismissed the appeal.

Long-Distance Telephony on the Continent.—Germany is connected by telephone with the following countries:—Austria-Hungary, Belgium, Denmark, the Netherlands and Switzerland. Frankfort-on-Main is connected with Basle and Brussels, the connection with Vienna not being yet completed. When telephonic communication is established between the United Kingdom and Belgium, this will give a connection between Germany and the United Kingdom, and render possible direct-speaking by telephone between Frankfort and London.

Malvern.—The desirability of erecting joint electric light and refuse destructor works is being reported upon by the town clerk.

At the meeting of the Malvern Hills Conservators, on Wednesday, it was announced that a syndicate had submitted a scheme for erecting a funicular railway from the town to the top of the Worcestershire Beacon, a height of 1,400ft. Mr. W. Davis considered an electrical funicular railway would be an attraction to the town, and he would not vote for steam. However, before deciding to support the scheme it was resolved to apply for further particulars.

Manchester.—The manager of the National Telephone Co. (Mr. W. E. L. Gaine) attended before the Telephone committee of the Corporation on Tuesday, in order to further explain the proposals of the National Company relative to the working of the telephone system in the Manchester area. The committee resolved to see representatives of the new Mutual Telephone Co., and also to obtain further information from Mr. A. R. Bennett, before coming to a decision.

Mill Lighting.—The new Leicestershire mills of Messrs. M. Wright & Sons have been equipped for electric lighting and electric driving by Messrs. Ellis & Ward, of Birmingham.

Peterborough.—A discussion took place at the last meeting of the Council on the proposal to borrow further moneys for electric lighting, but eventually an amendment was carried that before any further expenditure is incurred a full statement of expenditure to date should be published.

Press Telegrams.—A deputation from the Newspaper Society waited upon the Postmaster-General last week to urge upon the department the necessity for greater expedition in the despatch of Press telegrams. Sir J. A. Willox, M.P., pointed out that the provincial Press was chiefly affected, and that during the last six years the standard of expedition in the delivery of messages had gradually declined, especially in the provinces. In reply, the Postmaster-General promised to consider carefully the points submitted:—

It had been stated, he went on to say, that when the telegraphs were taken over by the State an assurance was given to the Press that the standard of efficiency and expedition of the telegraph companies should be maintained. He was not in a position to discuss that assurance, as it was given so long ago; but it had ever been the intention of his predecessors, since the change took place, to give effect to those instructions. To a great extent the promise had been fulfilled, and extra facilities afforded. But he wished to draw attention to the enormous extent to which the whole system of telegraphy had increased since 1870, and to the demands made upon the department. For the June quarter of 1900 the number of Press telegrams was 1,977,672, a 16·38 per cent. increase on the record of the similar period last year. This was the highest on record. Instructions had been given to consult the convenience of the Press, and he had no intention whatever of placing them in a secondary position. Instructions had been given to superintending officers to do their utmost to deal efficiently and promptly with news telegrams. The present had been an exceptional year. The war in South Africa had materially added to the work of the department; and about 100 of their best telegraphists were at the front. If there were delay it was to some extent to be accounted for by that fact. When the system was originated it was after consultation with the various news agencies, and the question might arise as to whether work now done by the department should not be done by the news agencies before the messages were handed in, and consequently the delay be reduced. Those in authority had been told they were not to shrink from incurring extra expense, if necessary, in having their staff fully equipped.

Projected Electric Power Scheme.—A correspondent of the *Glasgow Herald* states that Sir Wm. Preece (Messrs. Preece and Cardew) and Messrs. Strain and Robertson, civil engineers, of Glasgow, have, during the past week, been visiting various industrial centres in the West of Scotland in connection with a project for establishing on or near the coalfields stations for generating electrical energy on a large scale. The scheme, which has been under consideration for a considerable time, embraces portions of the counties of Lanarkshire, Ayrshire, Renfrewshire, Stirlingshire and Dumbartonshire. The promoters of the scheme propose to supply the electricity in bulk for power, traction and lighting purposes to local authorities and other large consumers.

Saddleworth (Yorks.).—The Council are recommended by the Lighting committee to establish electricity works for lighting the area between Delph and Junction, or Denshaw, and also to connect the two places by an electric tramway.

Salisbury (Rhodesia).—Mr. Cecil Rhodes is urging the municipal council to adopt an electric lighting project, and has offered to provide the installation if the council will agree to take it over at cost price within from three to five years.

Sheffield.—Acting upon the advice of the engineer and manager (Mr. S. E. Fedden) the Electric Light committee have decided to make no charge for service connections within 30ft. of the distributing main. At Wednesday's meeting of the Corporation Ald. Styring said that the modification would be much appreciated by would-be consumers, and it was expected that applications would be received in larger numbers than at present. He also stated that it would be in the memory of members that a week or two ago a somewhat serious breakdown occurred in connection with the lastly installed machine at the station. The breakdown was of a serious character, and it was just possible that they might be placed in some difficulty in keeping up the supply until the new alternator on order was completed.

For the six months ended June 30 the equivalent of 9,585 8 c.p. lamps was connected against 9,425 in 1899. The number of units generated was 999,377 against 745,210. The receipts for current sold (761,776 units) amounted to £12,227. 17s. 9d. against £8,743. 5s. 7d. (538,606 units) in 1899. During the half-year 37,594 yards of cast-iron piping were laid, and 20,137 yards of cable drawn in.

Shipley.—An inquiry has been held here into the application of the Council to borrow £22,000 for establishing electricity supply. The clerk (Mr. J. S. Rhodes) said there had been a general demand for electric current. Already several independent installations had been erected. From a short canvass recently made orders for the equivalent of 2,500 8 c.p. lamps, together with 49 arc lamps and 10 H.P. in motors were obtained. In 1903 the lines of the local tramways would be converted to electric traction. These tramways are a continuation of the Bradford system, but the Council insist on supplying current for operating the lines in their own district. The pumping at the sewage works is also to be effected electrically. The consulting engineer (Mr. Robert Quin) gave technical details. There was no opposition.

Smoke Nuisance.—At the Lambeth (London) police-court on Thursday the South London Electric Supply Corporation were summoned by the Lambeth Vestry for allowing black smoke to issue from their chimney shaft in such a quantity as to be a nuisance, and were fined £10 and 2s. costs.

St. Anne's-on-Sea.—The Local Government Board have sanctioned the Council's electricity supply scheme.

St. George's (London, W.).—Last week the Electric Lighting committee recommended that upon consideration of the report of Sir William Preece, and Prof. A. B. W. Kennedy's observations thereon, the Vestry adopt the first scheme of the Westminster Electric Supply Corporation for lighting the streets electrically. Some particulars of the scheme were given in *The Electrician* of June 29.

Spalding.—Though the application of the United Electric Light and Traction Co. for a provisional order is to be opposed, the Council have resolved that it is inadvisable to embark on electric lighting until the debt on the gasworks has been liquidated.

Stockton-on-Tees.—Extensions of the electric lighting mains, estimated to cost over £2,000, have been authorised. The Electric Lighting committee reported at the last meeting of the Council that they had agreed to supply the South Durham Steel and Iron Co. with electricity for motive power at their malleable works on the following terms: The company to provide and lay their own cable from the electricity station to the works, and also provide a meter at their own expense, the quantity of electricity to be supplied not to exceed a maximum of 200 H.P., and the price to be 1·2d. per unit, with a minimum payment of not less than £150 per quarter.

Sunbury.—The Twickenham and Teddington Electric Supply Co., which have already obtained a provisional order for Twickenham, wish to obtain powers for this district, and at the last meeting of the Council Mr. F. E. Gripper attended, and explained the company's proposals. Further consideration deferred.

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Tariff Changes.—Electric lighting machinery for the electric lighting of Georgetown and New Amsterdam (British Guiana) are to be exempt from duty, as are telegraph instruments and materials, and electrical machinery and apparatus, overhead equipment, &c., for the proposed electric tramway in Georgetown.

Electric motors imported into Victoria are subject to a duty of 25 per cent.

Telegraph Engineers Conference.—The annual conference of the Amalgamated Association of the Postal Telegraph Engineering Department was held at Leeds on Monday. Mr. T. Landrick (Leeds) presided, and delegates were present from most of the principal telegraph centres in the kingdom. The general secretary (Mr. G. Young, Norwich) reported that the Association was in a stronger position than it had ever been, mainly due to increased membership, notwithstanding that Cardiff and Belfast had seceded from the Association. The next confereuce is to be held in Birmingham. During the year they had had the welcome addition of Edinburgh, Coventry and Holloway.

Torquay.—Sanction to the borrowing of £15,000 for electric lighting extensions has been received. The Electric Lighting committee are to report upon the question of applying for powers to construct electric tramways.

Transvaal War.—Mr. W. G. McMillan, on behalf of the Electrical section of the "Building Trades Gift to the Nation," forwards a set of 19 specifications relating to the electric light installation at the Home of Rest for Discharged Soldiers, which is being erected at Bisley on freehold land presented to the fund by Lord Pirbright. Tenders are invited to these specifications, or, as an alternative, gifts in money towards the expense of the electrical equipment of the home. Further particulars can be obtained of Mr. McMillan, at the Institution of Electrical Engineers, 28, Victoria-street, London, S.W.

Tunbridge Wells.—The Council have decided to apply for power to borrow £5,000, the estimated cost of the following works: New chimney, 180ft. high (designed by the borough surveyor); economisers, flues, feed-water piping, and contingencies, under the superintendence of the borough electrical engineer (Mr. Horace Boot).

Water Power Utilisation in Italy.—A 30 years' concession has just been granted to put down a plant to utilise the water power of the Varaita torrent at Venasia (Como) in the generation of electrical energy.

Water Power Works in Finland.—It is reported that works are about to be established to utilise the waterfalls of Narowain and Imatra, in Finland, the energy generated to be transmitted to St. Petersburg.

Workhouse Lighting.—The Kingston-on-Thames Guardians have decided to obtain a report upon the advisability of adopting electric lighting, and particularly as to whether it would be more economical to put down independent generating plant or to obtain current from the Kingston Corporation.

Workmen's Compensation.—A Home Office return is issued giving statistics of the proceedings taken during 1899 under the Workmen's Compensation Act, 1897, and under the Employers' Liability Act, 1880. The statistics published are very meagre, but are sufficient to show that the procedure under these Acts, and especially under the Workmen's Compensation Act, are becoming better understood.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

TENDERS INVITED.

Hanley Electric Lighting committee invite tenders for two Lancashire boilers and fittings, including steam receiver; water-tank, girders, and pumps; fuel economiser, with engine or motor; smoke chimney, exhaust fan, with engine, &c; feed water heater, forced draught fittings, fire bars or other appliances to boiler furnaces, and coal conveyor and bunkers. Specifications from the borough engineer and surveyor (Mr. Joseph Lobley) and from the Corporation electrical engineer (Mr. C. A. Cowell). Tenders to Mr. Lobley before 25th inst. An advertisement contains further particulars.

Salford Corporation invite tenders for the supply and erection of lighting switchboard, traction switchboard, and balancing transformer. Specification, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh, and Sillar), 2, Queen Anne's Gate, Westminster, and 78, King-street, Manchester, but can only be obtained from the latter office. An advertisement contains further particulars, and tenders must be sent to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by Sept. 3.

Salford Corporation also invite tenders for laying cables, tramway feeders, and street lighting. Tenders to town clerk by Aug. 13.

Aberdeen Corporation Tramways committee invite tenders for the supply of steel poles, bases, and brackets for extensions of their overhead system of tramways. Specification from the city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen. An advertisement contains further particulars, and tenders must be in by noon of 25th inst.

Aberdeen Council also invite tenders for the supply of 650 tons of steel girder straight-track tramway rails, 150 tons steel girder curve track rails, and 60 tons fish plates. Specifications may be obtained from the engineer (Mr. William Dyack), Town House, Aberdeen. An advertisement contains further particulars, and tenders must be lodged at the borough surveyor's office by noon of 24th inst.

The Asylums committee of the *London County Council* invite tenders for the installation of boilers, engines, dynamos, &c., at the Horton Estate, Epsom, Surrey. Forms of tender, &c., can be obtained after the 13th inst. from the clerk (Mr. R. W. Partridge), 6, Waterloo-place, S.W. Further particulars are given in an advertisement, and tenders must be delivered at the offices of the committee by 10 a m. of Sept. 22.

Portsmouth Corporation invite tenders for plant and apparatus for the equipment of their proposed tramway power station. Specification may be obtained from the tramways engineer (Mr. E. Botter), and further particulars are set out in an advertisement. Tenders must be delivered to the town clerk (Mr. Alex. Hellard), Town Hall, Portsmouth, not later than 10 a.m. of Sept. 4.

Portsmouth Corporation also invite tenders for street work in connection with the laying of electric lighting cables. Tenders to superintendent of generating station by 15th inst.

Fulham (London) Vestry invite tenders for wiring the Town Hall. Specifications may be obtained from the surveyor (Mr. Charles Botterill), and tenders must be delivered to the clerk (Mr. W. J. H. Denselow), Town Hall, Walham Green, London, S.W., by 4 p m. of Friday the 24th inst. An advertisement contains further particulars.

Whitby District Council invite tenders for the supply and erection of electricity generating plant, some particulars of which are set out in an advertisement. Specification may be obtained at the offices of the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster. Tenders, addressed to the clerk (Mr. Wm. Seaton Gray), Council's offices, Whitby, must be in before noon of Sept. 3.

Worthing Corporation invite tenders for the supply and erection of electricity generating plant, particulars of which are set out in an advertisement. Copies of specifications, &c., may be obtained from the consulting engineers (Messrs. Burstall and Monkhouse), 14, Old Queen-street, S.W., after the 15th inst. Tenders, addressed to the town clerk (Mr. W. Verrall), must be delivered at the town clerk's office, Worthing, not later than noon of Monday, Sept. 3.

The *Pacific Cable* committee invite tenders for the supply and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cable between Vancouver and Queensland. Forms of contract, &c., from and tenders to Messrs. Clark, Forde & Taylor, 4, Great Winchester-street, London, E.C., by noon 14th inst.

Newcastle-on-Tyne Corporation invite tenders for constructing about 5 miles of double-track tramway. An advertisement contains further particulars, and tenders addressed to the New Tramways committee must be in by Wednesday, 22nd inst.

Central Electric Supply Co. invite tenders for dry back marine boilers with mountings, feed and drain pipes, &c. (or, alternatively, water-tube boilers). Tenders to general manager (Mr. F. J. Walker), 19, Carnaby-street, Golden-square, London W., by 10 a.m. Aug. 20.

South London Electric Supply Corporation invite tenders for condensing plant. Tenders to secretary (Mr. H. H. Boyer), Bengeworth-road, Loughborough Junction, S.E., by 14th inst.

Newport (Mon.) Guardians require tenders for the electric lighting of their new workhouse, Stow Hill. Tenders to clerk by 22 inst.

Accrington Corporation invite tenders for about 50 electricity meters. Tenders by 15th inst.

Belfast Electric committee invite tenders for auxiliary feed water heater, &c. Tenders to town clerk by noon 15th inst.

Luton Town Council require tenders for watt and demand meters. Tenders to town clerk by Sept. 14.

Warrington Corporation invite tenders for wiring Parr Hall and markets. Specification from Mr. W. H. Grimsdale, Bank House.

Plumstead (London) Vestry invite tenders for electricity generating plant. Tenders to Vestry Clerk, Vestry Hall, Maxey-road, Plumstead, S.E., by Sept. 19.

Grimsby Corporation invite tenders for additional steam dynamo and extension of switchboard. Tenders to town clerk before 18th inst.

Bradford Guardians invite tenders for an electric lighting installation at their workhouse. Tenders to clerk by noon Aug. 13.

Dorking District Council invite offers for leasing their provisional order. Tenders to clerk by 30th inst.

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Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment. Tenders to clerk by Aug. 31.

Cardiff Corporation invite tenders for pipes, feed-water heater, &c., at the electricity works. Tenders by Aug. 13.

Leeds Guardians invite tenders for an electric lighting installation at the Poor Law Offices. Tenders by noon Aug. 14.

Tenders are required for the electric lighting (about 800 lights) of the Fife and Kinross District Lunatic Asylum. Particulars from the clerk, Cupar, Fife.

A central telephone building is to be erected at *Budapest*, and tenders are invited for: (1) The complete installation of the local telephone exchange on the basis of 10,000 subscribers at first, but liable to be enlarged (if required) up to 20,000 subscribers; (2) the supply of an intermedial connecting board for equalising the work between the operators; (3) complete installation of the inter-urban telephone exchange; (4) supply of a cross-connecting board for the two exchanges (with lightning arresters), and other protecting contrivances for the cables; (5) the supply of all materials, insulated wires and cables, &c.; (6) the execution of all the work in connection with the contract, including fitting, mounting and connecting, testing, regulating, &c. The conditions include a deposit of 60,000 crowns. Tenders are due by Oct. 15. Conditions, &c., from the Royal Hungarian Direction of Telephones, Budapest (VI. Szerecsenutcza 7–9) on payment of 10 crowns.

The Civil Government of the province of *Ciudad Real* invite tenders until the 24th inst. for erecting and working a telephone exchange in the town of Ciudad Real.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by the Hammersmith (London) Vestry:—

Callender's Company, low tension distributor cables and boxes, estimated at £4,062.

W. T. Glover & Co., high tension feeder cables, estimated at £1,151.

Watson, Gow & Co., 200 tons of 2in. cast-iron pipe (£7. 5s. per ton) and 4 tons of specials (£9 per ton), £1,486.

Liverpool Corporation have given an order to Messrs. Willans & Robinson, Rugby, for three sets of plant similar to those on order for the Lister-drive and the Pumpfield generating stations, at £6,939 per set, less 2½ per cent.

Messrs. W. T. Glover & Co. have secured a large order for "Diatrine" cable from the Manchester Corporation.

The tender of Messrs. Simpson Bros., Hapton, has been accepted for the electric lighting of Hapton (Lancs.), from Sept. 1 to April 30, at £122.

The Southend Town Council have let the contract for the construction of a light electric railway in the district and for the supply of the necessary generating plant, &c. to Messrs. Dutilh-Smith, McMillan & Co., London and Philadelphia, at £87,500.

South Shields Guardians have accepted the tender of Messrs. Falconar, Cross & Co. for an electric lighting installation at the workhouse at £1,969.

APPOINTMENTS VACANT AND FILLED.

The tramways department of the Glasgow Corporation require a first-class mechanical engineer to take charge of the steam plant and general oversight of the tramways power station. Salary £250 per annum. An advertisement gives further particulars, and applications have to be sent to Mr. John Young, general manager, 88, Renfield-street, Glasgow, by Aug. 20.

Hull Electric Lighting committee have vacancies for two electrical improvers. Applications to the Chairman of committee, Town Hall, Hull, by noon of 23rd inst. Mr. A. S. Barnard is city electrical engineer. See advertisement.

Applications are invited for the position of senior demonstrator in electrical engineering at the South Western Polytechnic, Manresa-road, Chelsea, London, S.W. Forms of application from the secretary. See advertisement.

The position of senior demonstrator in applied physics, at the South-Western Polytechnic is vacant. Particulars from secretary up to 13th inst. See also advertisement.

An assistant lecturer and demonstrator in electrical engineering is required for the Croydon County Polytechnic. Applications to chairman of committee (Mr. J. W. Helps), by Aug. 14. See advertisement.

Jandus Electric Co., Hartham-road, Holloway, London, N., require an assistant draughtsman and an assistant electrician. See advertisement.

The Hartley Council require a principal and professor of physics for the Hartley College, Southampton. Applications by Sept. 1.

Mr. F. G. Jones, late of the Brompton and Kensington Electricity Supply Co., has been appointed assistant engineer at the Wakefield Corporation electricity works.

BUSINESS NOTICES.

Correction.—In a note on p. 578 of our last issue a clerical error occurred. Mr. S. J. Atkinson has entered into partnership with Mr. W. Schmahl at Grainger-street, Newcastle-on-Tyne, and the business will continue under the style of Atkinson, Schmahl & Co.—not Dickinson, Schmahl & Co. as stated in error.

Increasing business in the Northern provinces has necessitated the British Thomson-Houston Co. opening a branch at St. Nicholas-chambers, Newcastle-on-Tyne.

Messrs. Crampton & Co., electrical engineers, Great Yarmouth, Cambridge, and Bury St. Edmunds, have opened offices at 77a, Queen Victoria-street, London, E.C. Telephone 6057 Bank.

BANKRUPTCIES, LIQUIDATIONS, &c.

St. Stephen's Electrical Syndicate (Ltd.) is to be wound up voluntarily. Mr. H. Ebbsworth, 1, Arthur-street East, King William-street, London, E.C., is liquidator.

In the bankruptcy of Hy. Howe, electrician, 16, Bold-lane, Derby, the first meeting of creditors will take place on Aug. 14, at 47, Full-street, Derby, the public examination on Sept. 11 at the Court House, Derby.

In the bankruptcy of F. W. Henton (F. W. Henton & Co.), electrical engineer, 24, King William-street, London, W.C., the trustee has been released.

In the bankruptcy of L. J. Lawrence (trading as Lawrence & Butcher), electrical engineer, 5, Stafford-street (late Bond-street), London, W., the trustee has been released.

Plant for Sale.—Messrs. Wheatley Kirk, Price & Co. announce in an advertisement the sale by public auction, at Ormonde Works, Hornchurch-road, Romford, Essex, on Tuesday and Wednesday 28th and 29th inst., of a large quantity of high-class engineering plant, machinery, shafting, loose tools and utensils, accessories, &c. Catalogues may be obtained of the liquidator, Mr. Wm. Hutton, 39, Bennett's-hill, Birmingham; of Messrs. Hargreaves & Heaton, solicitors, Waterloo-street, Birmingham; or of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester. The sale commences each morning at 11 a.m.

Messrs. Wheatley Kirk, Price & Co., Albert-chambers, Albert-square, Manchester, have a 225 I.H.P. compound vertical steam engine (marine type) for sale. Further particulars are given in an advertisement.

Business for Sale.—The business of P. C. Middleton & Co. (Ltd.) (in liquidation), electric light and power engineers, Aberdeen, Edinburgh, &c., is for sale as a going concern. Some further particulars are given in an advertisement, and communications should be addressed to the liquidator (Mr. John Packman), 258, Union-street, or Mr. W. R. Reid, advocate, 46A, Union-street, Aberdeen.

Tramway Traction Patent for Sale.—Offers are invited for a one-fifth share in Lane's electro-magnetic system of traction. Further particulars are given in an advertisement, and applications should be sent to Mr. Lane, 6, Corporation-street, Birmingham.

B.T.H. Plant.—Pamphlet No. 70 of the British Thomson-Houston Co. describes magnetic blow-out lightning arresters for direct currents Several types of these arresters are shown.

Westinghouse Plant.—Circular No. 1,029, issued by the British Westinghouse Co., deals with polyphase induction motors, type C.

Electrical Accessories.—The 13th edition of the electric bell and general catalogue of the General Electric Co. is just issued and comprises electric bells, electric signalling devices, batteries and accessories. The company state that, notwithstanding the many improvements introduced considerable reduction has been made in the price of many of the articles described. A group of diagrams of connections and circuits is given, accompanied by simple explanatory notes and instructions. The list can be obtained gratis post free by the trade.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 1 to Aug. 8, with the ports of destination:—

Africa—Cape Town, £386 (including £200 telegraph apparatus); Durban, £1,045 (including £720 telegraph material); East London, £643; Port Elizabeth, £1,450. *Argentina*—Buenos Ayres, £779 (including £225 telegraph material); Parana, £2,014. *Australasia*—Adelaide, £273; Auckland, £1,573; Brisbane, £950; Fremantle, £125; Hobart, £150; Melbourne, £870; Nelson, £297; Perth, £126; Sydney, £688; Wellington, £2,615 (including £1,831 telegraph material). *Azores*, £2,382 (telegraph apparatus). *Belgium*—Ostend, £420. *British Guiana*—Georgetown, £150. *Ceylon*—Colombo, £45. *China*—Shanghai, £150 (old telegraph wire). *Gibraltar*, £200. *Holland*—Amsterdam, £30 *India*—Calcutta, £350. *Japan*—Hiogo, £15; Nagasaki, £92. *Malta*, £100. *Straits Settlements*—Singapore, £16. *United States*—New York, £500,375

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(telegraph cable). Total (for eight days) £518,303, against £63,542 for the corresponding eight days last year (Aug. 2 to Aug. 9).

A New Ceiling Rose.—The illustration below shows a new two-way ceiling rose for 200-250 volts pressure. It is provided with three contacts for a triple flexible cord, and thus will be found useful in cases where it is desired to turn on one, two, or three lamps in a pendant fitting from two wall switches. The base is solid, the illustration being full size, and the terminals are sufficiently large to

take two wires if the "looping" system is employed. The holes in the bridges and the screws for the "flexible" are also large enough for two or three cords—often a convenience for shop-window lighting. We are informed that the price is moderate, that the parts are all made in England, and that the ceiling rose may be obtained from the Sun Electrical Co. and other wholesale houses.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

May 19, 1900.

9,242. T. Thompson. Newcastle-on-Tyne. Improvements in electric arc lamps.
9,260. H. S. Browne. London. Improvements in or relating to electric light carbons. (J. F. Sanders, United States.)
9,262. A. R. Leask. London. Electric heating apparatus.
9,263. A. R. Leask. London. Improvements in electric heaters.
9,273. K. N. von Szopori. London. Improvements in or relating to telephonic connections.
9,279. P. A. Lorain and A. Deunery. London. Improvements in and connected with supports for electric conductors.
9,281. R. E. Disher. London. Improvements in galvanic batteries.

May 21, 1900.

9,306. G. H. Smith. Cardiff. Improvements in or relating to methods of extracting gold by electricity.
9,331. M Haas. London. An improved electrolysing apparatus.*
9,339. W. E. Evans. London. Improvements relating to multiplex telephony. (E. A. Faller and J. W. Chisholm, United States.)

May 22, 1900.

9,397. G. Heidel. Glasgow. Improvements in armatures.*
9,398. H. C. Doersch. Glasgow. Improvements in electric shampooing apparatus.*
9,413. G. Gibbs. London. Improvements in electric motor suspension.*
9,424. R. Kaiser. London. Improvements relating to electric incandescent lamps.
9,458. W. C. L. Eglin. London. Improvements in space telegraphy.*
9,464. S. B. Husselman. London. Improvements in the manufacture of filaments for incandescent electric lights.*

May 24, 1900.

9,469. A. Peloux. London. Improvements in motor meters for alternating currents.
9 492. W. M. Douglas. Liverpool. Improvements in ceiling roses and other similar electric connections.
9,486. D. Hunter and W. A. Jacks. Glasgow. Apparatus for converting electrical into mechanical energy suitable for actuating pumps and other reciprocating mechanism.
9,496. S. Oldridge. London. An improved method of increasing the sound of the phonograph, graphophone, gramophone, and other talking machines.
9,503. T. Bergmann. London. Improvements in electric igniters for explosion engines.*
9,507. A. G. Cooper. Colne. Improvements in apparatus for exciting dynamo-electric machines.
9,511. I. F. Cuttler. Bradford. Improvements in the construction of swivel heads of electric car trolleys.
9,533. P. M. J. Boucherot. London. Method of exciting alternating-current machines.
9,534. P. M. J. Boucherot. London. Improved method of starting multiphase-current motors.
9,552. H. Bremer. Germany. Improvement in electric arc lamps.*
9,561. C. Curwen. London. Improvements in fuse boards for electric lighting and the like.
9,563. C. D. Abel. London. An electrolysing process for zinc and other salts with soluble anodes. (Société des Piles Electriques, France.)
9,567. S. P. Thompson. London. Improvements in electric traction on a road contact or like system. (Partly by M. Walker, United States.)
9,576. A. Muirhead. London. Improvements in telegraphic transmitting, receiving, and translating arrangements.
9,579. V. Veysy. London. Improvement relating to telephonic apparatus. (Date applied for under Patents, &c., Act, 1883., sec. 103, Oct. 24, 1899, being date of application in France.)
9,592. A. Bluhm and J. Posnansky. London. Improvements in accumulators or secondary batteries for traction, motive power, or lighting purposes.
9,612. H. F. Joel, sen. London. Improvements in a commutating switch and combinations of electric motors and batteries for controlling electric carriages and like purposes.

May 25, 1900.

9,622. J. T. Niblett, M. Sutherland and E. Marcuson. London. Improvements in or relating to electric storage batteries.
9,631. C. O. Bastian. London. A new or improved detective lock or seal for gas and electric meters, electrical demand indicators and fuse-boxes, or for any other uses or purposes to which same may be applicable.
9,632. W. Hibbert. London. Improvement in electrical accumulators or secondary batteries.
9,647. C. D. Abel. London. A process of depolarising by liquid circulation. (La Société des Piles Electriques, France.)

May 26, 1900.

9,699. A. J. Henderson. London. Improvements in or relating to electric clocks or watches.
9,711. R. P. Wilson. London. Improvements in protective devices for use in the distribution of high-tension alternating currents.
9,716. E. B. Viles. London. Improved electric railway conduit.
9,730. F. S. Worsley and F. J. Green. London. An improvement in electric switches.*
9,731. S. O. Cowper-Coles. London. Improvements in apparatus for use in the electro-deposition of metals.
9,744. J. Lea and J. Taylor. London. Improvements in telegraphy.
9,746. A. Wright and The Reason Manufacturing Co., Ltd. London. Improvements in electrolytic meters.

May 28, 1900.

9,750. Cope, Allman & Co. (Ltd.) and W. Allman. Birmingham. Improvements in junction boxes, crosses, tees, bends, draw-in boxes and other fittings for metallic conduits for electric cables and wires, and for similar purposes.
9,751. S. Eyre. Wolverhampton. An automatic disc-catch lever switch for electric tramways.
9,753. A. H. Mayes. Hove. Improvements in the contact arm and contacts of motor-starting and similar switches.
9,768. T. J. McTighe. London. Improvements in the manufacture of electric railway rail-bonds.*
9,781. E. P. L. Mors. London. Improvements relating to primary batteries.
9,784. W. F. Jones. London. Improvements in electric switches.

May 29, 1900.

9,822. J. W. Garrett. Hull. A new or improved method and apparatus for automatically operating and controlling signal lights on board ships where electricity is employed.
9,873. J. Hewitt, C. A. Lindstrom and T. Hewitt. London. Improvements in electric motors, batteries, and connections thereof for propelling automobiles and like vehicles.*
9,879. R. Krayn. London. Improvements in "Nernst" lamps having automatic heat-current interrupters.*

May 30, 1900.

9,944. B. M. Drake and The "Nernst" Electric Light (Ltd.). London. Improvements in incandescent electric lamps.
9,953. A. T. Baldwin. London. Electric switches.
9,954. A. T. Baldwin. London. Electric air pumps.
9,955. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railway systems. (W. B. Potter. United States.)*
9,957. N. H. Holland. Kingston-on-Thames. Improvements in telephone signalling systems.

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

14,997. WRIGHT and AALBORG. Swiches for electric circuits. (Date applied for under International Convention, Jan. 30, 1899.)
14,998. DAVIS. Fuse blocks for electric circuits. (Date applied for under International Convention, March 23, 1899.)
15,002. BARTON and JANDUS ARC LAMP AND ELECTRIC CO. (LTD.) Electric arc lamps.
15,066. LAMME. Systems of electrical distribution. (Date applied for under International Convention, Jan. 30, 1899.)
16,210. COWPER-COLES. Manufacture of thin tubes or sheets of copper or other metal by electro-deposition.
16,215. WALKER, WILKINS, LONES and LONES. Electrolytic baths.
16,960. DE KANDÓ. Rheostats and means for operating the same.
24,231. KELLERMANN and KELLERMANN. Electrical massage rubbing or brushing apparatus.

1900.

837. LAKE (Shearman). Incandescence electric lamps.
840. LAKE (Shearman). Incandescence electric lamps.
2,326. HODGE. Gramophones and the like.
3,056. FEENY (Allgemeine Elektricitäts Gesellschaft). Electric meters.
3,532. GIBBS. Electric rollers for therapeutical and massage purposes.
4,122. KÜHLSTEIN and VOLLMER. Switch contacts for use in electrical ignition devices for multi-cylinder explosion motors.
4,193. JUSTICE (Williams). Signalling devices for telephone systems.
4,268. LAKE (American Vitrified Conduit Co.). Tools for use in the laying of tile conduits for electrical conductors.
4,308. FESSENDEN. Electric incandescent lamps. (Date applied for under International Convention, Aug. 7, 1899.)
4,369. RAWLINGS and RAWLINGS. Couplings for electrical connections.
4,457. SCHADE. Electrically controlled door locks.
4,586. CERBOTANI and SILBERMANN. Telegraph receivers.
4,607. VON ARNSWALDT. Electrical gas lighters.
4,933. BRITISH THOMSON-HOUSTON CO. (LTD.). (Alton.) Register dials for meters and the like.
5,003. MENGIS. Means for automatically reviving or reinforcing exhausted pulsations upon a telephone line.
5,032. MALIGNANI. Electrical cut-out devices especially adapted for preventing excessive flow of electric current.
5,136. BYNG and BELL. Intercommunication telephone systems.
5,167. YATES, YATES and BENT. Alternating-current electro motors.
5,179. DAY (White). Tool or means for forming or compressing joints of lead pipes or sheaths for electric cables, metal articles and the like.
5,216. BOULT (Blondel). Manufacture of filaments for electric incandescent lamps.
5,232. KENNEDY. Storage batteries.
5,321. HADDAN. (Lindstrom, Hewitt and Hewitt.) Plates for storage batteries.
5,394. ZAPPERT (Schaefer). Method of insulating electrical conductors.
5,443. WALKER. Magnetic work holders for metal working machines.
5,693. MENGIS and CHRISTENSEN. Telephonic systems.
5,698. LANGTON. Method of and means for protecting electrical connections.
5,806. BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz). Regulation of dynamo electric machines.
5,848. SMITH. Conduits and conduction supports for electric tramways.
6,023. BRITISH ELECTRIC WORKS CO. (LTD.) and BRANDER. Electric bells.
6,028. MIX. Brush holders for dynamo electric machines.
6,069. LUNDELL. Generation of direct electrical currents and apparatus therefor.
6,153. JUSTICE. (Columbia and Electric Vehicle Co.) Electrically propelled motor vehicles.
6,218. COFFIN. Machines for electrically heating, welding, or working metals.

COMPANIES' MEETINGS AND REPORTS.

British Electric Transformer Manufacturing Co. (Ltd.)

The second ordinary general meeting of this Company was held on Friday last, Mr. R. STEWART BAIN, C.A. presiding.

The SECRETARY (Mr. J. C. Wrist) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, the business done during the year has been quite up to our expectations. Our turnover has been £24,043. 8s. 10d., compared with £12,614. 16s. 6d. for the previous, our first year. It will be seen, therefore, that we have nearly doubled our output. Turning to the debit side, you will see that our manufacturing charges were £13,448. 11s. 4d., equal to about 56 per cent. of the turnover, as compared with £10,230. 1s. 9d., or equal to about 81 per cent. of the turnover for the last year—a decided improvement. Our general charges amounted to £2,433. 9s. 9d., as compared with £1,242. 2s. 10d., the percentage in both years being about 10 per cent. of the turnover. The amount written off for depreciation is £714s. 3s. 8d., as compared with £365. 3s. 8d. for last year, or nearly double. This has been done under the advice of our auditors, and represents a full depreciation on our plant and machinery. After deducting all these charges, there is left a profit of £6,184. 8s. 9d. for the year as compared with £998. 2s. 9d. for last year, which I think you will agree with me in considering a very satisfactory result. I now ask your attention to the balance-sheet. Our first and principal asset is the amount which we paid for our patents, viz., £25,336. 6s. 5d. Since I last had the pleasure of addressing you, we have succeeded in obtaining letters patent for our transformers in Germany, one of the most valuable of our foreign patents, and the addition of £86. 6s. to this item during the present year is in connection with the obtaining of this patent. Our transformers are now covered by letters patent in the following foreign countries: Germany, France, Belgium, Italy, Austria, Switzerland, United States of America, New South Wales, South Australia, West Australia, Queensland and Tasmania. We have recently been approached in connection with the purchase of the French patent. We have not been in a hurry to sell this or any other patent, one reason being that we were desirous of seeing the result of the year's trading before concluding a bargain, and the result has justified our policy. Our transformers are being exhibited at the Paris Exhibition, which entitles us to add an additional six months to the time within which we must work the patent in France. The average time which each of our patents has still to run is 11 years, and, although we are of opinion their value should not be depreciated in the balance-sheet, we considered it would be prudent to set aside the sum of £2,500 out of our profits as the nucleus of a reserve fund for the purpose of gradually writing this asset down. The next item is plant and machinery, £2,473. 12s. 9d. The additions during the year amounted to £374. 16s. 2d., and we have written off depreciation £494. 13s. 5d., or nearly 20 per cent., in addition to charging all repairs and renewals to revenue. Expenditure and alterations to works has cost £806. 14s. 6d., and you will see that we have now written it all off save £200, so that by the time we leave our present works the item will have disappeared entirely. The stock, as per manager's valuation, taken at cost price, is £3,482. 8s. 4d., and the work in progress amounts to £1,165. 0s. 5d. This last item is slightly less than last year, but on the other hand we have orders in hand of no less than £6,769, so that our prospects for the present year are as favourable as the one we are now dealing with. The amount due from our customers is £9,138. 11s. 3d. A large proportion of this is due by municipal corporations, who retain amounts varying from 10 per cent. to 20 per cent. on their contract for a year. On the other side of the account, you will see that our total issued capital is £40,000, viz., £20,000 subscribed and £20,000 in vendor's shares, which latter do not rank for dividend until the subscribed shares have received 10 per cent. for one complete year. As we propose at this meeting to recommend that a dividend of 10 per cent. be now paid, these 20,000 vendor's shares will rank pari passu with the subscribed shares as from July 1, and, considering the very excellent results we have achieved, I do not think anyone here will grudge Mr. Berry participating in our success. Of course, it will mean in the future that we shall have double the capital upon which to pay dividends, but you will notice we have taken that into account in our report by carrying forward a very substantial amount to next year. £5,552. 15s. 5d. is the balance of profit and loss account after deducting an interim dividend at the rate of 10 per cent. which we paid in February. The lease of our present works expires next year, and, as the buildings are coming down, this lease cannot be renewed. We have decided to purchase a plot of freehold land and erect our own works. The negotiations for the purchase of the land are now nearly completed, and we expect to be able to pay for this and erect and equip our works without increasing our present capital. I now move the adoption of the report and accounts.

The resolution was carried unanimously.

Mr. R. Stewart Bain was re-elected a director, and the auditors having been re-appointed, a hearty vote of thanks to the chairman and directors terminated the proceedings.

W. T. Henley's Telegraph Works Co. (Ltd.).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel, E.C., yesterday (Thursday) for the purpose of considering and, if thought fit, passing resolutions increasing the capital of the Company from £300,000 to £400,000, the ordinary capital being increased by 10,000 new shares of £5 each and the preference capital increased by 10,000 new shares of £5 each. Mr. SYDNEY GEDGE, M.P., presided.

The CHAIRMAN observed that the business of the Company had increased so much as to render it absolutely necessary that they should have more capital, and, he might add, there was the possibility—he ought not to use a stronger term—that the Company might obtain a contract for one of the three sections of the Pacific cable for which tenders were being invited. The Company's tender and estimate would be made up to-morrow, and he need scarcely say that if their tender was accepted, and they should have the privilege of being one of the three companies to join in that great enterprise, the Company would want all the money they could obtain. Should their estimate be accepted, the Directors might have to come again to the proprietors in regard to further capital, but he thought that this would not be the case, and that with the capital they were then asking power to raise the Board would be able to carry out all the work. The Directors had not yet made up their minds at what price the ordinary shares would be offered to the ordinary proprietors, but, following the precedent which had been set on each occasion when new capital had been issued, he thought that the shareholders might take it for granted that the price would be such as to give a good bonus to those ordinary shareholders who subscribed. On the assumption that the new capital was taken up at the price of £10 per share, the Company would get £50,000 in return for £25,000 new ordinary capital, and the £25,000 preference capital would provide another £25,000, making £75,000 in all, and this additional money he hoped would be sufficient for their purposes unless they were fortunate enough to obtain one of the Pacific cable contracts and then, probably, they would have to issue the other £25,000 of the two classes of capital, for which they would again hope to receive another £75,000. However, he could not pledge the

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Directors to exact figures, and he only stated this as the probable outcome of the meeting. With the £75,000 additional capital they would be able to carry on the work without the restrictions at present tying their hands. With regard to the increase in the business, he would mention that it had been very steady for several years, and that it had increased at least 100 per cent. every three years. That was to say, the present business was 30 per cent. more than this time last year, and taking it year by year, it had doubled itself every three years. The proprietors would quite understand that the business could not be doubled in this way without additional capital. However, he hoped the experience of the past would convince the shareholders that the Board were not increasing the capital to a greater extent than was absolutely necessary, or that it was being raised to a larger sum than the Directors saw their way to earn dividends upon. It was to be hoped that the preference shareholders would subscribe for the preference shares, which they would obtain at par as compared with the market price of about £5½. He concluded by proposing resolutions for increasing the capital as mentioned.

Mr. WILLIAM SEAL seconded the motion, which was unanimously passed.

At separate meetings of each class of shareholders—the preference and ordinary—subsequently held, resolutions were passed sanctioning the adoption of all the special resolutions agreed to at the extraordinary general meeting.

Waterloo and City Railway Company.

The thirteenth half-yearly meeting was held yesterday, at Waterloo Station, Mr. WYNDHAM S. PORTAL presiding.

The CHAIRMAN, in moving the adoption of the report, stated that the gross receipts for the half-year, after deducting Government duty, amounted to £14,069 compared with £13,093 in the corresponding six months, and the working expenses to £7,773 against £6,640. The difference between these two sums not being sufficient to pay a dividend of 3 per cent., the London and South Western Railway Co., under their working agreement, had provided the deficiency of £2,375. Including season ticket holders, 1,868,737 passengers had been carried, an increase of 152,912 for the half-year. As a neighbouring company he was sure that they would all join in offering their congratulations to the Central London Railway Co. on the successful completion of that undertaking, and it was to be hoped that the two lines would benefit each other. So far, during the current half-year the receipts on the Waterloo and City line had continued to show a steady increase. Up to the end of last June the total capital outlay had been £589,073, the expenditure during the past half-year having been as follows: On construction of way and stations £10,000, on engineering £800, and on electrical equipment £4,400 odd. In conclusion he expressed regret at the death of Lieut.-Gen. Sir Frederick Marshall, a director, and stated that Mr. F. J. Macaulay had been elected to a seat on the board.

Lieut.-Col. the Hon. W. H. CAMPBELL seconded the motion.

Mr. BEAVIS considered that the report was satisfactory and said that everything appeared to be going on all right. He asked the amount of the total indebtedness of the company to the working line, and said he supposed that the amount would have to be paid before a higher dividend than 3 per cent. could be paid.

Mr. STURDY thought that the facilities afforded by the line, in conjunction with the Central London Railway, ought to be more widely known, and suggested that 55 per cent. of the gross receipts was rather a high rate to charge for working such a line.

The CHAIRMAN, in reply, said that the total indebtedness of the company to the London and South Western Company was £8,712, which would have to be liquidated before more than 3 per cent. could be declared in the way of dividend.

The motion was unanimously agreed to.

CASTNER-KELLNER ALKALI CO. (LTD.)—At an extraordinary meeting on Wednesday it was resolved to purchase the undertaking of the Aluminium Co. (Ltd.), with certain exceptions, and for carrying out the agreement to purchase the directors were authorised to borrow, in addition to £150,000 already authorised, a further sum or sums not exceeding £120,000. At the same time it was decided to increase the capital from £300,000 to £450,000, in £1 shares, and to make certain alterations in the articles of association. The chairman (Mr. W. Mather, M.P.), stated that ever since the works were established and the successful prosecution of the industry had been proved the directors had been considering the importance of the future development of the undertaking and to add to it other branches of chemical manufacture. He was convinced that the proposed union would be mutually beneficial. The amalgamation would probably result in a considerable increase in the company's profits and in great economies being effected.

CENTRAL LONDON RAILWAY CO.—The ordinary general meeting was held on Wednesday. The chairman (Sir Henry Oakley), who moved the adoption of the report, which appeared in our last issue, congratulated the shareholders on the successful completion and opening of the line. There was every indication that the most sanguine estimates of its utility and popularity with the public would be realised. They expended only about £185,000 for the last half-year, and that was due to the fact that the body of the work had been completed, and that the lighter work of the stations, electrical machinery, lighting, &c., did not absorb so much money. Having carefully revised all their estimates of work yet to be done and paid for, they had every reason to believe that the whole undertaking would be completed for the original capital, and that unless their business so expanded as to render further larger expenditure necessary, they should not, at all events for the present, require any authority to raise further money. There was a large sum due to the contractors, but that was according to an arrangement made in the early days by the board. The contractors were to be paid a portion of their expenditure by debentures, but those debentures were not to bear interest until the line had been completed and open for traffic. The additional incentive of the interest on £500,000 remaining unpaid probably encouraged the contractors to display increased exertions. They opened the line for traffic on July 30. They began at 5 a.m. and started a series of trains five minutes apart. They established a general or average fare of 2d. for any distance. From the moment of its opening it had shown one continued success. The very first morning the trains to the City were crowded, and they had remained crowded ever since, with the additional advantage that the mid-day trains also filled extremely satisfactorily. The first day they carried 85,400 people, on Tuesday 91,900, on Wednesday 86,700, on Thursday 96,100, on Friday 80,700, and on Saturday 100,444. On Sunday last the number was 64,742, on Monday (Bank Holiday) 100,391, and Tuesday 105,170. There could be no reasonable doubt, therefore, that the public very much appreciated the services they had rendered. Their trains now run every five minutes; in two or three days they should run them every four minutes, and as fast as they could get complete trains ready, electrically fitted so as to rely on their working, they should get down to 3½ minutes or three minutes between each train: so that, as far as possible, they should remove all ground of complaint of overcrowding. The motion was seconded by Lord Rathmore and adopted.

GAS LIGHT AND COKE CO.—At the half-yearly meeting on Friday the chairman (Col. Makins) referred to the increase in the price of gas. He said that the rateable value of the company's undertaking was at present £730,000, but it had just been revalued at £791,800. Should the revaluation be confirmed consumers of gas in the company's district would have to bear the burden of a further addition to the price of gas. It could not too often be repeated that, in accordance with the terms of their deed of co-partnership, the act of 1876, whatever additional charge this company had put upon it, five-sixths must be borne by the consumers and one-sixth by the shareholders, and vice versa out of any savings or advantages which came to the company five-sixths went to the consumers and one-sixth to the shareholders. Though they had some 360,000 consumers, they had received protests against the recent rise from a quite insignificant number of them. [Perhaps the poor gas consumer has learnt the value of protest.] To meet the increase in the cost of coal, they had no funds available except the gas rental and the dividend account. He complained of the somewhat harsh and unfair treatment meted out to them by their critics. The charges against them always took the same form, because another company, acting under similar legislation, could make a sale of gas at a lower price than the Gas Light and Coke Co., therefore the management of the latter company must be bad. The differing circumstances of the two companies made the cases absolutely incomparable. The increase of the southern company's business for the past half-year had been 12¼ per cent.; their company's was 3¼ per cent. Taking the whole period, over which a comparison could be made, the figures were 136 per cent. and 46 per cent. Of course, too, the competition of electric lighting did not affect the southern company to anything like the same extent.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH ELECTRIC CAR CO. (LTD.)—This company was registered on Aug. 2 with a capital of £50,000, in £1 shares, to manufacture and deal in rolling stock for tramways and light or other railways, and to carry on the business of motor car, &c., builders. The subscribers are A. K. Baylor (electrical engineer), G. J. Jackson, W. M. Murphy (civil engineer), A. S. Tuffin, E. Moss, E. Beckett, and E. T. Botwright. Mr. A. K. Baylor is the first chairman.

NORTHERN ENGINEERING CO. (LTD.)—This company was registered on Aug. 2 with a capital of £30,000, in £1 shares, to acquire the business carried on by the Northern Engineering Co. (Ltd.), at Halifax, and to carry on the business of machine tool makers, electrical and general engineers, &c. The first directors are H. Longsdon, W. Partington, and S. Hey.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28 1/16d. per oz. (Aug. 9). Consols (2¾ per cent.) 97⅞—97⅞ for money, 97⅞—98 for account; 2½ per cent. 96¾—97¼ (Aug. 9). Stocks and Shares Continuation Days, Aug. 13 and 28; Ticket Days, Aug. 14 and 29; Pay Days, Aug. 15 and 30; Mining Share Carry-over Days, Aug. 11 and 27.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—Warrants for payment of a 6 per cent. interim dividend for the half-year ended June 30 on the preference shares have been posted.

GREAT NORTHERN RAILWAY CO. (IRELAND).—In the directors' report for the half-year ended June 30, it is stated that the bill for the incorporation of a company with power to purchase the undertaking of the Bessbrook and Newry Electric Tramway Co., and for the construction of a light railway from Bessbrook to Tynan had received the Royal Assent. The new Great Northern Hotel at Bundoran had been fitted with a complete electric lighting installation.

HOVE ELECTRIC LIGHTING CO. (LTD.)—The directors have declared an interim dividend at the rate of 7 per cent. per annum for the half-year ended June 30. The dividend will be paid on Oct. 15.

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NATIONAL ELECTRIC SUPPLY CO. (LTD.).—It has been decided to increase the capital of the company to £184,943. 15s. by the creation of 20,000 new shares of £5 each, to rank pari passu with the preference shares. The Chairman (Mr. J. Booth) said the company was now doing very well indeed. Last year was the best year they ever had, and so far they were this year able to show a substantial increase of profit over last year in spite of the greatly advanced price of coal. They expected a very busy winter, and hoped to have their new engine and boiler-house ready in time for it. They were sometimes asked about the proposed electric trams. With their new machinery they should be in a position to supply current for the trams at a lower rate than the Corporation or a separate company could possibly generate it for themselves, and hoped to be able to show the Corporation that it would be a waste of ratepayers' money to erect a separate generating station.

NORTH METROPOLITAN TRAMWAYS CO.—At the meeting on Wednesday the chairman (Mr. George Richardson) stated, in reply to a question, that the adoption of electric traction depended on the London County Council. That body had not yet made experiments on their own line, and until they did so nothing could be done by the directors.

ROYAL ELECTRIC CO. (MONTREAL).—At the recent annual meeting of this company an agreement with the Chambly Electric Co., which provides that the Royal Company shall purchase all the electric power developed by the Chambly Company for 50 years at the rate of $15 per H.P. for the first 15,350 H.P., and $10 per H.P. for any amount in excess of this was ratified. The contract does not affect the agreement with the Montreal Street Railway Co. The Royal Company takes an additional $90,000 of stock and $30,000 of bonds of the Chambly Company. The shareholders of the Royal Co. afterwards sanctioned the sale of their holdings in the Chambly Company to Mr. James Ross for $791,000.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—In a circular just issued to the shareholders it is stated that the business of the company has progressed and is progressing satisfactorily. Within the past few weeks 30 new installations have been obtained in the Central Markets. The number of units sold for the half-year to June 30 amounted to 367,306, against 174,827 for the corresponding period of 1899.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has been asked to allow 9,400 further ordinary £5 shares of *Edmundson's Electricity Corporation (Ltd.)* to be quoted in the official list. Tuesday, Aug. 14, has been appointed a special settling day in the further issue of 20,000 5 per cent. cumulative preference £5 fully-paid shares (Nos. 20,001 to 40,000) of *Callender's Cable and Construction Co. (Ltd.)*, and the committee has ordered the securities to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Aug. 4	4,571	+ 27	4	18,595	+ 597
Blackpool Corporation...	„ 2	1,134	+ 213	18	12,712	+ 2,920
Blackpool and Fleetwood	„ 4	1,290	- 69	5	5,883	+ 70
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	...	...	...	...	...	...
Brisbane Trams	June 20	1,684	+ 444	24	44,238	+12,546
*Bristol Trams & Carriage	Aug. 3	3,451	- 209	5	17,426	- 48
*Buenos Ayres & Belgrano	July 8	2,226	- 239	1	2,226	- 239
Central London Railway	Aug. 4	4,323	...	1	4,323	...
City & South London Ry.	„ 5	1,541	+ 608	5	7,446	+ 2,792
Cork Elec. Trams	„ 2	525	+ 5	31	12,141	+ 1,222
Dover Corporation	„ 4	275	+ 3	18	3,970	+ 330
Dublin & Lucan Rly. ...	...	...	...	..	...	...
Dublin United	„ 3	3,955	+ 442	5	18,996	+ 2,157
Dublin Southern Dist....	„ 3	1,046	- 110	5	5,592	+ 165
*Glasgow Corporation ...	„ 4	9,070	- 220	...	...	...
Hull Corporation	„ 4	1,312	+ 766	5	6,719	+ 3,965
*Liverpool Corporation...	July 28	9,054	+1,403	30	223,780	+27,156
Liverpool Overhead Rly.	Aug. 5	1,635	- 19	5	8,499	+ 506
*Sheffield Tramways	„ 5	2,472	+1,035	31	65,518	+22,535

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 1.	Price Wednesday, Aug. 8.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 8. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
26,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£823,720	Stock	15/0	Anglo-American.....xd	58 61	59 62	6 0 6	Feb., May, Aug., Nov.	58½	...
£3,068,640	Stock	20/0	Do. Preferred .....xd	110½ 111½	110½ 111½	5 7 7	„ „	111½	110½
£3,068,640	Stock	27/0	Do. Deferred	11¾ 12¼	12 12½	10 16 0	„ „	12⅛	12 3/16
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,569,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	102½	...
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	7 7/16	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	100¾ 104¾	100¾ 104¾	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	11½ 11¾	11½ 11¾	5 19 2	Jan., Apr., July, Oct.	11⅝	11½
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	145 150	145 150	4 13 4	Jan., Apr., July, Oct.	149	145
£1,626,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	96 99	98 99	3 10 8	„ „	99	97
£1,432,368	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	2/6	Eastern Extension.....	14½ 15	14½ 15	4 13 4	Jan., Apr., July, Oct.	15	14⅞
£220,000	Stock	4%	Do. 4 per Cent. Debenture Stock.....xd	110 115	110 115	3 9 7	February and August	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909 ... ..xd	99 102	99 102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	100¾ 103¾	100¾ 103¾	3 17 8	May and November'...	...	...
180,227	10	2/6	Globe Telegraph and Trust	11½ 11¾	11½ 11¾	4 9 4	Jan., Apr., July, Oct.	11⅝	11⅜
180,042	10	3/0	Do. 6 per Cent. Preference	15 15½	15 15½	3 18 8	„ „	15 7/16	15½
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July.....	33	...
£94,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99 101	99 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	52 56	52 56	4 9 3	May and November ...	54	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 9	June and December ...	...	...
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	98 101	5 0 4	March and September	...	...
20,008	2½	...	West Coast of America.....	½ 1	½ 1	...	...	⅜	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 13 7	January and July.....	93	...
88,231	10	1/0	West India and Panama	⅜ ½	⅜ ½	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	...	...	4 15 3	June and December ...	...	...
207,920	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	15	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	4 5 9	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November	...	...
98,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National .....xd	4½ 5	4½ 5	6 0 0	February and August	4⅝	4½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference xd	12 14	12 14	4 5 9	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference xd	12 14	12 14	4 5 9	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. xd	4¾ 5⅛	4¾ 5⅛	4 17 7	„ „	5 1/16	5
2,000,000	Stock	2½%	* Do. Debenture Stock 2½ per Cent. (red.)	97 100	97 100	2 10 0	June and December ...	...	...
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4¾ 5¼	4¾ 5¼	6 13 4	July	5	...
16,689	5	2/6	Do. 5% Cumulative Preference.....	5 5⅛	5 5⅛	4 10 11	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Aug. 1.	Price Wednesday, Aug. 8.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 8. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6 6½	6 6½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9½ 10⅛	9½ 10⅛	4 5 9	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅜ 5⅝	5⅜ 5⅝	3 18 3	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7⅛	6½ 7⅛	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	107 110	108 111	4 1 6	June and December...	110	109½
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8 9	8 9	4 8 11	February and August	8½	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref. xd	11½ 12½	12 13	4 16 0	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 128	123 128	3 18 5	June and December ...	126	125
40,000	10	8/0	County of London and Brush Prov. Ordinary	8½ 9½	8 9	4 8 11	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference xd	11½ 12½	12 13	4 12 4	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1½	1 1½	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	93 100	98 100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	14½ 15½	14½ 15½	3 11 0	April and October	15	14⅞
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December ...	...	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	96 98	3 11 6	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	4 4 10	March	...	..
10,000	5	5/0	Oxford Electric Ordinary	5⅞ 6⅛	5⅞ 6⅛	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	1 1/16 1⅛	1 1/16 1⅛	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary xd	14 15	14 15	4 16 8	February and August	14⅝	14⅜
20,000	5	3/6	Do. 7 per Cent. Preference xd	8 9	8 9	3 17 8	,, ,,	8⅝	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	2	1⅞
£250,000	Stock	4%	Do. 4% Debentures xd	85 95	85 95	4 4 3	—	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3 4	3 4	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	12½	12 13	5 0 0	March and September	12⅞	12⅜
29,437	5	8/7½	Do. £2 10s. paid	...	8½ 9½	...	...	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	1 1/16 d.	Alliance Electrical Co. 5% Cum. Pref.	1 1⅛	⅞ 1⅛	4 8 11	...	...	...
125,000	1	7 1/16 d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞ ⅞	⅞ ⅞	6 17 2	March and September	13/16	...
85,000	1	...	British Electric Works Co. Ordinary	⅞ ⅞	...	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1 1/16 1⅛	...	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	...	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary xd	11½ 12½	11½ 12½	4 0 0	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅝ 6⅛	5⅝ 6⅛	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅝ 5⅛	4⅝ 5⅛	...	...	...	...
90,060	2	1/2 3/16	Brush Electrical Engineering	1⅝ 1 3/16	1⅝ 1 3/16	4 5 4	September	...	...
90,000	2	1/2 3/16	Do. 6 per Cent. Pref. Non-Cum.	2 2¼	2⅛ 2⅜	5 1 1	,,	2 5/16	2 3/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 114	108 113	4 1 1	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 103	101 103	4 7 5	June and December ...	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13 14	13 14	5 7 2	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 5⅝	5½ 5⅝	4 6 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9 3/16	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	6 8 0	...	...	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.) xd	97 100	97 100	4 10 0	...	...	...
60,000	1	0/9 3/16	Chadburn's Ship Telegraph Ordinary	⅜ 1	⅜ 1	7 0 0	March	⅜	...
60,000	1	0/7 1/16	Do. 6 per Cent. Cumulative Preference	⅜ 1⅛	⅜ 1⅛	5 6 8	...	⅜	...
32,098	3	1/9 3/16	Crompton and Co. (Nos. 1 to 32,093)	3½ 4½	3½ 4½	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 18 0	,, ,,	101½	100⅞
60,000	1	0/7 1/16	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	1 1/16	...
99,261	5	1/9 3/16	Edison and Swan United ("A" Shares) (£3 paid)	2 2½	2 2½	7 3 9	February and August	2 1/16	...
17,139	5	2/9 3/16	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91 93	91 93	4 6 0	June and December ...	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	68 72	63 72	...	...	...	...
26,100	5	6/0	Edmundson's Electric Corporation Ord. (fully pd.)	4½ 5	4½ 5	6 0 0	Half-yearly	4 1/16	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
112,100	2	1/2 3/16	Electric Construction Co. (Limited) xd	2 2¼	1⅞ 2⅛	5 12 11	January and July	...	...
25,000	2	2/9 3/16	Do. 7 per Cent. Cumulative Preference xd	2¾ 3⅛	2¼ 3⅛	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	104 105	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13 14	13 14	6 15 9	February and August	13¼	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5½ 5⅝	5½ 5⅝	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 104	101 104	3 17 10	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance x i	35 39	35 39	4 12 4	March and July	35	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10 11	10 11	5 9 1	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 5⅞	5½ 5⅞	4 6 11	...	5⅝	...
30,000	5	7/0	Willans and Robinson Ordinary	10⅛ 11⅛	10⅛ 11⅛	5 4 4	April and October	10⅜	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7	6½ 7	4 5 9	,, ,,	6⅝	6½
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103 105	103 105	4 17 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22 23	22 23	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10½ 10¾	10½ 10¾	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10¾	10½ 10¾	4 13 0	May and November	...	...
45,000	10	11/0	British Elec. Trac. Ord.	14 15	14 15	4 0 0	...	14⅝	14½
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12 13/16	12⅝
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123 124	123 125	4 0 4	...	125½	125
£150,000	Stock	...	Do. Do. (Issued Feb. 5, 1900)	121 124	121 124	...	...	...	...
40,000	5	2/8 3/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 105	103 105	4 15 0	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	96 99	93 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	9½ 10	10 10½	2 17 2	June and December	10⅝	9⅝
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	53 59	56 59	2 6 7	February and August	59	...
37,500	10	1/5 7/16	Do. (Nos. 22,501 to 60,000)	6 7	6 7	2 2 0	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	,, ,,	...	...
£200,000	Stock	5%	Do. (1893)	132 137	132 137	3 13 8	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debentures	120 125	120 125	3 4 5	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22 23	22 23	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	115 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	1/16 ⅛	1/16 ⅛	...	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16 ⅛	1/16 ⅛	...	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10 10½	...	...	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 3/16 9 5/16	9½ 9¾	4 0 1	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13⅝	13½ 13⅝	3 14 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103 105	103 105	3 16 2	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3¾	...	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5½	4½ 5½	5 14 3	May	...	...
14,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 18	...	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜ 10½	...	...	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	93 93	90 93	3 5 7	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,161. [No. 17, Vol. XLV.] FRIDAY, AUGUST 17, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30c., or 70pf.

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NOTES.

IT is pleasing to learn that the reception which British electrical engineers have accorded to their American *confrères* during the past week has afforded much gratification to the latter. Some thirty Americans accepted the invitation of the Institution of Electrical Engineers to visit London and enjoy the varied programme described in our issue last week, p. 588. Owing to a fortunate improvement in the weather almost at the last moment, the river trip in electric launches proved a great success, and was enjoyed by some 50 guests and others. On Monday visits were paid to several works of electrical interest, including the Central London Railway. This latter was unanimously admitted by the American engineers to surpass any example of electric traction in the United States.

ABOUT 30 guests besides a number of members of the Institution, making a party of 76 all told, spent Monday evening in an agreeable manner at the Princes' Restaurant, Piccadilly, with Prof. PERRY in the chair. A well-served repast was followed by a number of lively speeches, and at times the fun was fast and furious. Following the toasts of "The Queen" and "The President U.S.A.," Mr. H. H. CUNYNGHAME, C.B., proposed, and Mr. J. S. RAWORTH seconded "Our Guests," the toast being responded to by Mr. CARL HERING, President of the American Institute, Prof. F. B. CROCKER and Mr. C. O. MAILLOUX. Prof. PERRY was repeatedly chaffed at his novel arrangement of double and treble-barrelled speakers.

ONE speaker perceived the fitness of things in there being two-phase speakers on what he termed the primary side, and a three-phase system on the secondary—a sort of "Scott system" of oratory! It needed, he said, a three-phase system on the secondary side to take all the heavy load of British hospitality. One of the most humorous speeches was that of Mr. R. W. POPE, Secretary of the American Institute, who proposed the impersonal toast of "Electrical Engineering," this being seconded by Mr. W. M. MORDEY and responded to by Prof. S. P. THOMPSON and Dr. A. E. KENNELLY. Tuesday the guests spent in visiting a number of engineering works, and on Wednesday they left in company with a large contingent of British electrical engineers for Paris.

IN a long communication addressed to the new POSTMASTER-GENERAL, and occupying four newspaper columns of small type, Mr. HENNIKER HEATON has formulated his ideas on postal and telegraph reforms, and without Lord LONDONDERRY'S permission has caused it to be published in *The Times*. We confidently say without his lordship's permission because nobody receiving such a letter, couched in terms so fulsome in its flattery and so offensive to his predecessors would have desired to see it in print. Mr. HEATON'S bad taste, however, has its compensations. After what he has said about the present POSTMASTER-GENERAL compared with all POSTMASTERS-GENERAL in the past, it will be impossible for Mr. HEATON to complain if he gets an answer not exactly to his liking. The wisest and most business-like of chiefs who have ever controlled the Post Office, according to the member for Canterbury, will have no difficulty whatever in disposing of that member's arguments or in dismissing most of his recommendations. Of the postal portions of his programme we will say only this, that if they are supported on no better ground than the telegraphic, Mr. HEATON has much to learn before he can be considered an authority. A halfpenny postcard ought to be sold at its face value; but we do not need a member of Parliament to tell us that: nor can he take credit for obvious concessions which time and opportunity are sure to bring about without his interference. His arguments are all wrong, and do not help matters in the least.

THIS, at all events, is true of his recommendations for improving the telegraph service. He begins with a complaint that the Post Office demand 2d. for a receipt in respect of telegraph charges, whereas the cable companies give one for nothing.

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The probable explanation is that the Post Office take but a fraction of the total charge, whereas the companies take the whole of it. In a like fashion Mr. HEATON argues that because the charge for inland telegrams in England, France, Belgium, Holland, and Germany is a halfpenny per word, the rate between England and these countries should be the equivalent of the two local rates—that is to say, 1d. per word instead of 2d. Leaving the cables connecting these countries out of account, we might, with just as much reason, demand similar rates to Spain and the Azores, and even to America. The fee for registered addresses should, he thinks, be abolished, chiefly, it seems, because it brings in a revenue of £60,000 per annum. To our thinking it ought to be abolished because it robs the revenue of its legitimate charge for addresses, which ought to be written at length. But Mr. HEATON is in favour of free addresses, and would virtually extend the limit of words to 20. Seeing that the telegraph service does not pay with a 12-word limit, it is hard to understand how Mr. HENNIKER HEATON can expect it to bear this additional burden.

UPON Mr. HENNIKER HEATON'S demand that all submarine cables and all telephone lines should become Government property we need not spend many words. His description of the telephone service is not overdrawn; but, unfortunately, it is almost past mending, and this chiefly through the mischievous meddling of reformers like himself. As to the great submarine cables, their transfer to the State has never been within the range of practical politics, and is further off than ever now that other countries are threatening competition in that line of business.

WRITING to the *Glasgow Herald* of last Saturday, Mr. H. A. MAVOR has attempted to show that experience in electric transmission schemes "goes to prove that electric transmission of power which has been profitable has been associated with development of new districts, and has depended for its financial success on increased capital value of land." The writer apparently seeks to recommend the moral to those who contemplate investing in projected electrical power schemes in this country. There may be some truth in what Mr. MAVOR says; indeed, to a certain extent, it is self-evident that electric power transmission *has* developed the capital value of land. The case of Niagara is cited. But it is easy to point this moral too markedly and to over-adorn the tale. Why has land improved in value at Niagara? Simply because electric power there has proved cheaper than steam power at Buffalo or Pittsburg. Mr. MAVOR puts forward as a prime cause what is only an incidental effect. If the success of electric power transmission requires that land should be developed in capital value, why is so much of that power being transmitted from Niagara across miles of waste land into the heart of Buffalo city?

BUT though we cannot agree with Mr. MAVOR in his supposed reasons, we are quite in sympathy with him in his desire to warn intending investors against unprofitable electric power schemes. It is to be feared that the measure of encouragement now vouchsafed by Parliament to this class of commercial venture will lead in the immediate future to some ugly company promoting. All well-wishers of electrical progress hope to the contrary; but the danger undoubtedly exists, and the best that can be done is to warn the investing public against the black sheep which are to be found in every fold, and to advise them to look well into the individual merits of each promotion before parting with their money.

University College (Bristol).—The 1900-1901 session begins on Oct. 2.

The Telephone in Madagascar.—The first telephone in Madagascar was opened on Wednesday, the 8th inst., Antananarivo and Tamatave being connected.

Heriot-Watt College, Edinburgh.—The 1900-1901 session commences on October 2nd and extends to June 7, 1901. Particulars of the day classes can be obtained from the librarian.

Battersea Vestry Electric Supply Station.—The ceremony of laying the foundation stone of the new electric supply works of the Vestry of Battersea will take place to-morrow (Saturday) at 3:30 p.m., the ceremony being performed by Mr. W. Matthew, J.P., chairman of the Vestry.

Sunderland Corporation Electric Tramways.—The official opening of these tramways took place on Wednesday last, the 15th inst., the ceremony being performed by Councillor Trewhitt, the chairman of the Tramways committee. Power is supplied from the Corporation electric lighting station.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 5, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Serena—Valparaiso	Aug. 2, 1900
Iquique—Valparaiso	Aug. 2, 1900

The Paris Meeting of the Iron and Steel Institute.—Under the presidency of Sir William Roberts-Austen, the Iron and Steel Institute will hold its autumn meeting in Paris from Sept. 18 to Sept. 21 inclusive. A number of metallurgical papers will be read, and the meeting will, of course, include visits to the Paris Exhibition and other places of interest in the neighbourhood. A detailed programme can be obtained of the secretary.

Electric Inclined Elevators.—We have received a letter from Messrs. Graham, Moreton & Co., of Leeds, stating that they have made and erected elevators similar in construction to the Reno inclined elevator described in our issue last week. It appears, however, that the elevators made by this firm have been used for conveying sacks and other goods, one of these, erected at Battersea, being capable of handling 1,000 sacks per hour.

Telegraphic Communication between London and Vienna.—Recently a member of the Austrian Chamber of Commerce petitioned the Minister of the Interior to use his influence in favour of the establishment of a third direct telegraph line between Vienna and London. The Minister has now replied that there is no immediate necessity for such a line, although some difficulties have been recently experienced with Anglo-Austrian telegraphic communications.

The Telegraph in German East Africa.—According to the Berlin correspondent of the *Standard*, preparations for laying the telegraph from Dar-es-Salam to Kilossa, in German East Africa, began about the middle of last month. The German Postmaster-General has promised to ask for 200,000 marks (about £10,000) in the next budget for carrying out the work, and he is reported to have stated that the telegraph must reach Ujiji before Mr. Rhodes' Cape-to-Cairo telegraphs.

Röntgen Society.—We have received a copy of the annual report for the year ended June 30 last. This useful society has now been in existence for three years, and during that time has greatly increased the number of its membership. During the past year no less than 62 ordinary members

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have been added to its list. Dr. J. B. Macintyre, of Glasgow, has consented to be nominated as president for the next session.

London University Senate.—It is officially announced that the Faculty of Laws in the University of London having failed to exercise the power of appointing one member of the Senate by reason of there being no person entitled to be, Her Majesty has been pleased, by and with the advice of Her Privy Council, to appoint Baron Davey to be a member of the Senate. Her Majesty has also appointed as members of the Senate Sir John Wolfe Barry, Sir H. E. Roscoe, Mrs. Eleanor M. Sedgwick, and the Hon. W. P. Reeves.

New Treatment of Tuberculosis.—A Reuter's telegram states that in the International Congress of Medicine held at Paris, Dr. Labadi, delegate of the Medical Legal Society of New York, Dr. Bertheau, of Paris, and Dr. Ducamp, of Bordeaux, have reported on a new treatment of tuberculosis discovered by a Frenchman, M. Francisque Croth. This discovery consists in the direct transmission of antiseptics by means of static electricity. The most elaborate circumstantial statistics of the three physicians, covering a period of two years, agree in affirming that a high percentage of patients treated by this method have been cured.

Another Large Electric Power Scheme.—With reference to the note on page 615 of our issue last week, describing a projected electric power scheme, we are authoritatively informed that another large scheme for the supply of electric power for manufacturing, lighting, and other purposes throughout the industrial districts round Glasgow has been under preparation for some time past and is now completed. The scheme is being promoted by a number of influential engineers and others in the various localities within the proposed area of supply, and a bill for the necessary Parliamentary powers is to be introduced next session.

Telegraphic Communication with Pekin.—The Eastern Extension and Great Northern Telegraph Companies announce that they have received the following intimation from the Chinese Telegraph Administration: "Since despatches have come through safely at different times from Peking via Tsinanfu by couriers, attempts will now be made to forward on messages for Peking via same route at ordinary rate, plus $3 for courier service. Messages, however, will be subject to delay, and will only be accepted at sender's risk." The companies, therefore, propose to accept messages for Peking, subject to above conditions, at 6s. per message—in addition to the ordinary tariff of 5s. 6d. per word.

Locomotive Breakdown on the City and South London Railway.—As we go to press we learn that yesterday morning at about 9 o'clock a breakdown occurred on one of the trains between the Borough and Elephant stations on this railway. A short-circuit on one of the armatures resulted in the ignition of the insulation and a portion of the wood-work of the engine. Consequently the train came to a standstill in the tunnel until a spare engine could be sent up behind to push it into the Elephant station. The smoke appears to have incommoded the passengers in the train, which was rather crowded, but no injury was done to any passenger, nor, indeed, to the driver on the engine. There was only a slight delay of the traffic.

Appointment.—The Council of University College, London, have appointed Prof. G. Carey Foster, B.A., F.R.S., to be Principal of the College. Prof. Carey Foster is a Fellow of the College and has held the offices of Professor of Experimental Physics and of Quain Professor of Physics; he is also a Fellow of the University of London, in which university he acted as Examiner previous to his election to the Senate. Owing to this appointment and to the retirement of Mr. J. M. Horsburgh, the secretary of the College, there will be a reorganisation of the administrative and executive department of the College. Pending the completion of this reorganisation the Council have invited Dr. Gregory Foster, Fellow of the College and Professor of English Language and Literature at Bedford College, to temporarily hold the office of secretary, and he has accepted the invitation.

French Cables.—In the report of the French Cable Commission, referred to in our article on "French Cable Projects" last week, the length of some of the cables set out in tabular form was not given. By way of supplying the omission and rectifying errors which inadvertently occurred in our article, we give the table afresh with the correct estimated lengths inserted:—

Description of lines.		Cable length in marine miles.	Approximate cost.
Mediterranean System—*Oran-Tangier*		290	£32,000
Atlantic System.	*Brest-St. Louis* (or *Dakar*)	2,500	680,000
	St. Louis-Pernambuco (or *Cayenne*)	1,800	400,000
	Aerial line—*St. Louis to Kotonou*	1,700	40,000
	Kotonou-Libreville	660	96,000
	St. Louis-Libreville (direct)	2,040	720,000
Indian Ocean System.	Libreville-Madagascar	4,730	1,480,000
	Madagascar-Reunion	455	72,000
	Reunion-Indo-China	4,080	1,520,000
Indo-Chinese System—*Hue-Amoy*		1,000	220,000
		19,255	£5,260,000

The Electrical Engineers (R.E.) Volunteers at the Front.—We have received from Major R. S. Erskine a letter giving an extract from a report received from Major Crompton, dated Pretoria, July 17 and 18, showing where the officers, non-commissioned officers, and men of the corps were at work on those dates. Of the six who were taken prisoners, two escaped and the other four were released. Lieut. Pott is reported to be convalescent and to be returning home. Second-Lieut. Bigge, who was wounded, has returned to duty. Of those in hospital, Sapper Dalton is reported to be doing well, Sapper Arundel is convalescent, and owes his life to splendid nursing, Sapper Brander is convalescent. No information is given as to the condition of the others reported in hospital. The men have been at work: (1) As electrical engineers fitting up and repairing electric light and power plant; (2) search-light men; (3) arc-light men for working parties; (4) on telephone light lines; (5) as army telegraphists; (6) as railway telegraphists; (7) as Royal Engineers working parties on crib and tressel reconstruction, railway bridges; (8) as a fighting unit. Major Crompton reports that they have done well in each branch. He desires to be remembered to all the officers and the corps as a whole, and hopes that what has been done out in Africa will help the corps both as regards its prestige and future popularity, and he feels proud to have had command of such a thorough good lot of men.

Municipal Ownership in America.—Municipally owned electric light works in the United States seem to differ very much from those in this country, to judge by a leading article in the *Electrical Review* of New York, from which the following is quoted:—

Municipal ownership is a species of contagious infection which breaks out sporadically, much as the mumps and measles do in small towns and cities. The fever gets into the municipal blood and brain, and recovery is more or less rapid according to the violence of the attack. Those places that pass through the serious crisis of actually building a municipal plant recover slowly but very completely. Those that stop short of this acute phase are subject to recurring attacks. In the United States, the history of municipal electrical undertakings has been one long chapter of failure, and the features of each case have been practically identical. The place is a town of, say, 10,000 or 20,000 inhabitants. The municipal government is almost always thoroughly honest but highly inefficient. Some citizen suddenly discovers that if the electric light company makes a profit the municipality could get the same amount of light for less money. He talks in the town council and at public meetings, the newspapers take the matter up it becomes an issue in local politics. The question goes to a popular vote, and by an overwhelming majority it is determined to build a plant. All this time the agents of several contractors have been supplying data and figures to the committee or clique that is working for the plant. One of them secures the contract and the plant is built. Of course no engineer is employed, for by this time the committee in charge feels that it knows all about the lighting business and needs no advice. Generally the plant is well built, though frequently it is not. At the end of its first year of operation a balance-sheet is struck off, showing that street lighting is costing less than ever before. Nobody notices that such items as depreciation, remitted taxes, sinking fund for renewals, &c., are not charged on the balance-sheet. Soon it becomes necessary to find a berth for one of "the boys"—for some broken-down politician out of a job. A soft "snap" is found for him at the electric light plant. Then the politician anxious for re-election discovers that the wages paid by the plant are too low, and consequently wages are raised. And at the end of about five years the plant is for sale and the town council is advertising for bids for lighting and considering how large an increase of the tax rate the citizens will stand.

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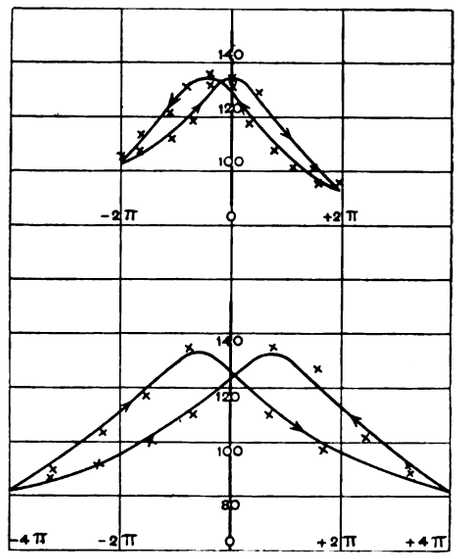
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Artificial Radio-activity.—One method by which light may be shed upon the origin of Becquerel rays consists in endeavouring to produce them in an ordinary body by some known process. This has been accomplished by P. Villard, who succeeded in rendering ordinary bismuth radio-active by subjecting it to the action of cathode rays in a vacuum tube. The best results are obtained by employing the metal as an anode and anti-cathode combined. Those parts upon which the cathode rays impinge in the greatest intensity are the most active. Success is also attained by making the bismuth the cathode. But, then, the region whence the cathode rays emerge becomes the least active. This is not surprising, since the rays emitted by radio-active bodies probably consist of negatively charged particles. Powdered bismuth and bismuth deposited by cathode rays can also be made radio-active by this process. The radio-activity obtained is very feeble, and inferior even to that of uranium. It is, however, sufficiently intense to verify the properties of the rays photographically, and to show that they are essentially the same as those of uranium. They are also very stable, and show no decrease within a month. It remains to compare this artificial radio-activity with the induced activity discovered by the Curies. In any case much of the mystery of these rays has been now solved.

[P. Villard, *Bull. Soc. Franç. de Phys.*, 152, 1900.]

Thermo-Electric Effect of Twisting.—When an iron wire is clamped in the middle and heated at the clamp, and one-half of it is twisted, an E.M.F. is generated which differs with the



angle of torsion. It is, however, not constant for a given torsion, but depends upon previous twistings. There is, in fact, a hysteresis of twist just as there is a hysteresis of magnetisation. The annexed curves, in which ordinates represent E.M.F.s and abscissæ twists, show this clearly. When mechanical disturbances take place their effect is to accelerate the process the metal happens to be undergoing. They raise the rising curve and lower the falling curve.

[K. Tsuruta, *Phil. Mag.*, August, 1900.]

Electrolytic Estimation of Bismuth.—Hitherto it has been found impossible to obtain, by the electrolysis of bismuth salts, a sufficiently adhesive deposit to permit washing and weighing. Usually an amorphous deposit of oxide is obtained which is useless for quantitative work. A great variety of plans have been tried, but the only successful one appears to be that devised by D. Balachovsky, who states the following as the essential conditions of success: Feeble acidity of the solution; absence of chlorine, bromine, or iodine in any large quantities; feeble current; and unpolished electrodes. The best salt to operate upon is the sulphate or nitrate (but not the chloride), dissolved in nitric acid, to which is added about six times its weight of urea. The maximum current is 0·06 amperes, the voltage 1·5, and the temperature 60deg. The analysis takes about six hours or eight hours. Much care must be taken to prevent the current density unduly increasing, as then the deposit immediately begins to oxidise. After washing and drying the precipitate is very stable. Instead of urea, formic or ethylic aldehyde may be added to the electrolyte. The part played by these additions is not yet clear, but when aldehyde is used the temperature has to be a little higher, and the current density a little lower.

[D. Balachowsky, *Comptes Rendus*, July 16, 1900.]

Motion through the Ether.—The greatest difficulty hitherto presented by the undulatory theory of light lies in the motion of ponderable bodies through infinite space occupied by an elastic solid. Lord Kelvin has approached this difficulty by a supposition which is at variance with the idea of the incompressibility of the ether, but which suggests a conceivable explanation of the difficulty, and throws some light on aberration and refraction. He supposes that each atom acts on the ether within it and around it "according to the old-fashioned eighteenth century idea of attraction and repulsion." Also that "the distribution of positive and negative density of the atom, and the law of compressibility of the ether, is such that the avevage density of the ether within the atom is equal to the undisturbed density of the ether outside." He then proceeds to investigate the probable distribution of the ether within the atom, and the stream-lines of the ether through the atom when the latter moves through the ether. He finds that a density of ether in the centre of the atom considerably greater than 100 times the density of undisturbed ether is required to make the refractivity as great as that of oxygen. A difficulty is offered by Michelson and Morley's proof that the atmosphere carries the ether along with it. But an escape is offered through the brilliant suggestion advanced independently by Fitzgerald and Lorentz that the motion of ether through matter may slightly alter its linear dimensions.

[Kelvin, *Phil. Mag.*, August, 1900.]

Magnetic Balance.—H. du Bois has improved the magnetic balance designed in 1890 for the Physikalisch-Technische Reichsanstalt so as to make it an instrument of precision, without reducing its practical convenience of manipulation. This task was facilitated by the proof brought by Taylor-Jones that Maxwell's law of magnetic attraction is valid over a wide range. Magnetic balancing is now superior to the ballistic method for most purposes. Superior results can only be obtained by the magnetometric study of ovoids, and these therefore offer a means of deciding doubtful cases. But such measurements are troublesome, and for ordinary purposes the accuracy to within 0·5 per cent. offered by the magnetic balance may be taken as sufficient. The normal sectional area of the specimen to be tested is 0·5 sq. cm. It may be fastened in two different ways, either by ordinary clamps, or, for more accurate work, between concave spherical contacts. The magnetic field is excited by two coils carrying a current of from 2 amperes to 5 amperes. The magnetic forces generated in the specimen are balanced against two running weights, moving along separate scales, one weight being 25 times the mass of the other. The ordinary length of specimens is 25cm., but for cases of brittle metals and alloys lengths as small as 6cm. may be employed. The author gives the mathematical theory of the instrument in full.

[H. du Bois, *Ann. der Physik*, No. 6, 1900.]

Electrical Plant for the Construction of the Dover National Harbour.—We understand that the contractors for the National Harbour at Dover have recently adopted some ingenious electrical machinery for carrying out the extensive and difficult constructive work at the new harbour. Among other purposes this machinery is employed in making the 40-ton concrete blocks used in the deep-sea work.

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GLOUCESTER CORPORATION ELECTRICITY WORKS.

Amid all the *éclat* of gaily-decorated streets the municipal electric supply works of this historic city were opened on the 19th ult.

The electric lighting question first demanded the attention of the town by the notices given by four companies in June, 1889, of their intention to apply for provisional orders. It was then decided not to consent to any such applications, and meanwhile to consider the advisability of a municipal undertaking. No less than six companies between that time and 1895 gave similar notices, and in the latter year one company gave notice a second time, and the City of Gloucester Tramway Co. (Ltd.) made proposals for a combined scheme of lighting and traction.

After visiting the lighting and traction installations at Bristol, the Corporation decided, in November, 1895, to apply for their own order. In 1897 a special committee was appointed to advise the Council, and Mr. Hammond was asked to prepare a report dealing with the matter of electricity supply and the providing of a dust destructor. In August of that year it was decided to erect a station and destructor in combination, and after further visiting by a sub-committee, who embodied their experience in a report to the Council, a site on the Bearland estate was secured. The works are excellently situated in the south-west part of the city. They are easy of access and near the river, canal and dock branch railway. The station is practically on what was the south-west corner of the old Roman wall—a fact testified to by a stone built into the wall opposite the front entrance to the works, which bears the inscription: "While excavating for the foundation of the chimney-stack in May, 1899, this stone, which formed part of the old Roman wall of the city, was met with at 15ft. below the ground."

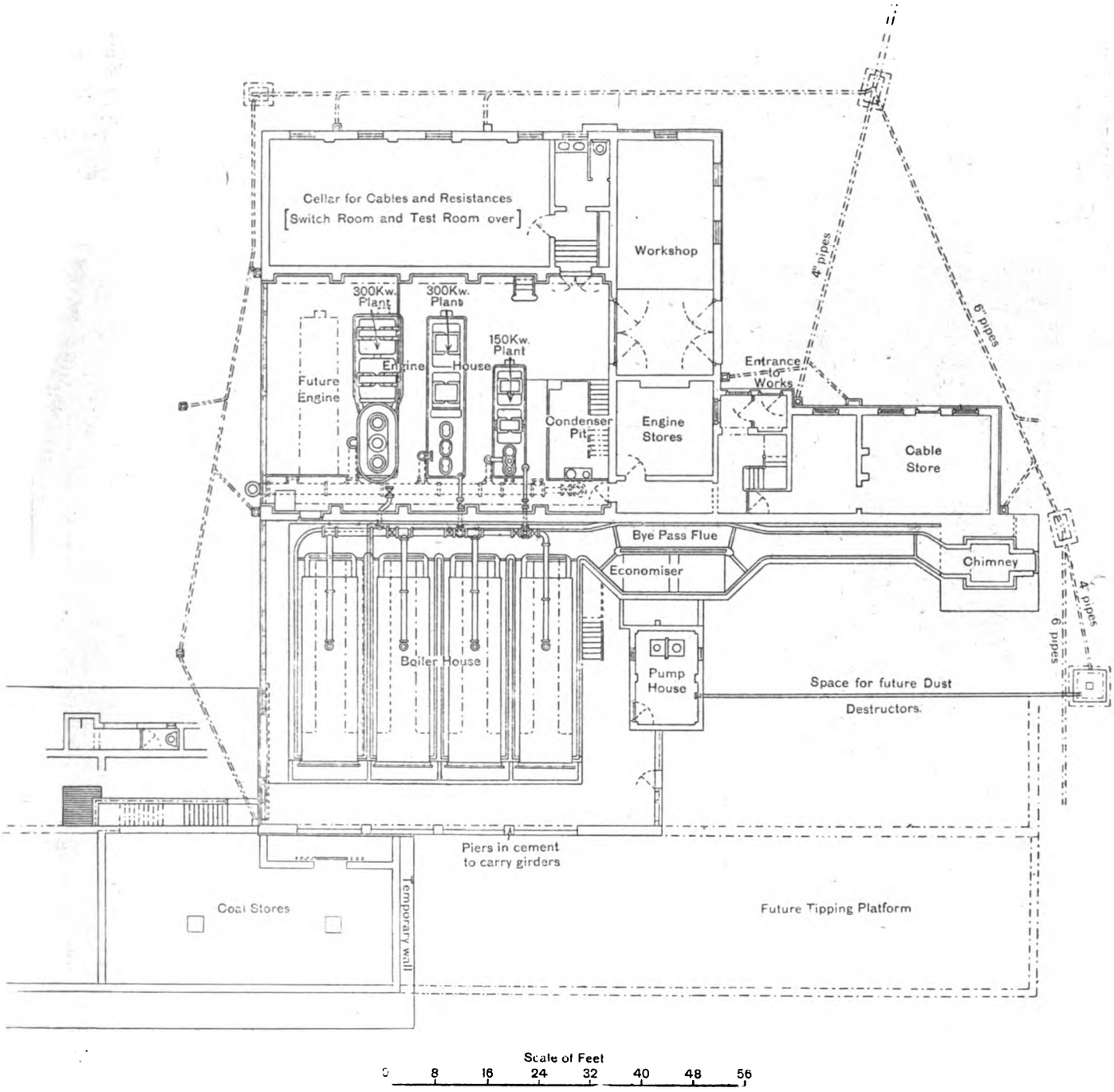

FIG. 1.—PLAN OF GLOUCESTER ELECTRICITY WORKS.

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The natural disposition of the ground is remarkably well adapted to the requirements of a dust destructor, as it permits of a level roadway being run from Ladybellegate-street to the charging floor, which is 15ft. above the clinkering floor—the ground level of the present buildings.

The works approaches are from Commercial-road and Ladybellegate-street, and the buildings, which were erected by Messrs. John Gurney & Sons, to the designs of Mr. H. A. Dancey, of Gloucester, include an engine room 54ft. by 87ft. by 28ft. high, and a boiler house slightly larger.

The interior walls of the engine room are of buff bricks with a dado of brown glazed bricks. The general arrangement of the works may be gathered from the ground plan, Fig. 1. In the north-west corner of the engine room is the condenser pit, the floor of which is 12ft. below the engine room level. On the south side is the switch room, and immediately behind this the test room. The level of both these two latter rooms is 4ft. above that of the engine room floor. The office and stores accommodation is excellent.

At present the generating plant consists of two sets. The larger set is of a capacity of 300kw., and consists of a triple expansion Belliss engine, directly coupled to a pair of Silvertown dynamos each capable of generating 600 amperes at 250 volts, the speed being 350 revs. per min. Looking at the engine of this set broadside on, one of the three upper cylinders is the high-pressure one, and the two other adjacent to each other are intermediate—the steam being distributed between them. The three lower are the low-pressure cylinders. The high-pressure cylinder is 13in. diameter, the intermediate and the low pressure cylinders being all 17¼in. diameter.

Being coupled in series on either side of the neutral wire of the three-wire system employed, the set develops current at 440 volts to 500 volts at the station end of the feeders. The engine of the smaller set is a two-crank compound, with one high and one low-pressure cylinder working on cranks set at 180deg. angle apart. Steam is distributed by a single piston-valve between the cylinders and the engine speed is 380 rev. per min. At 180lb. pressure steam the I.H.P. of this engine is 250. To this engine are also coupled two Silvertown dynamos, but each of 75kw. capacity at about 220 volts pressure. The engines are fitted with a system of forced lubrication, oil being supplied to each bearing under pressure from a pump on the main shaft.

The remaining item of electrical machinery in the engine room is a 15kw. motor-generator. The motor, which has a capacity of 85 amperes, receives current from the 'bus bars at from 220 volts to 250 volts, and drives a dynamo capable of delivering a current of 100 amperes at from 20 volts to 150 volts, running at a speed of 780 revs. per min. All the dynamos and the motor are of the single horse-shoe under-type.

In the condenser pit already referred to, there are installed two Blake and Knowles jet condensing plants. Each of these is capable of dealing with 10,000lb. of steam per hour, and of maintaining a vacuum of 26in. Condensing water from the dock enters the condenser without any auxiliary pump besides the air-pump.

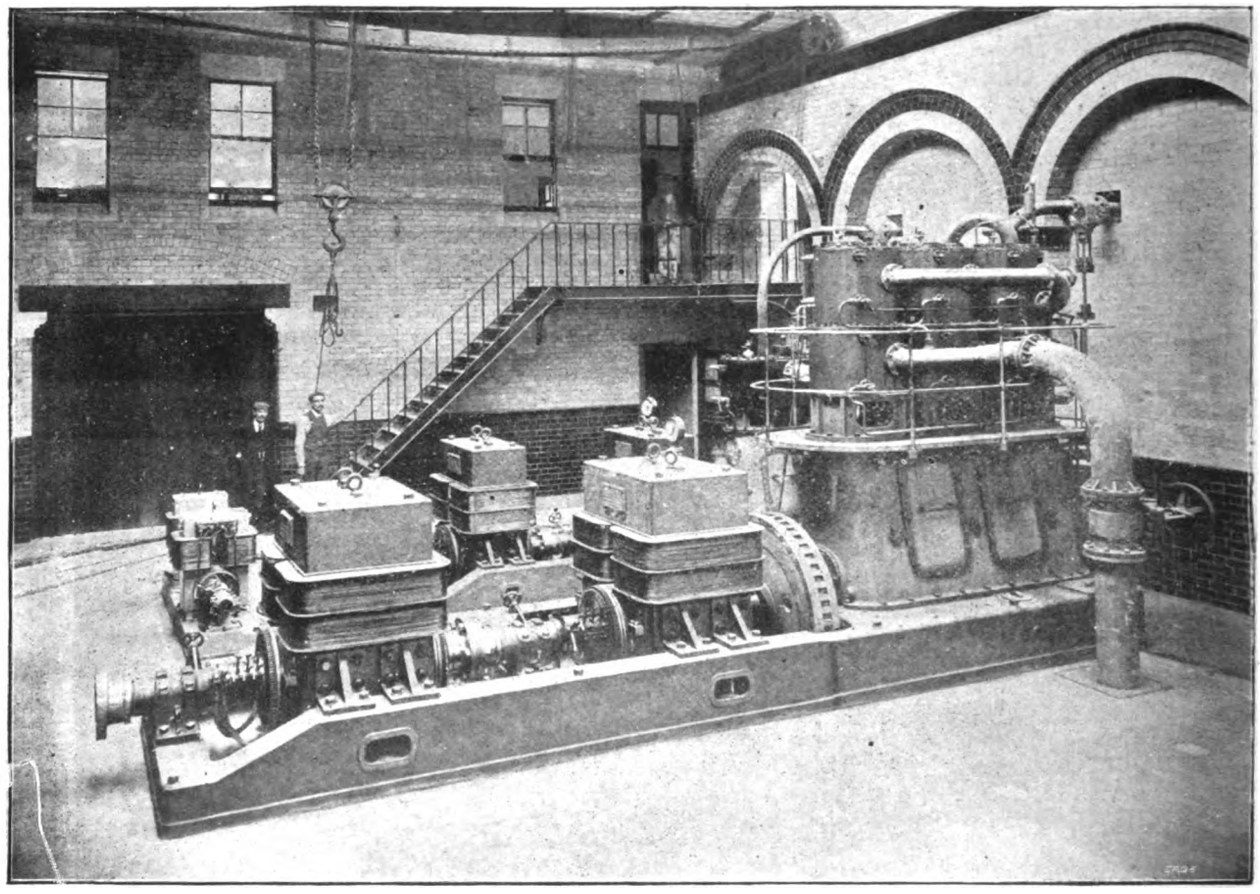

FIG. 2.—VIEW OF ENGINE ROOM, SHOWING GENERATING SETS AND MOTOR GENERATOR.

The exhaust main is 16in. diameter and of cast steel.

Spanning the engine-room is a 10-ton travelling crane by Messrs. J. Spencer & Co., of Manchester.

At present the boiler house contains three Lancashire boilers, each 30ft. long by 8ft. diameter, by Messrs. Yates and Thom. The evaporating capacity of each is 6,000lbs. steam per hour. They are throughout of steel, the shells being composed of seven rings, each made from one plate $\frac{3}{16}$in. thick. The working pressure is 160lb. per square inch. As may be seen from Fig. 3, which gives a view of the boiler-room looking toward the extension end, Proctor mechanical stokers are installed. These and the economiser scrapers are driven from a Bruce Peebles 5 H.P. shunt-wound motor, taking 20 amperes at 230 volts.

The feed arrangements include a double-acting ram pump by Evans, of Wolverhampton, with a Holden and Brooke injector

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as a stand-by. The feed water can, at will, be delivered directly into the boilers, or alternately through a feed-heater and a Green economiser of 192 tubes. The feed-heater is heated by the exhausts of the auxiliary plant. It may be mentioned that the coal used at present is Forest slack, a steam jet blast being provided.

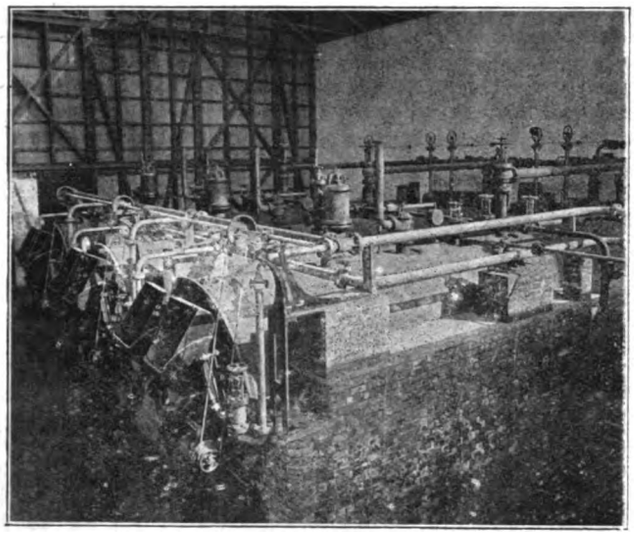

FIG. 3.—BOILER HOUSE.

All the main steam and feed pipes are of lap-welded steel by Messrs. Ashton, Frost & Co., of Blackburn. The boiler branches to the main steam pipe are 6in. diameter. The main steam pipe has a variable diameter, the maximum being 10in. From the main a 4in. pipe leads to an engine of the smaller set, and a 5in. pipe serves the large engine.

The minimum internal diameter of the chimney shaft is 6ft., the height being 150ft.

Leaving the steam plant and turning our attention to the switchboard, we were struck by the excellent arrangements in the cellar under the switchboard for bringing in the feeder and other cables. Fig. 4 gives a view in this room looking towards a sort of extended base of the actual switchboard in the room above. The trestle table shown in the figure is of slate slabs, and supports the feeders, &c., in their course from the outside wall to the meters. The whole arrangement is well lighted and get-at-able.

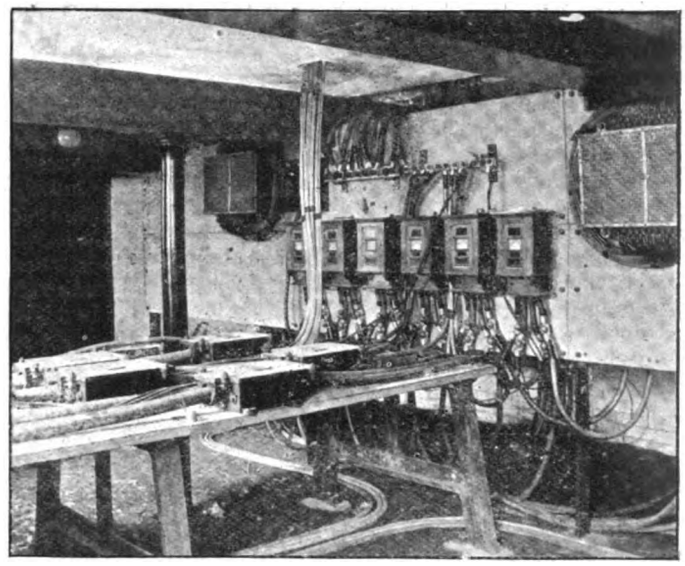

FIG. 4.—CELLAR UNDER SWITCHBOARD.

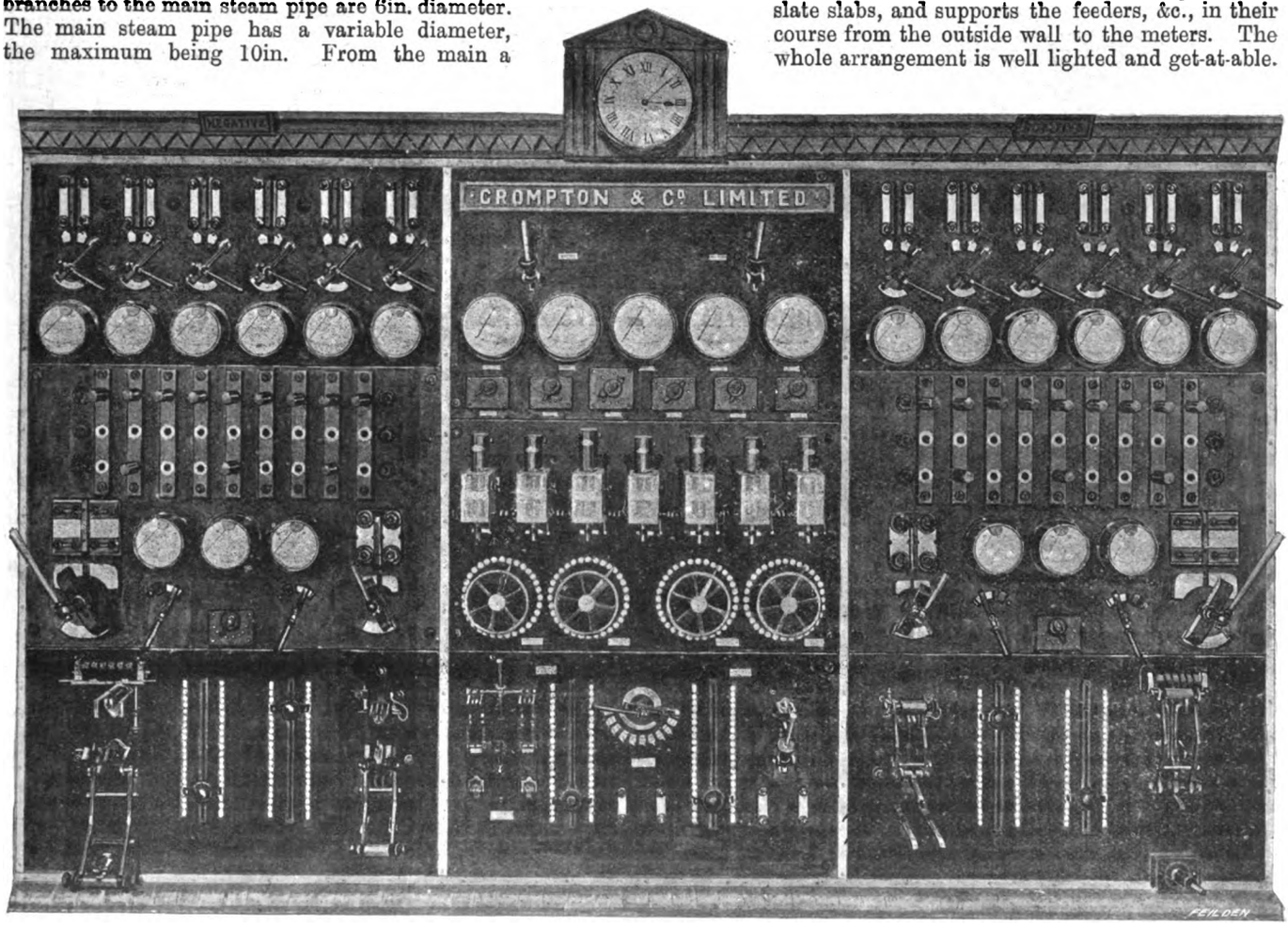

FIG. 5.—SWITCHBOARD.

Fig. 5 gives a view of the switchboard, which was built by Messrs. Crompton & Co., and Fig. 6 is a diagram of the connections. It will be noticed that the board is divided into three parts: A positive section on the right, the booster and

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battery switches in the centre, and the negative section on the left. On the positive section are fixed two minimum automatic cutouts, shunt-regulating switches, and shunt-breaking switches for the dynamos, together with their duplex fuses and two-way switches. A Crompton shunted-type ammeter is in circuit with each dynamo, while a Crompton dead-beat voltmeter is common to the two machines. On the top of the board are the six sets of feeder-regulating devices, consisting of an ammeter, a two-way switch with quick-break action, and a duplex fuse.

The negative side of the board is symmetrical and similar in every respect. The centre panel contains the switches for operating the booster. Above are placed hand-wheels, which gear, by vertical screws, with the battery regulating switches in the battery room overhead. Each hand-wheel is surrounded by the numbers corresponding with the contacts on the battery switch, and the gear is such that for each complete turn of the wheel the battery switch is moved on to a new contact, the number of which is indicated by a pointer on the board.

poured in to surround the cable is further protected by cast-iron covers to the troughs.

The arc lighting cables are connected at suitable points to the distributing network, they are lead-sheathed and have 7/16 single conductors.

At present the total length of cable laid is as follows: Feeder cables 8¾ miles, pilot cables 8¾ miles, distributor cables 12½ miles, and public lamp cables 3¾ miles—a total of 23¾ miles

The battery room in the station is over the switchboard and test room. In it is installed 280 K.W.S. type cells by the E.P.S. Co. These are capable of maintaining a discharge of 80 amperes for 10 hours, or a maximum discharge rate of 216 amperes for three hours. Of the total number, a half, or 140, are on each side of the neutral wire and 60 on each side and adjacent to the neutral wire are regulator cells. These are switched in or out two at a time by the battery switch already referred to.

The arrangement of the regulating cells adjacent to the middle wire entails the employment of but one motor generator in place of the usual two boosters. The connections for this

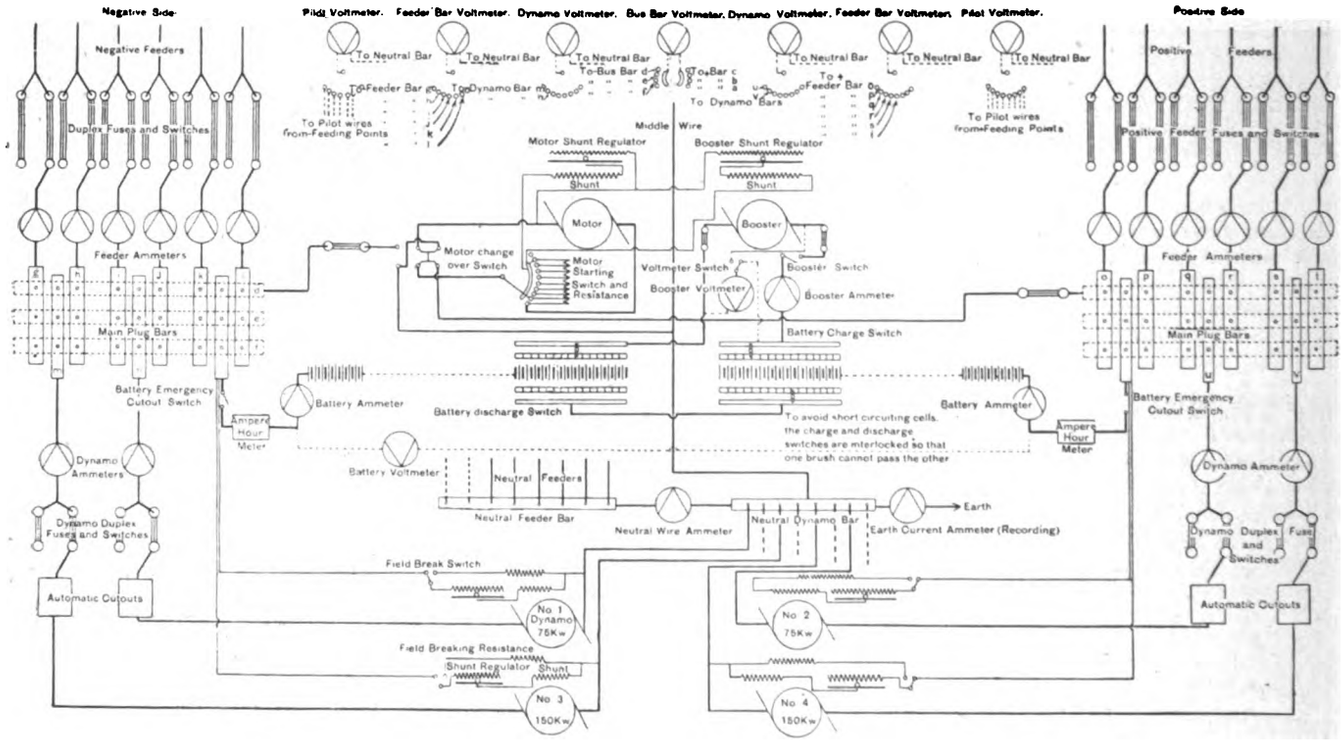

FIG. 6.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

An automatic switch by Messrs. Crompton of the same design as their automatic cutout is so arranged in circuit with the earth connection of the middle wire that when the current to earth exceeds 10 amperes the earth-current ammeter is short-circuited, leaving a direct connection from the middle wire to earth. An interlocking arrangement prevents the re-interposing of the ammeter until the earth-current has again fallen below 10 amperes. The dynamos and booster are connected to the board by means of india-rubber lead-covered cables drawn into Doulton casing. Aron meters are included in the circuit of each feeder.

The private supply to the town is served by six feeders. These are triple-concentric, the neutral wire being the outermost. In five of these feeders the "outers" of the system are of 0·4 sq. in. section and the neutral 0·2 sq. in. The remaining feeder has conductors of 0·25 sq. in. section with a neutral wire of 0·125 sq. in. section. By the side of each feeder a three-core 7/20 pilot cable, lead-sheathed and armoured, is buried direct in the earth.

All the mains were supplied and laid by Callender's Co., and are on the "solid" system. The feeders and distributors being triple concentric, lead-sheathed, are supported on wooden bridges in cast-iron troughs. The bitumen then

are interesting, and are clearly seen in Fig. 6, in which the generator part of the motor generator is marked "booster" for simplification in lettering. Each cell contains 80 plates separated by glass tubes held in position at the top and bottom. The containing boxes are of wood, lead-lined, and the cells are supported on two-tier stands with iron standards and wood bearers. The weight of each cell, with acid, is approximately 435lb.

The battery is coupled up by ½in. copper rod run on insulators, which are suspended from the roof by iron straps.

The arc lighting is carried out by 44 Brockie-Pell single carbon open arc lamps. These are run in series of nine, there being four series of nine lamps each across the 440 volt-mains or "outers" of the three-wire system, and two series of four each across the 220 volt-mains. The arc columns are of the overhanging bracket type, and were supplied by Messrs. Hardy and Padmore, of Worcester. Each lamp is furnished with an automatic switch for inserting a substitutional resistance should the main circuit in the lamp be broken. Trimming and repair is facilitated by the lamps being lowered by a winch in the base of the pillars.

The refuse destructor has not yet been erected, but the contract is being executed by Messrs. Heenan and Froude, who

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are to instal two pairs of their twin-cell destructors. The plant, having a capacity of 50 tons per 24 hours, will consist of two cells side by side, separated only from each other by a low bridge, like that of a boiler, so that open communication will exist between the cells. Each cell will have a charging door on one side of the furnace corresponding to a clinkering door on the opposite side, while the combustion chamber will be placed above the two cells extending their entire length. The boiler is installed above the combustion chamber. A hopper at each charging door will feed on to the grate bars, and the firemen can pull forward the refuse from the clinkering side or push it from the charging side. A fan will supply air blast to the grate and a steam blast by a jet. The main feature of the destructor is, we learn, that by altering the direction of a damper the gases from either grate can be alternately made to travel over the hot fire in the other grate before entering the combustion chamber, charging and clinkering taking place alternately, so that there is always a hot fire in one cell to consume completely the smoke and fumes from the other.

A water-tube boiler of 1,300ft. heating surface is to be erected over each of the two pairs of cells, thus supplementing the boiler of the generating station. As already mentioned, the level of the charging platform will correspond with that of Ladybellegate-street, consequently, the approach roadway for refuse will be level, and the portion of this roadway opposite the electricity works boiler-house will be partly of girder construction, so that space will be left below for coal storage and bunkers.

Owing to the fact that even before the works were completed the demand for supply had already exceeded the effective capacity of the original plant, it was necessary to think of extensions, and contracts were made as follows:—With Messrs. Tinkers for one Lancashire boiler 30ft. × 8ft. 6in. capable of evaporating 8,000lb. of water per hour, and to be fitted with Proctor's mechanical stokers, and for a 500 H.P. generating set with Messrs. Mather and Platt. This set consists of a Willans triple expansion central-valve engine, speed 320 revs. per min., coupled to two 150 kw. shunt-wound four-pole Mather and Platt dynamos. The switchboard will be extended by Messrs. Crompton, and another jet condenser, capable of condensing 10,000lb. of steam per hour, is being supplied by Ed. Chester & Co.

We understand that up to the present the capital expenditure has been £43,469. 10s. The tariff adopted is on the maximum demand system, with an initial price of 7d. per unit for the first 100 hours' use per quarter, at the rate of maximum demand, and thereafter 2d. per unit.

We have to express our thanks for the courtesy extended to us at Gloucester, and especially to Mr. Duesbury, the engineer-in-charge, for useful information necessary for this description.

THE RATHMINES ELECTRICITY SUPPLY STATION.

The small electric light works which are just approaching completion in Rathmines, near Dublin, have also been designed by Mr. Hammond, and follow almost the same lines as the Gloucester works. The Urban District Council of Rathmines and Rathgar obtained its provisional order in 1896 but did not bestir itself to erect electric light works until the various schemes for the aggrandisement of Dublin and its electricity supply system began to take shape, when it became most anxious to have electric light in the district supplied from works of its own.

Although the supply system is similar to that of Gloucester the contractors are different. There are only two generating sets, each with the two 220-volt dynamos for the three-wire system directly coupled at the same end of the engine. The larger set is a three-crank, triple-expansion engine, driving two 150kw. dynamos, and the smaller one a two-crank compound engine driving two 75kw. dynamos. The steam pressure is 150lb. per square inch. The machines are all four polar, and of Messrs. Mather and Platt's usual construction for machines of this small size. The larger engine indicates 575 H.P. at its maximum load when running at 320 revs. per min., and the cylinder diameters are 720mm., 480mm., and 320mm., the stroke being 260mm. The engine is on a combination bedplate, which takes the two dynamos. The smaller engine indicates 240 H.P. when running at 360 revs. per min. The cylinder diameters are 600mm. and 36mm. by 200mm. stroke, and the combination bedplate is similar to that of the larger machine. As two dynamos are used on each set, no balancing transformer is required, and the only auxiliary generator is a booster, or rather a motor generator for charging the middle cells of the battery, with the same connections as at Gloucester. There are 274 cells of the Tudor type, of which 50 on each side are for regulating, the cell switch having 30 steps. The capacity of these cells is 800-ampere hours for a 10-hour discharge or 650 ampere-hours for a 3½-hour discharge, and they are designed for a maximum discharge rate of 216 amperes.

In the engine room is a 10-ton travelling crane made by Messrs. Higginbottom and Mannock. Its span is 35ft. 6in., and it has rivetted girders and under carriages, and steel wheels throughout. All the motions are worked from the crab on the platform above.

In the boiler-house are three Lancashire boilers by Messrs. Taylor & Sons, 30ft. by 8ft., each capable of developing 7,000lb. of steam per hour at 160lb. per square inch pressure. They are fitted with Vicars' stokers, and work in conjunction with a 96-tube Green economiser, whose scrapers, as also the stoker gear, are driven by a 6 H.P. Crompton motor. The boilers are fed by a three-throw single-acting Blake and Knowles feed pump driven by a Lundell motor, and in addition there is a 4in. by 6in. double ram flywheel steam pump made by Messrs. J. Green & Sons. The boilers are also fitted with injectors. A 30in. jet condenser, made by the Wheeler Condenser and Engineering Co., is employed working with one of the same firm's horizontal wet and dry vacuum pumps, the dimensions of which are 14in. steam cylinder, 16in. wet vacuum cylinder, 16in. dry vacuum cylinder, and 16in. stroke. This is a combined plant arranged so that the dry vacuum cylinder creates the vacuum while the wet vacuum cylinder handles the circulating water and pumps the latter to the top of the cooling tower. This latter is of the Klein standard "chimney" type with natural draught. It consists of a rectangular chimney about 60ft. high, constructed on a substantial pitch pine framing. The cooling stack is placed in the base of the tower and the water is pumped to a height of about 25ft. In the design of the tower every effort has been made to give an uniform distribution of water in thin films over a large surface, and at the same time to allow of a sufficient current of air between the surfaces to carry off the vapour. Town water is used both for the condensers and feed.

The switchboard has been supplied by Messrs. James White, and is made up of enamelled slate slabs mounted on a steel framework. Over the board is an ornamental iron frame and electric clock. The board itself is in three parts: The negative dynamo and feeder panels to the left, the positive to the right, and in the middle is the battery balancer and middle wire connections. In the circuit of each dynamo is a Ferguson & White aluminium automatic cutout, a Kelvin square pattern ampere gauge and a duplex fuse and switch connecting on to the dynamo bar in front of the board. Each feeder has also a duplex fuse and switch connecting on to the feeder bars likewise in front of the board, and there is a Kelvin edgewise ampere gauge in series with each feeder. The field regulating switch of the dynamos works as usual by a handwheel. On each positive and negative panel is provided a Kelvin paralleling voltmeter for the dynamos, and at the top of the middle panel are two edgewise ampere gauges for the middle wire current and earth connection current respectively, and also a Kelvin earth current recorder and an automatic short-circuiting switch. The recorder is not mounted on the switchboard itself, but on the wall close by. The 'bus bar and feeder voltmeters are of the Kelvin multicellular type. The battery regulator itself is placed in the middle of the battery room, and is connected by chain gearing and shafting to handwheels on the switchboard, the gearing and shafting running through a tunnel specially provided for the purpose. All the connections between the regulator and regulating cells

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are of bare copper rod coated with anti-sulphuric enamel and carried on porcelain insulators. An Aron three-wire watt-hour meter is fitted on each feeder in a recess under the switchboard.

The mains are all of the triple concentric lead-covered type, laid in cast-iron troughs and filled in solid with bitumen. The distributing network consists of 0·1 sq. in. and 0·05 sq. in. cable, and embraces all the principal streets, the total length of distributing cable laid to the present amounting to about 16 miles, and the district, which is practically the residential part of Dublin, covering 2½ sq. miles. The outer conductor of the triple concentric is the neutral wire. The network is fed at seven points by 0·4 sq. in. and 0·3 sq. in. feeders laid with their respective pilot wires in troughs. Four-way and three way disconnecting boxes are provided at about 40 points in the network. They are arranged in brick pits, fitted with easily removable covers so that any section of the network can be cut out without difficulty. The house services and the services to the street incandescent lamps are made by means of cast-iron boxes filled with insulating compound, the services to the lamps terminating in earthenware end connections. The present scheme of incandescent street lighting includes 225 posts on each of which is a bracket holding two 16 c.p. lamps. In addition to the cable mentioned above, there is about 9 miles of 7/16 single lead-covered cable for supplying 108 10-ampere arc lamps which are arranged in 12 circuits of nine each. This cable is laid in B.I.W. earthenware troughing filled in solid with bitumen, the branches to the lamps ending in porcelain end-connections. The arc lamps are of Messrs. Crompton's make, and no trouble is anticipated in running the lamps nine in series, this having worked quite successfully with Crompton lamps at Canterbury, where, however, each section is brought back to the station. Each arc lamp has a turn-over switch and also an automatic cutout for inserting the substitutional resistance. They are lowering lamps with contacts in the hoods. The incandescent lamps are arranged on the ordinary distributing network, and therefore require the services of a lamplighter.

The total amount of loan sanctioned by the Local Government Board for the 450kw. plant is £71,000, distributed as follows :—

Buildings, foundations and chimney shaft	£8,000
Generating works	17,668
Mains	33,092
Public lighting	7,360
General charges and engineering fees	4,880
	£71,000

The resident engineer is Mr. G. F. Pilditch.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"La Poste Électrique : Note sur un Transporteur Électro-Automatique." By Hans Dubs and Léon Laffitte. (Marseilles : Société Scientifique Industrielle.)

"Ein- und Mehrphasen—Wechselstrom-Erzenger." By Dr. F. Niethammer. [Handbuch der Elektrotechnik. No. IV. Edited by Dr. C. Heinke.] (Leipzig : S. Hirzel. 1900.)

ELECTRICITY WORKS ACCOUNTS.

Huddersfield Municipal Electric Supply Works.

As will be seen from our first table this week the accounts of the Huddersfield undertaking for 1899 indicate remarkably good results in every essential respect. Last year's output, at 951,033 units sold, marks an advance of no less than 60·8 per cent. on the business of 1898. Not only in amount, however, but in character, the load on the station shows a great improvement. In 1898 the load factor was 8·8 per cent. During the last year this factor had risen to 10·7 per cent.

Naturally, these altered conditions were not without their due influence upon the costs, but to have effected a reduction in the fuel item as well as in the other generating costs is a most commendable result in view of the excellent 1898 figures and of the prices ruling in the coal trade. As they stand, the works costs are but little more than half what they might reasonably have been under the conditions of output and load which prevailed during the year. The increase in the lamp connections was nearly 30 per cent.

Year ended Dec. 31.	No. of con-s'mers.	No. of 8 c.p. lamps con-nected	Out-put : units sold.	Gross sur-plus.	Appropriation of surplus.			Met by the boro' fund.	Carr'd to dep. preciation & c'tingencies
					Int. on loans.	Sinkng fund.	Net surpl's.		
*1893	112	9,613	43,224	-£209	£658	£1,680	...	£2.547	...
1894	214	15,342	156,169	+1,376	1,606	1,836	...	2,065	...
1895	280	20,889	227,753	2,474	1,769	2,079	...	1,373	...
1896	385	28,983	304,163	3,724	1,880	1,410	£434	...	£434
1897	598	41,702	438,848	4,964	2,190	1,589	1,184	...	1,184
1898	806	54,154	593,377	6,936	2,602	1,898	2,437	...	2,437
1899	1,082	70,178	951,033	9,040	3,646	2,565	2,829	...	2,829

* 17 months.

Stafford Municipal Electric Supply Works.

It was by no means to be expected that Stafford could have kept the figure for the fuel cost at the low value which secured for the undertaking the record in this respect for the year 1898-9. The result of the working during the last financial year is a fuel charge which indicates but slight retrogression and which is practically a repetition of the figure attained in 1897-8—also a record for that year.

Unfortunately the increase in this item and other items of generating costs, especially repairs and maintenance, has had the effect of discounting materially the lower station wages, distribution, public lighting and management charges, which have all been reduced, and with the exception of wages at the station show most excellent figures. However, the total costs exhibit a decided reduction and stand at a very satisfactory value considering the low load factor of only 8·54 per cent.

So far as the increase of business is concerned, the undertaking made much greater progress last year than previously, in that the output advanced by nearly 28 per cent. and the lamp connections by 16·5 per cent. While the working profit shows a marked advance the undertaking has not yet attained a self-sustaining stage; the year's operations resulting in a deficit of £375, as compared with £514 in the preceding year.

This is, of course, a decided improvement in view of the material reduction in the already moderate average price obtained per unit.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	July 20, 1900
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, ,,
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	Aug. 3, ,,	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	July 6, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, 1899	Liverpool (Municipal)	June 22, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	July 14, 1899	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, 1900	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	Aug. 3, 1900	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, ,,	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	July 13, ,,
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, 1899
Croydon (Municipal)	July 20, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, ,,
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 18, 1900
Hanley (Municipal)	July 27, 1900	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, 1899	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	July 6, ,,	Wolverhampton (Municipal)	July 27, 1900
Huddersfield (Municipal)	Oct. 6, 1899	Woolwich (Company)	Jan. 18, 1899
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 20, 1900
Kensington & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	July 13, ,,		

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	HUDDERSFIELD.		STAFFORD.	
Undertaking Worked by	Huddersfield Corporation.		Stafford Corporation.	
Date of Commencement of Supply	July, 1893.		October, 1895.	
System of Supply	Alternate-current transformer sub-stations.		Three-wire continuous-current.	
Chief Engineer	A. B. Mountain.		J. F. Bell.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	MAR. 31, **1899.**	MAR. 31, **1900.**
QUANTITIES—				
Units generated	883,962	1,319,221	91,134[a]	118,341[d]
,, **SOLD (TOTAL)**	593,377	951,033	67,908	86,780
,, sold to consumers	520,989	871,246	64,703	83,311
,, sold for public lighting, &c.	72,388	79,787	3,285	3,469
,, used on works	47,337	73,550	5,508	6,477
UNITS SOLD PER 8 C.P. LAMP CAPACITY	16·7	13·3	11·0	14·0
Maximum supply demanded	770 kilowatts	1,012 kilowatts	106 kilowatts	116 kilowatts
Number of public lamps	32 arc, 53 glow	33 arc, 52 glow	4 arc	4 arc
Number of consumers	805	1,082	89	—
Connections to mains in 8-c.p. lamps	54,154	70,178	7,346	8,558
CAPACITY OF PLANT IN 8-C.P. LAMPS	35,600	71,600	6,190	6,190
CAPACITY OF PLANT IN KILOWATTS	1,140	2,290	198	198
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£94,215 / £82·7	£144,215 / £63·0	£20,000 / £101	£20,000 / £101
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	94,215 / 82·7	144,215 / 63·0	20,000 / 101	20,000 / 101
RECEIVED (TOTAL)	94,600 / 83·0	114,215 / 49·9	20,000 / 101	20,000 / 101
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	94,600 / 83·0	114,215 / 49·9	20,000 / 101	20,000 / 101
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	30,000 / 13·1	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	30,000 / 13·1	— / —	— / —
REPAID (TOTAL)	5,785 / 5·08	5,785 / 2·53	1,858 / 9 38	2,463 / 12·4
RESERVE OR SINKING FUND	5,528 / 4·85	8,286 / 3·62	— / —	— / —
DEPRECIATION FUND	2,856 / 2·51	5,684 / 2·48	— / —	— / —
EXPENDED (TOTAL)	93,494 / 82·0	105,684 / 46·6	19,620 / 99 0	19,950 / 101
Lands and buildings	17,107 / 15·0	17,665 / 7·71	6,963 / 35 2	6,963 / 35·1
Plant	40,627 / 35·7	48,278 / 21·1	8,959 / 45 2	9,052 / 45·7
Mains	35,244 / 30·9	40,225 / 17·6	2,932 / 14·8	3,169 / 16·0
Miscellaneous	517 / 0·454	517 / 0·226	766 / 3·87	765 / 3 87
BALANCE OF CAPITAL ACCOUNT	−1,106[a] / −0·970	+7,531 / 3·29	+380 / 1·92	+50 / 0·25
REVENUE—	**Total.** / **Per unit sold.**	**Total.** / **Per unit sold**	**Total.** / **Per unit sold.**	**Total.** / **Per unit sold.**
TOTAL	£11,865 / 4·800d.	£14,943 / 3·773d.	£1,435 / 5·075d.	£1,770 / 4·900d.
Revenue from supply	10,432 / 4·220d.	13,215 / 3·333d.	1,253 / 4·430 l.	1,571 / 4·346d.
,, meters, &c.	630 / 0·255d.	827 / 0·209d.	76 / 0·269d.	86 / 0·238d.
,, public lighting	719 / 0·291d.	794 / 0·200d.	90 / 0·318d.	90 / 0·249d.
,, sale of lamps, &c.	83 / 0·034d.	107 / 0·027d.	— / —	— / —
,, miscellaneous sources	nil / —	nil / —	16 / 0·057d.	23 / 0·064d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,929 / 1·994d.	£6,266 / 1·581d.	£784 / 2·770d.	£980 / 2·710d.
WORKS COSTS	3,480 / 1·408d.	4,248 / 1·072d.	584 / 2·065d.	749 / 2·073d.
Generation of electricity	*2,846* / *1·152d.*	*3,555* / *0·898d.*	*451* / *1·594d.*	*612* / *1·693d.*
Fuel (including cartage, &c.)	1,170 / 0·473d.	1,814 / 0·458d.	70 / 0·247d.	116 / 0·321d.
Oil, waste, water, stores	161 / 0·065d.	203 / 0·051d.	14 / 0·050d.	30 / 0·083d.
Wages at station	1,018 / 0·412d.	1,121 / 0·283d.	342 / 1·210d.	378 / 1·046d.
Repairs and maintenance at station	498 / 0·202d.	417 / 0·105d.	25 / 0·088 l.	88 / 0·244d.
Distribution of electricity	*416* / *0·168d.*	*502* / *0·127d.*	*120* / *0·424d.*	*126* / *0·349d.*
Wages, &c.	74 / 0·030d.	167 / 0·042d.	120 / 0·424d.	126 / 0·349d.
Repairs, renewals of mains, &c.	342 / 0·138d.	335 / 0·084d.		
Public lighting	*218* / *0·088d.*	*191* / *0·048d.*	*13* / *0·046d.*	*11* / *0·030d.*
Attendance	218 / 0·088d.	85 / 0·022 l.	13 / 0·046d.	11 / 0·030d.
Renewals		107 / 0·027d.		
MANAGEMENT AND PROPERTY CHARGES	1,449 / 0 586d.	2,018 / 0·510d.	200 / 0·708 l.	229 / 0·634d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*317* / *0·128d.*	*829* / *0·209 l.*	*133* / *0 470d.*	*178* / *0·493d.*
Management	*1,132* / *0·558d.*	*1,189* / *0·300 l.*	*67* / *0·237d.*	*51* / *0·141d.*
Salaries	677 / 0·274d.	695 / 0·175d.	8 / 0·028d.	8 / 0·022d.
Stationery, &c.	113 / 0·045d.	124 / 0·031d.	1 / 0·004d.	7 / 0·019d.
Establishment charges	126 / 0·051d.	40 / 0·010d.	4 / 0·014d.	15 / 0·042d.
Law charges, &c.	216[b] / 0·087d.	330[d] / 0·083d.	54[b] / 0·191d.	21[e] / 0·058d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Tota'.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£6,936 / 8·51%	£8,677 / 8·68%	£652 / 3·36%	£790 / 3·99%
Sum carried to Depreciation Fund	2,437 / 2·99%	2,829 / 2·83%	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,898 / 2·33%	2,565 / 2·56%	587 / 3·03%	604 / 3·05%
Net interest on loans (incl. Debenture charges)	2,602 / 3·2%	3,647 / 3·65%	579 / 2·93%	560 / 2·83%
BALANCE FROM LAST ACCOUNT	nil / —	nil / —	432 / 2·23%	− 82 / 0·41%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	nil / —	nil[e] / —	— / —	— / —
Deficit	— / —	— / —	*83* / *0·423%*	*457* / *2·31%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	41·6%	41·9%	54·6%	55·3%
Expenditure per kilowatt capacity	£4. 6s. 6d.	£2. 14s. 8d.	£3. 19s. 2d.	£4. 19s. 0d.
REVENUE PER KILOWATT CAPACITY	**£10. 8s. 0d.**	**£6. 10s. 7d.**	**£7. 5s. 0d.**	**£8. 18s. 10d.**
Expenditure per 8-c. lamp capacity	2s. 9½d.	17s. 6 l.	2s. 6½d.	3s. 2d.
REVENUE PER 8-C.P. LAMP CAPACITY	**6s. 8d.**	**4s. 2d.**	**4s. 7¾d.**	**5s. 8½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**4s. 4½d.**	**4s. 3d.**	**3s. 11d.**	**4s. 1½d.**
Price charged for lighting, per unit	6d. to 1½d.[c]	4½d.[g]	7d. to 3d.[c]	7d. to 3d.[c]
Price charged for power, per unit		2½d. to 1d.[f]	3d.	3d. [ann.
Price charged for public lighting	—	[glow. Arc £25 & 45s. per 32 c.p.	4½d. per unit.	£22. 10s. per lamp per

HUDDERSFIELD.—REMARKS—*a* Over-expended. *b* Includes deputation expenses £137, insurance £16, and compensation and costs *re* accident £63. *c* By system of discounts, from 2 per cent. to 25 per cent., according to consumption. *d* Includes £102 cost of loan, &c., £54 deputation expenses, £21 boiler insurance, and £389 legal expenses. *e* After crediting account with £364 in respect of legal expenses paid by defendants. *f* Maximum demand system, 2-hour scale. *g* During first half-year the charge was as in 1898, but in second half-year the tariff was 4½d. per unit, reduced from 1 per cent. to 15 per cent.

STAFFORD.—REMARKS—*a* 79,679 being the output from station 'bus bars. *b* Includes electric fittings £34, and insurance £20. *c* By maximum demand system, 1-hour scale; or, alternatively, a uniform price of 5d. per unit. *d* Includes 98,748 units output of station. *e* Includes insurance.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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EARTHING THE MIDDLE WIRE.

Before the Board of Trade permitted the earthing of the middle wire of a three-wire system, many supply station engineers considered that this simple connection would be a panacea for all their troubles. There would be no more leakage, no more danger from fire, no more electrolysis, no more trouble from consumers' bad wiring, and no more testing of mains. Now that the Board of Trade, instead of prohibiting this earthing of the middle wire, insists on it, except in connection with a few older networks, there is no longer such enthusiasm on this point; the advantages of the rule are taken in a matter-of-fact way, and the best that can be said is that there is no grumbling. The only persons who have all along warmly welcomed the earthed middle wire, as a step towards a bare middle wire both in the streets and on consumers' premises, have been those interested in special systems of wiring, the introduction of which has been delayed by the necessity of insulating both conductors. Mr. Wordingham, who, with the five-wire system at Manchester, has probably had longer experience than anyone else with networks with an earthed middle wire, gives as his opinion, in the Paper we publish this week, that the only consideration which makes this practice desirable is "that it admits of all three conductors being brought into a consumer's premises, thus enabling every installation to be balanced within itself." Since the revision of the Board of Trade Regulations in 1896, Mr. Wordingham has been extending the Manchester network on the three-wire system only, with 400 volts between the outers, instead of the same pressure between the outers of the five wires, and we must presume that he has been following the practice he alludes to of bringing all three wires into the consumer's premises. As Mr. Wordingham can only have been doing this with the knowledge of the Board of Trade, it appears that the common interpretation of Regulation A (1) is incorrect. This regulation reads: "The pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals, except with the express approval of the Board of Trade. Such approval will only be given for special purposes, and on the joint application

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of the consumer and the undertakers, and the supply will be subject to such further regulations as the Board of Trade may from time to time prescribe." Consequently we must take it that, by employing two distinct pairs of terminals, 500 volts pressure may be introduced in a house. This is certainly an important advantage, as it enables all large consumers to be wired on the three-wire system, even when the declared pressure is 240 volts, and thus assists considerably in balancing the two sides of the network. It is not quite clear to what extent the supply station engineer is legally justified in compelling the consumer to wire on two independent circuits for connecting to the three-wire systems, for he is compelled to supply any consumer who demands it with a "reasonable" maximum power. The meaning attached to this word "reasonable" therefore governs the situation, modified perhaps by the right which the undertaker possesses to cut off supply if the consumer uses it in such a way as to interfere improperly with the supply to others. At Manchester, Mr. WORDINGHAM will not supply a consumer with more than 2½kw. from one pair of terminals, but Manchester is in a different position from most other supply undertakings in having Parliamentary powers to enforce wiring rules. The majority of other undertakers put the limit at about 5kw., but some approach closely to the low maximum laid down at Manchester, and it would be interesting to know what would be the result if a consumer in the compulsory area supplied by one of these undertakers refused to go to the expense of wiring from two pairs of terminals for a maximum demand of 3kw. or 4kw.

But to return to the main question of earthing the middle wire. There are other advantages which are obtained by this practice, the most notable one being the increased security of house-wiring, both as regards shock and safety from fire, and we should not be surprised if the result were soon the rehabilitation of the practice of placing fuses on one pole only (the pole which is not earthed, of course), in spite of wiring rules and fire office inspectors. We are surprised also that Mr. WORDINGHAM does not attach more importance to the fact that an earthed middle wire accelerates the burning-out of faults with the minimum of damage to the remainder of the network, for on one occasion he is reported to have said that he preferred to employ 3,000 H.P. or 4,000 H.P. for localising these troubles unaided by more scientific methods. For this reason the first of the two disadvantages enumerated in the Paper, to earthing the middle wire is not generally serious, for if a bad leak occurs it is surely best that it should be burnt down to a dead earth as soon as possible, and then isolated by the blowing of the fuses in the service or network boxes as the case may be. Where, however, this consideration does become really serious is in the case of overhead wires, bare-strip systems, and rubber cable. With overhead distributing systems we have, as yet, little to do in this country, and it is doubtful whether on such networks it would be desirable to earth one pole. Bare-strip systems on insulators have given considerable trouble by the deterioration in the insulation of the negative conductor mentioned in the Paper, which is increased if the negative is prevented from assuming zero potential by the earthing of the neutral wire. However, bare-strip systems are in the minority, and those recently erected have been constructed in such a way that the insulators are easy of access for inspection. With regard to the behaviour of rubber cable, however, Mr. WORDINGHAM has given us some new facts in his Paper. It appears that this same creeping effect, which has long been known to be disastrous to the insulation of the negative pole of bare-strip mains, actually extends to the rubber insulation of the negative cables, which therefore continues to absorb water, at a rate following a sort of compound interest law, until the cable becomes unusable. But nowadays indiarubber-covered mains are chiefly employed in special circumstances and with special precautions, and the effect of this osmotic action on house-wiring is probably only important in damp situations, where specially protected fittings and special wiring systems or lead-covered cable should be employed.

Taking all things into consideration, therefore, we go further than Mr. WORDINGHAM, and consider that it would be advisable to earth the middle conductor of a three-wire system even if this did not make it allowable in all instances to bring the three wires into consumers' houses. We now come to the questions whether the earthing should be at one or more points, and whether it should be removable. These two questions hang together, for the more points there are at which the earth connection is made, the more difficult it is to remove it, and, in fact, in the case of house-wiring with one conductor bare removal of the earth connection becomes impossible. Mr. WORDINGHAM gives very good reasons for having the earth only at the generating station and for arranging it in such a way as to facilitate its removal for testing purposes, or in the event of a serious leakage to earth on one of the other poles of the network. He states his case so ably that the advocates of bare-return house-wiring will have to argue well to prove that their systems are suitable for large supply networks. It must be remembered that a slight cheapening of house-wiring and perhaps a slight added increment of safety will not compensate for introducing a risk of injury to the constancy of the supply. The earthing of all the feeding points has much to recommend it, especially on smaller networks, as a compromise between bare conductors and a single earth connection, but, as Mr. TROTTER pointed out in the discussion on Mr. WORDINGHAM'S Paper, it renders the testing of the network more complicated and makes it impossible to cut off the earth connection at short notice to meet an emergency. It is to be regretted that Mr. TROTTER'S other two suggestions were not discussed—viz., that it might be advantageous to add a resistance between the middle wire and the earth connection, and that the advisability of keeping the lead 2 volts or 4 volts negative to the middle 'bus bar was worthy of consideration.

ELECTROMAGNETIC THEORY.—CXVII.*

BY OLIVER HEAVISIDE.

(*Continued from page 445.*)

§ 469. The last result brings us back to the simple theory of pairs of inclined terminated plane waves. It was, in the first place, from the theory of generation of a single complete plane wave that we concluded that a straight line of curl of e of strength f generated induction at the rate f. This property has now been applied to the wave generated by a plane sheet of f continuously growing at one of its straight edges, thus introducing new filaments of f, both when $u < v$ and when $u > v$. The first case includes, for a steadily moving state, the theory of Vol. I., § 166. The second case is much simpler in results. The H can be determined from the first moment of starting the action of f, including the initial partially cylindrical cap. Behind this cap H soon becomes constant, equation (40). This signifies slanting divergent plane waves. For, by taking differences, we can derive the H due to a plane strip of f of constant width started and set in motion at any moment in its own plane at speed u. Except as regards the cap, or rather, with the addition of the cap, we get a pair

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of diverging plane waves, as described at the end of § 456 above, according to the formulæ there given. Likewise the result for a moving filament of f. These results were easily obtained, but the initial effects required closer consideration. Besides that, we have had the advantage of seeing in detail that the results of moving magnets or electrets are really due to the waves coming from the sources f and g.

But when we pass from the abstract problems of moving sources to those connected with material bodies, it must be so done that the conditions assumed are not changed by the materialisation if the results are to be the same. In particular, the ether must not be disturbed by the motion of the matter. This is the assumption I have always made in my investigations of the waves arising from moving electrification or other sources. (See, for example, *El. Pa.*, Vol. II., p. 504; and E.M.T., Vol. I., p. 269 to 282, and the above investigations.) The reasons are tolerably obvious. First, simplicity. Next, the changes due to any dragging along of the ether with the matter cannot be determined without some assumptions as to the extent of the drag, and its nature. This is one of the unsettled and very speculative matters in electrical science applied to moving bodies. I would rather have no drag at all, or else complete drag, if I had the management of it. But it may be that a partial drag is an essential condition of the connection between ether and matter, even though that connection be entirely through electrification, that is, by ions or electrons. Even a full drag is not inconceivable. For consider a single charge or electron moving through the ether without any assumed drag externally. It might really be the limiting case of a moving ether; that is, the electrification might be inexorably associated with a definite part of the ether. Or again, with perfect slipping possible, resultant effects of moving collections of matter and electrification might give an apparent motion to the ether in the circuital equations.

§ 470. The question of the drag of a moving body on the ether has occupied the attention of physicists for a very long time, especially from the optical point of view, and it is open to question whether the last word has been said about it by the latest investigators. The following comparisons of different results will serve to illustrate some aspects of the subject.

Divide the displacement **D** and the induction **B** each into two parts, thus,

$$\mathbf{D} = c\mathbf{E} = (c_0 + c_1)\mathbf{E} = \mathbf{D}_0 + \mathbf{D}_1, \tag{1}$$

$$\mathbf{B} = \mu\mathbf{H} = (\mu_0 + \mu_1)\mathbf{H} = \mathbf{B}_0 + \mathbf{B}_1. \tag{2}$$

Here $\mathbf{B}_0$ and $\mathbf{D}_0$ belong to the ether, and $\mathbf{B}_1$ and $\mathbf{D}_1$ are the extra parts due to the matter, that is, the two polarisations, magnetic and electric.

Next, write the two circuital laws for a moving medium in the form

$$\operatorname{curl}(\mathbf{H} - \mathrm{V}\mathbf{D}_0\mathbf{q}_0 - \mathrm{V}\mathbf{D}_1\mathbf{q}_1) = \mathbf{C} + \dot{\mathbf{D}} + \mathbf{u}\rho, \tag{3}$$

$$-\operatorname{curl}(\mathbf{E} - \mathrm{V}\mathbf{w}_0\mathbf{B}_0 - \mathrm{V}\mathbf{w}_1\mathbf{B}_1) = \dot{\mathbf{B}}. \tag{4}$$

Compare with § 71, Vol. I. We leave out impressed forces, except motional, also the hypothetical magnetic conduction current and magnetification. As regards the motional electric and magnetic forces, instead of one velocity, there are now four, one for each part of the two fluxes concerned. This is required for our comparisons. As for u, the velocity of the electrification ρ or divD, it need not be assumed to be the same as that of the matter.

To ease matters, let there be a simple plane wave traversing a non-conducting dielectric without volume electrification, and let $\mathbf{E} \parallel \mathrm{x}$, $\mathbf{H} \parallel \mathrm{y}$, $\mathrm{VEH} \parallel \mathrm{z}$, and let all the q's and w's be $\parallel \mathrm{z}$. Then $\mathrm{V}\mathbf{q}_0\mathbf{D}_0 \parallel \mathbf{H}$; also $\mathrm{V}\mathbf{q}_1\mathbf{D}_1$; and $\mathrm{V}\mathbf{B}_0\mathbf{w}_0 \parallel \mathbf{E}$; also $\mathrm{V}\mathbf{B}_1\mathbf{w}_1$. These simplifications bring the circuital equations to

$$-\Delta(\mathrm{H} + q_0\mathrm{D}_0 + q_1\mathrm{D}_1) = p\mathrm{D}, \tag{5}$$

$$-\Delta(\mathrm{E} + w_0\mathrm{B}_0 + w_1\mathrm{B}_1) = p\mathrm{B}, \tag{6}$$

where Δ is d/dz and p is d/dt. All scalars now.

But the type of a plane wave is $f(z - \mathrm{U}t)$, where U is the wave speed. So $p = -\mathrm{U}\Delta$, and therefore

$$\mathrm{H} + q_0\mathrm{D}_0 + q_1\mathrm{D}_1 = \mathrm{UD}, \tag{7}$$

$$\mathrm{E} + w_0\mathrm{B}_0 + w_1\mathrm{B}_1 = \mathrm{UB}. \tag{8}$$

These are the same as

$$\mathrm{H} = (\mathrm{U} - q)\mathrm{D}, \tag{9}$$

$$\mathrm{E} = (\mathrm{U} - w)\mathrm{B}, \tag{10}$$

where q and w are the speeds given by

$$q = \frac{c_0q_0 + c_1q_1}{c}, \qquad w = \frac{\mu_0w_0 + \mu_1w_1}{\mu}. \tag{11}$$

So there are only two effective speeds of motion. In this notation the circuital equations become

$$\operatorname{curl}(\mathbf{H} - \mathrm{V}\mathbf{D}q) = \mathbf{C} + \dot{\mathbf{D}} + \mathbf{u}\rho, \tag{12}$$

$$-\operatorname{curl}(\mathbf{E} - \mathrm{V}\mathbf{w}\mathbf{B}) = \dot{\mathbf{B}}. \tag{13}$$

When q and w are zero, $\mathrm{U} = v$, given by $\mu cv^2 = 1$. And in general, (9) and (10) lead to

$$v^2 = (\mathrm{U} - q)(\mathrm{U} - w); \tag{14}$$

of which the solution is

$$\mathrm{U} = \tfrac{1}{2}(q + w) + \sqrt{v^2 + \tfrac{1}{4}(q - w)^2}; \tag{15}$$

and further, when q and w are small compared with v, we get

$$\mathrm{U} - v = \tfrac{1}{2}(q + w). \tag{16}$$

This represents the increased wave speed (referred to stagnant ether at a distance) due to the motion of the matter. It is the mean of the effective speeds associated with D and B. Now compare different cases.

§ 471. (1). When there is symmetry, so that $c_1/c = \mu_1/\mu$, and also $q_0 = w_0$, $q_1 = w_1$, then

$$q = w = \frac{q_0c_0 + q_1c_1}{c}, \tag{17}$$

and

$$\mathrm{U} - v = q, \tag{18}$$

exactly; that is, without limitation to small speeds. This is a fanciful case, though interesting.

(2). Let $q_0 = q_1 = w_0 = w_1$; then also $= q$, and

$$\mathrm{U} - v = q, \tag{19}$$

again exactly. Here q is the speed of the matter and ether moving together, equivalent to a single medium theory. There is full superposition of velocities; that is, the wave speed *through the body* is the same whether it is stationary or moving. This is the result we ought to have in any rational theory of one medium, in a primary theory, that is to say. (See Preface to Vol. 1, E.M.T. for remarks on this subject.)

(3). Consider an unmagnetisable body, $\mu_1 = 0$. Then

$$\mathrm{U} - v = \frac{c_0q_0 + c_1q_1}{2c} + \tfrac{1}{2}w_0. \tag{20}$$

If we can agree that w_0 should be the same as q_0, then

$$\mathrm{U} - v = \tfrac{1}{2}q_0\left(1 + \frac{c_0}{c}\right) + \tfrac{1}{2}q_1\frac{c_1}{c}. \tag{21}$$

(4). If the ether is entirely left behind as the matter moves through it, we may take $q_0 = 0$ in (21); then

$$\mathrm{U} - v = \tfrac{1}{2}q_1\frac{c_1}{c} \tag{22}$$

Here q_1 is the speed of the matter. The result is therefore just one-half of Fresnel's result, according to which, in the present notation, the extra wave speed is q_1c_1/c, which means that the wave traverses the moving body more slowly than when it is at rest by the amount q_1c_0/c.

(5). Let q_0 and q_1 be both zero in the first circuital law, and $\mathrm{w}_0 = \mathrm{w}_1$ in the second. Then

$$\mathrm{U} - v = \tfrac{1}{2}w, \tag{23}$$

where w is the velocity of the matter. This result was obtained by J. J. Thomson by using Maxwell's theory in its unamended form. In my amendment of the same, given in 1885, I concluded that the motional argument which led Maxwell to the motional electric force $\mathrm{e} = \mathrm{V}\mathfrak{w}\mathfrak{B}$ involved a similar one leading to a motional magnetic force $\mathfrak{h} = \mathrm{V}\mathfrak{D}\mathfrak{w}$, using the full flux in the case of $\mathfrak{h}$ quite as much as in the case of e; for an obvious gastronomical reason relating to sauce. Whether right or wrong, it rationalises Maxwell's theory, and I maintain, as before, that it is the proper expression of his theory, because of his form of the motional electric force. It leads to a full superposition of velocities, as in example (2) above. But it does not follow that either e or $\mathfrak{h}$ is correct in form universally. That is a distinct question.

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(6.) Larmor, "Ether and Matter,"* p. 60, takes $q_0=0$ in the first law, and $w_0=w_1=q_1$ in the second. This produces

$$U-v=\tfrac{1}{2}w\left(1+\frac{c_1}{c}\right), \tag{24}$$

where w is the speed of the matter. This is the mean of J. J. Thomson's and Fresnel's results. The ether is assumed to be stagnant, or not dragged at all. Nevertheless, the full $e=VwB$ is used, but the full $h=VDw$ is replaced by VD_1w. This pictures the larmorial bearings correctly, I think.

(7.) But Larmor (*l.c.*) does not obtain the result (24), but Fresnel's wc_1/c instead. This is, in fact, the reason why he adopts VD_1w, though it may be questioned whether the optical result is sufficient to determine the theory. His equations are equivalent to

$$-\Delta(H+wD_1)=cpE, \tag{25}$$

$$-\Delta(E+wB)=\mu pH, \tag{26}$$

in my notation. I derive (24) in the above way, getting

$$v^2=\left(U-w\frac{c_1}{c}\right)(U-w) \tag{27}$$

for the quadratic, a special case of (14) above.

It may perhaps fairly be asked, if the assumed fact that the ether is stationary causes the influence of the electric polarisation to introduce $h_1=VD_1w$, why should not the influence of the magnetic polarisation introduce $e_1=VB_1w$? I do not dogmatise, but wait for more light.

(8.) Let us see what connection is needed between q_0 and q_1 to obtain Fresnel's result. That depends upon w_0 and w_1 also. If we take, as seems the fairest at first sight, $w_0=q_0$ and $w_1=q_1$, then equation (21) supplies the answer, for an unmagnetisable medium. The right member has to be q_1c_1/c; so

$$\frac{q_0}{q_1}=\frac{c_1}{c+c_0}=\frac{c_1}{2c_0+c_1}, \tag{27A}$$

which may be grossly imagined to represent the drag of the matter on the ether. It is here conditioned by the electric polarisation, and cannot exist without it. It is small when c_1/c_0 is small, but may be nearly unity with large c_1/c_0. The corresponding e is

$$e=V(w_0B_0+w_1B_1)=VwB$$

where

$$w=\frac{\mu_0q_0+\mu_1q_1}{\mu}=\left(\frac{\mu_1}{\mu}+\frac{\mu_0}{\mu}\frac{c_1}{2c_0+c_1}\right)q_1 \tag{28}$$

So e is zero in an unpolarisable medium, for then $\mu_1=0$, $c_1=0$. But this e is the electric force impressed in a wire carried perpendicularly across the lines of magnetic force in a stationary ether. The vanishing of e seems wrong at first; but there is no necessary absurdity. For by assumption the body is unpolarisable, and is unaffected by either magnetic or electric force. Being perfectly neutral, why should there be an e impressed upon it when it just slips through the ether without disturbing it? Then why, on the present hypothesis, is there e in a conductor? Because c_1 is not zero. Conduction in the physical part of Maxwell's theory implies polarisation, because it is a breaking down of the displacement, with external renewal of the same, maintaining an average steady state of D. The value of c/c_0 can only be measured in very poor conductors. Even then it may be very large: for example, the value 60 to 80 in water has been found. It is likely to be much larger in good conductors. This would make $e=VwB$ closely, with $w=q_1$ nearly, with nearly full drag of the ether, or what is equivalent thereto.

If, on the other hand, we assume $w_0=q_1$, and inquire into the relation between q_0 and q_1 to obtain Fresnel's result in an unmagnetisable medium, we have

$$\frac{q_0c_0}{2c}+\frac{q_1c_1}{2}=\frac{q_1c_1}{c}, \tag{29}$$

which makes q_0 be negative; nothing more need be said abou that.

It is to be noted that should c_1/c be very large, the idea and the measure of D_1 as an elastic phenomenon becomes indistinct. It is then also of little importance to preserve it in the equations, because conduction, unless very feeble, works a revolution in the manner of propagation, turning elastic waves to diffusive waves. The precise nature of the failure to support elastic displacement without a continuous supply of energy, in relation to the ions, electrons, or corpuscles, is a matter of speculation at present. I am rather prejudiced against the view that in a solid conductor the conduction consists of a continuous flow of electrons or of J. J. Thomson's corpuscles either one or both ways, and think it more likely to be a local phenomenon in the main.

(9.) A very simple way of obtaining Fresnel's result is to assume $e=Vqb$, $h=VDq$, that is, the standard forms of e and h, but with the velocity of q so chosen as to give the required result. We require

$$q=\frac{c_1}{c}q_1, \tag{30}$$

if q_1 is the real velocity of the matter. This applies to both circuital equations. But an electrical argument founded upon the absence of drag which would justify this procedure in the first circuital law, would surely fail in the second. However, there is this remarkability, that Fresnel's result becomes exact, instead of for small speeds only of the matter. I do not know that this is to be considered a recommendation. But it may be possible to invent some hypothesis to justify the procedure in the second circuital equation as well as in the first.

There is a difficulty in applying optical evidence to the circuital laws which has not been mentioned, viz., dispersion and change of wave-speed with the frequency of vibration. In applications involving assumed definite equations of motion or of connection between the etherial E and the molecular atomic electrical arrangements, the symbols c and μ, constants for the ether, become differential operators (functions of p), and the permittivity and inductivity can only be effectively constants at a given frequency of simply periodic vibration. This must necessarily affect in some degree all arguments of the above kind.

§ 472. The general nature of the modification of electrical distributions due to the introduction of the four velocities q_1, q_2, w_1 and w_2 in the circuital equations (3), (4) above may be readily seen in the manner of § 164, Vol. 1, by considering the effect of moving a single charge in a homogeneous medium. Using them in the form (12), (13), impress upon the whole system the velocity $-u$. This makes

$$\text{curl}\,\{H-VD(q-u)\}=\dot{D}, \tag{31}$$

$$-\text{curl}\,\{E-V(w-u)B\}=\dot{B}. \tag{32}$$

As we have not altered the relative velocities by thus bringing the electrification to rest, these are the proper equations when we travel with the electrification. In a steady state, that is to say, moving forward steadily at speed u, the right members vanish. Equation (31) then gives

$$H=VD(q-u), \tag{33}$$

and (32) makes

$$\text{curl}\,\{E-V(w-u)B\}=0. \tag{34}$$

Insert (33) in (34), and suppose u is parallel to k. Then the vector

$$\begin{aligned}&E+\mu c(u-q)(u-w)VkVkE\\&=E+\mu c(u-q)(u-w)(kE_3-E)\\&=(1-m^2)E+m^2E_3k \quad \text{if } m^2v^2=(u-q)(u-w).\end{aligned} \tag{35}$$

By (34) it is polar. So the vector

$$E+\frac{m^2}{1-m^2}kE_3=iE_1+jE_2+\frac{kE_3}{1-m^2} \tag{36}$$

is polar. Therefore

$$D=-c\{i\nabla_1+j\nabla_2+k(1-m^2)\nabla_3\}P, \tag{37}$$

where P is the potential. The result is, when m^2 is positive, to effectively reduce the permittivity in the line of motion both ways, to an amount governed by the size of m^2, so as to cause a concentration of displacement equatorially. This concentration is complete when $m^2=1$. Then $u=U$. That is, the previously investigated U is the speed with which the electrification must move to make a plane wave. There is no distortion when either $u=q$, or $u=w$, if u and w are unequal.

* I can recommend this work as a brain-stiffener during the hot weather. It deals with many abstruse questions.

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But m^2 is not necessarily positive. If u lies between q and w, m^2 is negative, and the distortion is a concentration in the line of motion. As an eminent authority once remarked, there is a lot of humbug in mathematical papers. He knew, having done it himself several times. To obviate a remark of that sort, I remark that the cases of vanishing distortion are unlike as regards H. For, if $u = q$, then $H = 0$; but if $u = w$, then $H = VD(q - w)$, showing magnetic force proportional to the difference of the speeds associated with D and B. In general, H is positive or negative according as q exceeds or is less than w. Unless D is reversed. When can that happen? When $m^2 > 1$. Then, as in the case of a charge moving through Maxwell's ether at a speed greater than that of light, there is a generation of an impure conical wave within which D is reversed.

(*To be continued.*)

ON THE MAINTENANCE OF CERTAIN PORTIONS OF DISTRIBUTING SYSTEMS AT EARTH POTENTIAL.*

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From the very earliest days of the application of the science of electricity to practical needs, the earth, or as our American brothers prefer to term it, the ground, has played a prominent part, and each branch of electrical industry has in turn set up a claim to a vested interest in it. The potential of the earth is usually taken as zero, other potentials being reckoned with respect to it. This, however, does not accord strictly with the facts, since a difference of potential may, and very frequently does, exist between two points on the earth's surface; such difference of potential, however, is never very great. The earth in some text books is regarded as forming a large reservoir, and its office is stated to be that of maintaining the potential of a point connected to it at zero. Thus, if a battery has one pole connected to earth, and the other to one end of a long conductor, and the far end of the conductor be connected to earth so that a current flows, the earth is regarded as merely absorbing the electricity that passes along the wire by draining down its potential to the same value as the potential of the earth at the battery end of the line, and no actual current is supposed to flow through the earth back to the battery. This explanation is not borne out by experience, as the return currents can actually be detected, and it is more correct and more convenient to regard the earth as a large conductor through which the current actually does flow.

The earth may be used in two distinct ways. It may either be employed to take the place of an ordinary conductor, as in telegraphy and telephony, in which case the whole of the outgoing current has to return by the earth, or it may be employed merely to keep one of the conductors of an electrical system at or near zero potential. No one would now think of intentionally employing the earth in the former manner when energy was to be transmitted at any appreciable rate, and even for signalling circuits its use in this manner is attended with great disadvantages. We may therefore confine our attention to the second way in which the earth is employed, namely, to keep down the potential of one portion of an electrical system of transmission.

It will be convenient in considering the various practical instances of earth connections to divide the subject into high-pressure and low-pressure circuits, and to further subdivide the latter into those circuits which have a conductor earthed at one point only, and those which are earthed at more than one point. If there be a two-wire circuit, consisting of a generator, two conductors and a consuming device, such as a transformer, and if a given difference of potential be maintained between the two conductors by the generator, then if all parts of the circuit be equally well insulated, each conductor will assume a potential relatively to the earth, which is half the difference of potential between the two. In other words, if the pressure be 10,000 volts one conductor will be 5,000 volts above earth, and the other 5,000 volts below earth. If, however, the insulation resistance of one conductor falls below that of the other, the conductor's potential with respect to the earth will at once diminish, while that of the other conductor will increase, and, if the insulation of one conductor fail altogether it will arrive at earth potential, while the other conductor will alter to 10,000 volts above or below the earth, as the case may be. Now it is obvious that if the conductors be insulated only with a view to withstanding the normal potential from earth, *i.e.*, 5,000 volts, an undue stress will be placed upon the better insulated conductor when the insulation resistance of the other falls, and this stress may be sufficient to cause the other to break down also. Inasmuch as it is impossible to foresee which conductor may assume the potential of the earth, it would appear that if both have to be insulated, both must be capable of withstanding a pressure of 10,000 volts. It was first pointed out, the author believes by Mr. Ferranti, that, seeing that either conductor might have to withstand the full pressure, it would be best to at once face the situation and insulate one of them for the maximum pressure possible, and insure that it alone should be subjected to this pressure by deliberately connecting the other conductor to earth. This exceedingly simple, and at the same time ingenious, device at once diminished the risk of breakdown and cheapened the cost of insulation, but at the same time it enabled a further great advantage to be reaped by admitting of much greater security to life being introduced. This end was attained by completely enclosing the insulated conductor within the uninsulated one, thus rendering it physically impossible to handle a conductor at a dangerously high potential, and if by any chance the outer conductor should be cut through, a short circuit would be established before the inner conductor could be touched.

This system has been almost universally adopted for two-wire high-pressure circuits, and is perfectly familiar to all at the present time, but it is worth while recording the fact that when originally introduced many people looked askance at connecting a high-pressure conductor to earth. For systems of transmission employing more than two wires the same perfect security cannot be attained, but a near approach may be made with two-phase working by employing two separate concentric cables, the outer conductors of which are connected to earth, or by enclosing two parallel conductors within an outer envelope. In three-phase working, if a star winding be employed, the middle point of such winding may be connected to earth. When this is done the stress on the insulation from earth is diminished to the smallest possible value, but all three conductors have to be insulated. It is important that one point only of the zero potential conductor should be conducted to earth, because inasmuch as there must of necessity be some fall of potential in the outer conductor, there exists between any point and the one connected to earth a difference of potential depending upon the resistance of the conductor and the current flowing through it. So long as the outer conductor is insulated from earth, except at one earth connection, no current can pass through the earth; but if a connection be established with earth at some distant point, the difference of potential between it and the other point will cause current to flow through the earth.

A digression may here be made to point out exactly the manner in which such return currents travel through the earth. A most instructive experiment carried out by the author in his student days, under Prof. W. Grylls Adams, made such an impression on him, and has been found by him to be so helpful, that he may perhaps be pardoned for describing it. In a large flat sheet of tinfoil two needles were fixed, connected respectively to the two poles of a battery, which thus sends a current through the tinfoil. A sensitive galvanometer was provided and its ends connected each to a needle; one of these needles was stuck at random into the tinfoil, and the other was moved about on the tinfoil until a point was found which gave no deflection on the galvanometer. The needle was then pressed into the tinfoil, and an impression left on a sheet of clean paper underneath. A series of such positions were found, corresponding to an equi-potential line in the tinfoil. The first needle was then moved to a new position and a second equi-potential line traced out. When a sufficient number of such lines had been determined, other lines normal to them were drawn between the two points to which the battery had been connected. This, of course, represented the lines of flow of the current. Anyone who carries out this experiment for himself will be at once struck with the number and diversity of the paths along which the current can flow. These paths spread out in the same manner as the lines of force from a magnet, and extend to a great distance away from a direct line.

In the case considered of a conductor carrying a heavy current and unearthed at two points of its length, the current may return from one point to the other by paths that are an almost incredible distance away from the main conductor, though, of course, the bulk of the current will take the shortest possible path through the earth. If two plates be buried in the earth at two points along a line of flow and be connected together through a conductor, this conductor will take up a portion of the current. If the conductor be part of a signalling circuit the signalling currents will be interfered with, and, with any conductor, electrolytic action may take place at one or both points of connection with the earth. If, instead of dealing with the high pressures, we are dealing with low, exactly the same effect will be produced by making one or more earth connections to a conductor, but the objects of making the earth connection are usually different. In the case of a low-pressure distribution system, the object of earthing one conductor is not to diminish the cost of the insulation, since no appreciable saving is made by using a pressure of, say, 200 volts instead of 400 volts, nor is it to secure safety to life; the chief object is to enable a consumer to be supplied at such a pressure

* Paper read before the Municipal Electrical Association, at Leeds, June 25.

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that no one of the conductors brought into his house will exceed the limit of pressure defined by the Board of Trade to be low pressure. In the case of electrically-driven tramways, the one object is to enable the rails to be used as one conductor, chiefly with a view to simplifying the working arrangements, and partly to enable the conducting power of the rails, which must in any case be laid, to be utilised. In this last case it is obvious that the conductor is connected to earth throughout its length, and the only way to obviate the difficulties pointed out on the score of current returning by the earth is to keep the difference of potential between the ends of the earth conductor so low as to cause the amount of current returning by the earth and metallic structures buried in it, other than the rails, to be very small. With these preliminary observations we may now consider some particular cases. The author regards all the high-pressure systems as systems of transmission, though it is true that at present high pressure is still used to some extent for distribution. Inasmuch as this Paper deals only with the earthing of distribution systems, the author proposes to confine his attention to these.

The most important case of earthing conductors is undoubtedly that of tramways. The system adopted so largely in America has been imported into this country, and every tramway system, excluding battery driven cars, is being worked with one conductor insulated and the other consisting of the rails connected to earth. It is well-known that if the difference of potential between the end of the earthed conductor which is connected to the source of energy differ in potential considerably from that of a distant point on the same conductor, the current returning through the mass of the earth and through pipes buried in it may be very large and may cause most serious damage to the pipes by causing the metal to be dissolved at the points at which the current leaves. How great this difference of potential must be before serious damage is done is a matter upon which there is not a large amount of information available. The Board of Trade have fixed the limit of what may be allowed at 7 volts, but it is maintained by some authorities that this limit is too high and that a lower potential than 7 volts will cause damage. This point is receiving a considerable amount of attention at the present time and the author is himself engaged in a joint investigation with engineers of other departments of the Manchester Corporation with a view to thoroughly thrashing out what is the minimum difference of potential that can be allowed. It is obviously in the interests of all concerned to arrive at reliable data on the subject. If 7 volts be found to be safe, well and good, but if not the sooner it is known to be dangerous the better. All engineers must be agreed that the lower one can keep down the difference of potential the better. The object may be effected in various ways. One of the most common is to provide auxiliary conductors of low resistance which are tapped on to the rails at various points to supplement their conductivity. Another device is to employ similar conductors but to lower the potential of the far end by means of so-called negative boosters which subtract instead of add a certain number of volts. A third means, and in the author's opinion the best and most effectual, is to feed the line from a number of independent points either by means of a number of generating stations or, preferably, by means of a number of transforming sub-stations. Except in the case of very heavy traffic this method should prove effectual without either the employment of return feeders or negative boosters.

The simplicity and reliability of the so-called overhead system of traction are such as to render it worth while to go to great lengths to retain the system, but if it be found and clearly demonstrated that extremely minute differences of potential are sufficient to cause serious damage to underground structures in urban districts, it will be necessary to re-consider the whole position, and perhaps to adopt an insulated return conductor, or else to fall back upon a battery system of self-contained cars, either of which expedients would be greatly to be deplored.

The second case of earthing in order of importance is that of one conductor of ordinary lighting and power circuits, and it is on this point that the author desires to raise discussion chiefly. It has been hotly debated, and much difference of opinion still exists as to whether it is desirable or not to earth the middle wire of a three-wire system. Let us consider what are the advantages and disadvantages of such a course. The main advantages are the following: (1) By earthing the middle conductor the extreme difference of potential that can be attained by any one of the conductors from earth is halved, and all can be handled not only with great safety, but practically without inconvenience. (2) The stress on the insulation is halved. (3) All three conductors may be taken into a consumer's premises for all pressures up to and including 250 volts pressure across the outers without contravention of the regulations of the Board of Trade. This advantage is undoubtedly by far the most important. (4) Immediate notice of a leak on one of the outer conductors is given.

The disadvantages of earthing the middle conductor are: (1) If a leak exists on one conductor, current is continually forced through it, thus causing in many cases complete destruction of the insulating material. (2) A leak on one conductor produces a short circuit on one side of the system of distribution, unless the earth connection is removable at will.

In Manchester the Board of Trade require that the middle conductor shall be maintained at or near the earth potential, and the author has now had nearly seven years' experience of this system. In his judgment there can be no possible doubt that at all events with continuous current, and quite possibly with alternating, the effect upon the insulating material of the negative main is most severe. In operating a system of distribution by means of continuous currents, it is always found that if none of the conductors be deliberatively earthed those connected to the negative pole assume earth potential; the positive conductors consequently being at the maximum potential above earth corresponding to the pressure used on the system. The reason for this is well known. It is the phenomenon known as electric osmosis, whereby moisture tends to travel away from the positive pole and towards the negative pole. Whatever system of mains be employed there are always many points at which surface leakage can take place, and whether the conductors be bare copper on porcelain insulators, or be continuously insulated cables, at every point where the conductor is exposed leakage from the negative pole will take place, but if the negative conductor be kept near earth potential, this tendency will be small. If, however, the middle conductor be deliberately connected with earth so that the negative outer is kept below earth potential, a current corresponding to the amount of the leakage will be constantly forced through the leak, and the tendency for moisture to flow to the negative conductor will be maintained. If the leakage was confined to the surface of the insulation at points of connection to the conductors the result would not be so serious, but the author has found that with certain makes of rubber the material is evidently porous, and small as is the leakage current at first, it is sufficient to cause water to enter through the pores of the rubber, and the conductivity of this water so increases the leak that in course of time the whole of the rubber on the negative conductors is destroyed, large blisters forming within its substance and becoming filled with strongly alkaline liquid almost certainly derived from the substances mixed with the rubber. The rubber is often much distended, causing the liquid to be under considerable pressure. In course of time this pressure increases to such an extent as to burst the rubber, causing a hole completely through the insulating material. It is clear that the water could not merely flow into these blisters; it is almost certainly driven in by osmosis. What happens with rubber may happen with other materials and, in the author's opinion, there can be no doubt whatever that very grave risk of breakdown of the insulation of the negative conductors is introduced by earthing the middle conductor.

As a set-off against the above inconvenience it must not be forgotten that the insulation resistance of the positive conductors is substantially improved by earthing the middle one, but very little importance need be attached to this, since, as already stated, the negative conductor would be at earth potential if the middle one was not earthed, and the tendency to dry the positive outer would then be doubled. The only consideration that impels me to desire to earth the middle conductor is the fact that it admits of all three conductors being brought into a consumer's premises, thus enabling every installation to be balanced within itself if it be of sufficient size to render it desirable to do so. The author is convinced that the only method of effectually balancing a multiple wire system is to carry that balancing back to every consumer except to consumers of the very smallest size and, therefore, it is of great importance to be allowed to bring the three conductors into installations. Serious as are the disadvantages, this advantage is, in his judgment, sufficient to outweigh them, and, therefore, he would, on the whole, decide in favour of earthing the middle conductor, but if this be done it must be clearly understood that it necessitates the utmost care in protecting the mains from moisture and the only possible system of laying them becomes the so-called solid system, in which every cable is completely surrounded by a thoroughly waterproof material, or an air-insulated system with accessible porcelain insulators at intervals, as in the Crompton system of bare copper. If it be granted that the middle conductor should be earthed, the question at once arises should it be permanently and irrevocably earthed or should the earth connection be capable of removal at will. The author would unhesitatingly reply "it *must* be removable." The first consideration is continuity of supply, and, if a leak developing on one conductor is to cause a short circuit the chances of interruption are increased manifold beyond what they would be if the earth connection could be removed until the fault had been localised and repaired. It is quite clear that the chances of a leak occurring on one conductor are many times greater than those of two leaks occurring on two separate conductors simultaneously. It may be argued that if the earth connection is liable to be removed all the advantages of making it at all are done away with, since the distribution of potential will alter when it is cut off. To some extent this is true, but it must be remembered that the connection would only need to be removed for short periods and at long intervals and, therefore, in practice but

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little risk would arise. If it were a question of dangerous pressures it would be entirely different; in such case the earth connection must never be removed while the main is in use. Once it be granted that the earth connection must be removable it becomes obvious that the conductors must be earthed at one point only, and that must be easily accessible from the generating station. This consideration shows that it is impossible to allow one of the conductors in a consumer's installation to be uninsulated, a system of wiring frequently advocated by some on account of its cheapness and some other advantages.

There is, however, another reason for not using this system of wiring, depending on the undesirability, already pointed out, of earthing a conductor at more points than one. It is often argued by the advocates of the system that the balancing wires carry so little current that the fall of potential in them is negligible. It is true that balancing wires frequently bring back but little current to the generating station, but locally it is unavoidable that these should be heavy currents, causing substantial differences of potential, flowing between the various installations, composing a balanced main, and these differences of potential may cause destructive electrolysis, and, with alternating currents, interference with telephone lines. Certain special features arise in connection with a distributing network fed from transforming sub-stations supplied with high-pressure current to which attention may be called. In a case likely to become not unusual in practice, namely, that of three-phase transmission with rotatory converters supplying continuous current to the network, it will probably be required that the grouping of the transformers shall be star and the middle point be earthed. Now, if this point, which is also directly connected to the middle distributing conductor be earthed at the transformer, we shall have all the disadvantages of a middle conductor earthed at several points. A much more serious case, will, however, arise if, in addition to this, the middle wire be opened between two sub-stations but the outers be carried through. In such an event the whole balancing current may be conveyed by the earth and do great damage. A similar difficulty would arise with balancing transformers distributed at various points of the network if the middle wires are not continuous throughout, and an earth connection is made in the balancers. In order to comply with this condition of earthing the middle point of the transformers, the earth should be made by connecting the middle wire to the point in question and earthing this middle wire at one point only for the whole system.

The author has made no attempt to treat this subject at all fully, his desire being merely to raise a discussion on the subject generally of connecting any portion of a distribution system to earth, the chief points being: (1) Should any portion of any system of distributing conductors, whether for the ordinary supply of energy or for traction, be connected to earth. (2) If such a course is desirable what conductor or conductors should be earthed, and at what point or points. (3) What difficulties may be expected from earthed conductors, and in what way may these difficulties be met, especially in the case of distribution for electric traction purposes.

The following is an abstract of the discussion on the above Paper:—

Mr. A. P. TROTTER (communicated): In this valuable Paper the author assumes, in accordance with his own practice, that no resistance is intentionally introduced in the earth connection. The advantages and disadvantages of adding, say, 1 ohm, to prevent a dead short-circuit, might be discussed, and it would be interesting to hear the experiences of those who use recording ampere-meters in the earthing circuit. It has been proposed to earth at the feeding points instead of at the works. Ampere-meters would have to be placed at the works in order that leaks might be noted, by observing the current passing to earth at each point; but the advantages to be gained do not seem to balance the disadvantages, the chief of which is the impossibility of cutting off the earth connection, temporarily, at short notice, in case of an accident. Lead-sheathing of cables generally constitutes a connection to earth, and electrical precautions for its protection seem to come within the scope of this Paper. The advisability of keeping the lead 2 volts or 4 volts negative to the middle 'bus-bar seems worthy of consideration.

Mr. S. Z. DE FERRANTI (Hollinwood) agreed with Mr. Wordingham's views on this subject; he did not think there was any doubt about it that the central conductor should be earthed.

Mr. J. F. C. SNELL (Sunderland) thought Mr. Wordingham had put the case before them in a masterly manner. He would like to ask if the direct-current engineers had considered the difference in cost between a three-wire distribution and a two-wire distribution. On actual tenders received he found that the only saving for a three-wire distribution for precisely the same capacity as the two-wire was 8 per cent. If that be the case, what was the use of having a three-wire system at all? If the repairs on a three-wire system increased, might one not say that there was an actual saving in putting in a two-wire distribution instead of a three-wire? In the case of St. Pancras, where they had a five-wire system, the whole of the cables were jute, lead-covered, and as a rule the negative was equal to earth. In actual practice, where a fault developed on the middle wire of a three-wire system, it was a most difficult matter to localise it. He thought it would increase the simplicity and the reliability by adopting the two-wire system.

Mr. W. A. CHAMEN (Glasgow) said the practice at Glasgow at present was earthing through a resistance. The fact that they had lead-covered cables brought into the consideration points which did not trouble Mr. Wordingham. Another matter was that they had concentric cables, and when these were employed it was necessary to use fuses. The plan he had adopted to reduce electrolysis to a minimum was to use a triple concentric, having the positive in the centre and the negative next to the centre conductor. They connected to earth at only one point through recording instruments required by the Board of Trade. If they could get a proper earth to all their water mains in Glasgow, then he thought they would not have much trouble. He had one day a very remarkable case with a distributor going wrong, showing an earth connection on the middle wire; but it was very slight indeed, being just sufficient to light up a 16 c.p. lamp. He noticed the lamp rapidly dropping; they reversed the connections, and the lamp immediately lit up and gradually went down.

Mr. E. TREMLETT CARTER thought he might say a few words upon the tramway question. Some years ago he saw in Cincinnati some experiments to get over the earth return on the trolley system. The double trolley might be quite satisfactory to the water companies and the gas companies, but the trouble consequent upon having two bare wires at 500 volts or 550 volts only a few inches apart was serious and made complicated crossings. It was also necessary to carry two independent trolley wheels on each car, and there were great risks of causing short circuits through the jumping of the trolley arm. In the trolley system, he thought, they *must* carry the return current through the rails, and some of it would travel along the gas and water pipes in the neighbourhood. The question really was, "How were they to minimize the eating of the pipes?" With only the 7 volts limit, the eating of the pipes did go on, and he thought that even with only 2 volts this would occur. It was like slow poison: the time would come when those pipes would come down to the thickness of tissue paper, and then there would be a catastrophe, if not before. What they had to consider was how they could best prevent the destruction of these pipes.

Mr. R. C. QUIN (Blackpool) said he had been an advocate of earthing the middle wire on a three-wire system before the Board of Trade gave permission for this to be done, but he had had some very astounding results which had puzzled him. He referred to the installation at Brighton. There were high-tension concentric mains with the outer earthed, and low-tension three-wire mains with the middle wire earthed. The low-tension fuses on the alternating network for a distance of some 2 miles gave out, the earth fuse on the continuous current network went, the high-tension alternating fuses failed and the low-tension fuses to houses and low-tension network some 3 miles distant all went immediately. There was one common earth. He thought those present would also be puzzled at this result. At Blackpool the difficulties from electrolysis had not arisen, although they had crossed the track something like 200 times. They had also had a leakage of 400 amperes, but no sign of electrolysis. Wherever it was possible they had coupled the lead of the cables to the water pipes. The Blackpool & Fleetwood Tramway Co. had not done this, and lately they had been looking for the lead which was on their cables. He thought the whole point came in here. The current must not be allowed to pass into the earth, but must be kept in metal the whole way.

Mr. C. H. WORDINGHAM (Manchester) in replying, said that Mr. Trotter asked for information regarding ammeters on the earth connection. They had such an ammeter in Manchester, and had had the same in use for some two or three years. Their experience was that the leakage current was pretty steadily maintained, that it was always in one direction, but that it sometimes increased and decreased very considerably. These cases were, however, exceptional. He thought the cost of laying mains in Sunderland must be fairly high, and did not think that the simplicity of the two-wire system would justify their spending 8 per cent. more. Further than this, it would also not be as convenient as the three-wire system for motors, as a higher voltage could be used for this purpose. He thought that if damage was going to be done at all through electrolysis by using the earth return, it was only a question of a few years before they would be prevented from using this system, and he thought they had better face the difficulty now. He congratulated Mr. Quin upon the methods adopted to avoid electrolysis at Blackpool.

A METER FOR MEASURING TRACTIVE FORCE ON ELECTRIC TRAMCARS.*

BY GISBERT KAPP.

A tube is mounted in the car parallel to the rails, with the ends turned up to form vertical branches. Let us imagine the line to be horizontal and the tube filled with water up to a certain point in the vertical branches, which we will consider the zero point. In order to be able to observe the water level the vertical branches are glass tubes. If the tube is inclined to the horizontal the water level changes proportionally to the tangent of the angle of inclination, and an experimental scale can be marked on the branches with points corresponding to gradients of 1 in 1,000, 2 in 1,000 up or down, the position of these points being ascertained by trial. The distance of these points apart depends on the width of the branches and the length of the horizontal tube. If the car is at rest on an incline, the apparatus being, as already remarked, mounted parallel

* Paper read at the eighth annual meeting of the "Verband Deutscher Electrotechniker" at Kiel.

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to the rails, the water level indicates with sufficient accuracy the horizontal gravity component per ton of rolling weight.

The accuracy is not absolute, as the displacement of the water is proportional to the tangent, the gravity component on the other hand to the sine of the angle of inclination of the track. The error is, however, even on considerable inclines, quite inconsiderable. On an incline of 5 per cent. the difference between sine and tangent is $\frac{1}{769}$, *i.e.*, 0·13 per cent., and on inclines of 10 per cent., the steepest allowable on any tram line, it is $\frac{1}{185}$, or 0·54 per cent. That proportion of the tractive force which serves to overcome the gravity component can, therefore, be directly read off on the graduated glass tube when the car is proceeding up a steady incline.

Let us now consider the car as moving with variable speed on a level track. The acceleration pressure acting on the horizontal column of liquid causes a displacement of the surface of the water. If l is the length of the horizontal tube and h the difference in height between the surface of the water in each of the vertical branches, we have the following relationship :—

$$l\frac{p}{g}=h,$$

where p is the acceleration imparted to the car, and g the acceleration of gravity. As $\frac{p}{g}$ is always less than l,

$$\frac{p}{g}=\sin\beta,$$

β being the angle through which the apparatus would have to be turned while at rest to produce the same displacement as has in this case been caused by acceleration on a horizontal track. That portion of the tractive force which goes to accelerate the car, may, therefore, be read off on the empirically graduated scale, the level of the water in this case indicating both for the incline and the acceleration the necessary tractive force per ton of rolling weight.

The following consideration will serve to show the degree of accuracy obtainable in this respect :—

In Fig. 1 let *ab* be the horizontal tube of length l, *ac* and *ad* its two vertical branches, α the angle of inclination of the track, and p the acceleration imparted to the tube in the direction of its length

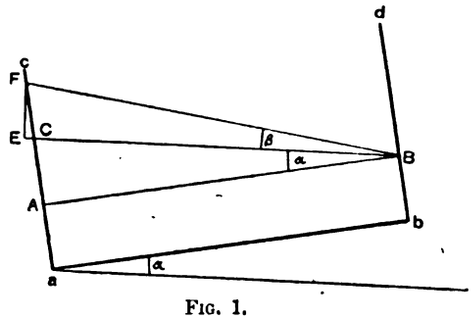

FIG. 1.

Let B and F be the water level in the two branches. Of the total difference of level read off between the two, $AF=l\tan(\alpha+\beta)$, $AC=l\tan\alpha$ is that portion due to the incline, and $CF=\frac{EF}{\cos\alpha}$ is that portion due to the acceleration, whence

$$EF=l\sqrt{1+\tan^2(\alpha+\beta)}\sin\beta,$$

$$CF=l\frac{\sqrt{1+\tan^2(\alpha+\beta)}}{\cos^2\alpha}\sin\beta.$$

The value of the expressions under the root may be taken as equal to unity without serious error. The tractive force read off on the scale is AF kg. per ton ; the true tractive force is $1{,}000\left(\sin\alpha+\frac{p}{g}\right)$kg. per ton. Introducing an element of error which we will term $1{,}000f$, we have the equation, $l\tan(\alpha+\beta)=1{,}000f+1{,}000\left(\sin\alpha+\frac{p}{g}\right)$.

As the dimensions of the apparatus are without influence on the theory here developed of its limits of error, we can give to l any dimensions we please. If we make the tube 1,000mm. the scale divided into millimetres will show the tractive force in kilogrammes per ton. The above equation thus assumes the simpler form

$$\tan(\alpha+\beta)=f+\sin\alpha+\frac{p}{g}$$

$$\tan(\alpha+\beta)=f+\sin\alpha+\sin\beta.$$

It is plain that the error is greater as the incline and acceleration increase. An average for the acceleration on street tramways will be 0·4, though occasionally it may amount to 0·75, a value which it will, however, not be likely to exceed on account of convenience to passengers. When putting on the brakes, and particularly the emergency brakes, this value may be considerably exceeded. When the apparatus is employed to determine the tractive force of the motor, the value $p=0{\cdot}75$ may be regarded as the limit. If the brake action is to be tested, a maximum retardation of 1·40 on a horizontal track must be assumed for the purpose of testing the limits of error.

Thus we have, with an acceleration of 0·4 and an incline of 5 per cent., $\sin\alpha=0{\cdot}05$; $\sin\beta=0{\cdot}4/9{\cdot}81$; $\sin\alpha+\sin\beta=0{\cdot}0907$. If the apparatus were without error it should show a difference of level of 90 7mm. In practice it shows a difference of level of 1,000 tan $(\alpha+\beta)$, which from the values above given comes out at about 91mm. The apparatus, therefore, indicates 0·3mm., *i.e.*, one-third per cent. too much. In a similar way the error for other conditions of working can be estimated from the following tables for starting and braking obtained :—

Table of Limits of Error in Starting.

Profit of track.	Horizontal.		Rising.		Falling.	
	—	—	50%	100%	50%	100%
Acceleration	0·4	0·75	0·75	0·4	0·75	0·4
Percentage error	0·00	0·29	0·60	0 82	0·23	0·38

Table of Limits of Error in Braking.

Acceleration	0·75	1·4	0·75	1·4	0·75	0·4
Percentage error	0 29	1·03	0·23	0·80	0·60	0·82

In all cases the errors are either smaller or of the same order as the errors in reading so that the apparatus may be looked upon as thoroughly suited for practical purposes.

A further and greater source of error is due to the fact that in going up hill and in starting the front springs of the car are more heavily loaded than the rear springs, while on running down hill and applying the brakes the opposite is the case. The result is that the tube *ab* does not remain perfectly parallel to the rails, but assumes a slight incline. The smaller the wheel base and the higher the centre of gravity of the car above the springs, the more the car will tend to tip under the influence of the tractive force, or of

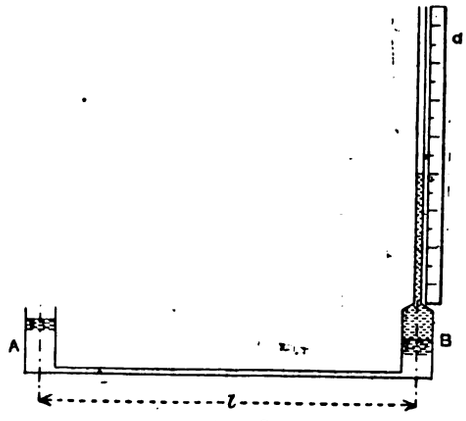

FIG. 2.

the retardation due to the brakes. The unequal distribution of the load may also cause a similar displacement. These are sources of error that depend on particular circumstances, and cannot be determined generally. Exhaustive calculations which I have made lead me to conclude that these sources of error may amount to several units per cent.

The apparatus indicates directly only that portion of the tractive force which is necessary for mounting the incline or producing the acceleration, not the remainder which is required for overcoming the friction resistance. To estimate this, the procedure is as follows : The car is set in motion on a length of track as nearly level as possible, and allowed to come to rest. The water level is read off, and indicates the retardation due to rails, gear, friction, &c. To eliminate the effect of any deviation from the horizontal, the test should be made running in each direction. The mean of the readings is the so-called traction coefficient expressed in kilogrammes per ton of rolling weight. When this coefficient has been determined it is only necessary to displace the scale by a certain fixed amount to enable the total tractive force to be read off.

The form of the apparatus just described is suited for being permanently fixed up in motor-cars, the length of the tubes *ab* being as long as the frame of the car will allow, the vertical branches being brought up at any convenient spot. One of the upright tubes may be provided with a float adapted to operate a recording instrument for producing a permanent record on a paper strip mounted on a time-controlled drum in the ordinary way. In this way is obtained a curve of the tractive force as a function of the track. The integration of this curve is the work per ton of rolling weight. Instead of the water tube, a suitably graduated manometer may be employed. In any case, the apparatus constructed as above is not very portable, owing to the length of the tube *ab*. To obtain a portable apparatus I have employed two liquids—mercury, to produce the difference of pressure, and water to indicate it. This apparatus is shown in Fig. 2.

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AB are two pots of 40mm. in diameter, *l* is the connecting tube of such a length that the centres of the pots are separated by a distance of 50cm. *d* is the water tube, the bore of which is 5mm. With these proportions an incline of 0·1 per cent. corresponds to a displacement of 4·7mm., and as 2mm. can be read with accuracy the tractive force may be determined within about 0·5kg. per ton of rolling weight. Prolonging the tube *ab* would enable a greater degree of accuracy to be obtained, but the apparatus would then become too unwieldly. In addition it would be useless, as, in the first place, too extreme a degree of accuracy is useless for practical purposes, and secondly, it would be illusory, owing to the error due to the tipping of the car.

A much more convenient form of apparatus would be a bent spirit-level. As the water-level tube only indicates an angle of inclination, this might be shown by the air bubble in an equally bent level. But though I have had half-a-dozen made I did not succeed in getting one to give anything like the accuracy of the apparatus shown in Fig. 2.

I have tested the apparatus on one of the Berlin tramways and on the high-speed line of Siemens and Halske in Lichterfelde. The amount of damping down produced by the narrow tube *l* (bore 3mm.) proved to be adequate in cases of starting and ordinary braking but too powerful for examining the effect of the emergency brake. It would be advisable to enlarge this tube and to employ a throttle-valve to regulate the amount of damping required. For ordinary street trams the apparatus gave a traction coefficient of 12kg. per ton which rose to 20kg. on a sharp curve. On the high-speed railway the apparatus was arranged inside a car destined for the Berlin overhead railway, and gave an acceleration pressure of 75kg. As the under carriage is double-bogied, and the centre of gravity lies low, appreciable tipping can hardly occur, and an error on that account is not likely. The coming-to-rest experiments were carried out on a 0·3 per cent. track. Out of six double experiments (12 readings) and speeds varying from 13·5km. to 30·7km. per hour, the traction coefficient varied between the narrow limits of 8·0 and 8·1 per ton. The day was calm. It appears, consequently, that air resistance has not much influence on speeds up to 30km. per hour. The increase in the coefficient caused by a curve of 200m. radius amounted to 1·5kg. The car was quite new, and had not run long enough to ease the parts, and after the experiments it was found that one of the brake-blocks was warm, which may account for the high coefficient of 8kg.

ALTERNATING-CURRENT INDUCTION MOTORS.*

BY A. C. EBORALL.

In the following Paper some practical points connected with the construction, design, and performance of modern single and polyphase induction motors are first considered, and then follows a brief consideration of some recent developments in this branch of electrical engineering. The author originally intended to submit a short Paper on starting devices for single-phase motors, but it afterwards occurred to him that it might prove of interest to bring up the whole question of alternating-current induction motors for discussion, as the subject is of considerable interest to many, and has been somewhat neglected in this country up to the present. On the other hand, some apology is needed for presenting such a Paper to the Institution, because there is little that is really new in this branch of electro-technics.

PART I.—THE CONSTRUCTION OF INDUCTION MOTORS.

A. *Ironwork.*—The design of the ironwork, that is, of the stator and rotor cores, motor case, bearings, &c., is the same for all motors, single or polyphase, because a single-phase motor is practically a polyphase motor running on one phase.† The general design of all induction motors with regard to the case and bearings is fairly uniform with all makers. Up to 100 H.P., and for pressures not exceeding 1,000 volts, all standard motors are semi-enclosed, the stator core-discs being built up inside a cast-iron case, and the bearings carried on open end shields. Thus the motors are virtually without bed-plates. Bearings are always provided with ring or chain oilers, and the sleeves are of gunmetal for the small sizes and of Babbitt metal for the larger sizes. Shafts are frequently case-hardened in the neck and afterwards ground true. For larger motors than 100 H.P., and for voltages above 1,000, a more open construction is employed, involving the use of a bed-plate, to which the stator case and the pedestals are bolted. In this case the bearings are usually spherical. With large motors, great care has to be taken to keep the bearings absolutely rigid with regard to the stator case, on account of the relatively small air-gap. For instance, for a 300 H.P. induction motor running at 200 revs. per min., at 40 cycles, the diameter of the rotor works out to be about 8ft., and the air-gap (iron to iron) would not exceed 0·2in. With such a motor it is absolutely necessary to stiffen the pedestals by means of arms radiating from them and bolted to the stator case. Stator stampings are usually not less than 20mm. in thickness, and are built up with or without insulation between them. Ventilating ducts are usually provided in the core for all sizes above 30 H.P. Rotors are built up from stouter stampings, which need never be insulated; ventilating ducts in them need not be provided for motors less than 50 H.P., on account of the absence of iron loss in the cores of any appreciable amount. The windings for both stator and rotor must always be iron-clad; that is, the cores must be provided with holes or slots. In Fig. 1 are illustrated some typical forms of stator holes and slots. The form marked A is the well-known Brown rectangular hole; that marked B is used by Messrs. Kolben & Co.; that marked C is the usual shape used in Germany; those marked D and E are American forms; while finally, the slot marked F is generally used in the motors built by the author's firm. The greatest winding space is given with square-topped slots. The bottom of a slot or hole is best kept rounded, as it produces a more even pole.

The arguments for and against the use of holes and slots are as follows: With the employment of a hole-winding, the magnetising current of the motor is reduced to a minimum, because the inner periphery of the stator is smooth all round, and consequently the area of the air-gap is as large as possible. But if the small iron bridges at the bottom of the holes are more than mere shreds of metal, of the thickness of paper, there is considerable magnetic leakage across them, which may greatly affect the performance of the motor. In order to prevent this leakage, not only have the stator core discs to be tooled after being built up, that is, a cut has to be taken off the bore of the stator, but the interior of the holes has to be filed, and so the ironlosses are unavoidably increased. A hole-winding produces a somewhat smoother pole than a slot-winding, but the former is much more difficult to wind, and the conductors are liable to get injured owing to

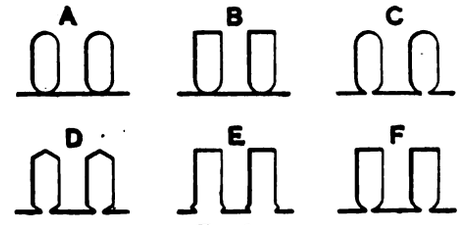

FIG. 1.

abrasion of the insulation while being pulled through, especially as the holes get nearly filled up with wires, and this injury may easily escape detection at the time. The only real objection to partly closed slots is the increase of magnetising current produced by their use (it will generally increase 10–15 per cent.), but in the author's opinion this objection is far outweighed by the smaller iron loss and greater convenience attained with slot-windings. In many American motors the slots are quite straight, as shown—that is, their sides are parallel; this permits the use of former wound stator coils, which is an advantage; but, on the other hand, the magnetising current of such motors is relatively very high. A hole-winding is open to another objection—unless a great many experimental data are available it is impossible to calculate the motor in question accurately, as magnetic leakage cannot be estimated with any accuracy. On the other hand, the performance of a motor having open or partly-closed slots can be accurately predetermined from the drawings, by means of suitable vector diagrams, such as those of Heyland* or Rothbert.

With regard to the relative proportioning of stator and rotor holes or slots, the lengths of these should not, if possible, exceed two and a-half times the width, and the nearer they approximate to square or circular shape, the better. This amounts to saying that the winding depth must be kept down, as otherwise the power-factor and the over-load capacity of the motor will be affected. The performance of a motor at starting, particularly if it has a permanently short-circuited rotor, and especially if single-phase, may be greatly improved by so designing the rotor that the slots or holes of the latter are not parallel to the holes or slots of the stator—for instance, they may be "staggered" by an amount not exceeding their pitch. This constructional feature, first put forward by Mr. C. E. L. Brown about six years ago, is used with all the induction motors built by the author's firm, including the Heyland single-phase motors, as the results of many tests show it to be of con-

* Paper read before the Institution of Electrical Engineers.

† While this is perfectly true, and although the general constructional lines are similar in each case, it must be borne in mind that far greater care has to be taken with the design of a single-phase motor than with that of a polyphaser if the best results are to be obtained. The bad effects of magnetic leakage are felt far more with the former than with the latter, and the performance of the motor is affected by apparently insignificant details of design. However, a very good polyphase motor will make a fairly good single-phase motor as a general rule.

* Refer to "Polyphase Electric Currents" (Dr. Thompson), 2nd edition, 1900; or to Mr. Heyland's latest publication, "Experimentellen Untersuchungen an Induktionsmotoren," 1900 (published by F. Enke, Stuttgart).

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siderable value. The insulation of holes or slots is usually effected by means of insulating tubes of compressed paper, fibre, veneer board, or micanite, the latter material being of course best, but not necessary for low-tension motors.

The building-up of the stator core in the motor case is an important feature of the design, and, moreover, the details connected with it are frequently neglected. First, the stator core-discs should always be supported away from the case, and secondly, after having been assembled together, the stampings should not be tooled.* It is frequently difficult to avoid this after-tooling, more especially on account of the absolute necessity of having everything concentric, and therefore the author thinks it may be of interest to describe one method employed by his firm, as it has been found to give excellent results from all points of view; the method described is somewhat modified for large motors. The stator core-discs are first stamped out of the sheet-metal as exactly as possible (with modern American tools great accuracy can be attained), and then built up on an iron mandrel. After this, the end rings *r r* (Fig. 2) are riveted on, the whole arrangement put in the lathe, and the four projections on the rings *a a* turned down to the right diameter, but left a trifle full. The case of the motor, already turned on the faces *b b*, is now heated, and pushed over the core in this condition, so that after cooling, the shrinkage of the case holds the core tightly and securely. But to make everything absolutely certain, two or three screws *s* fix the case and the core positively. After the core is fixed in

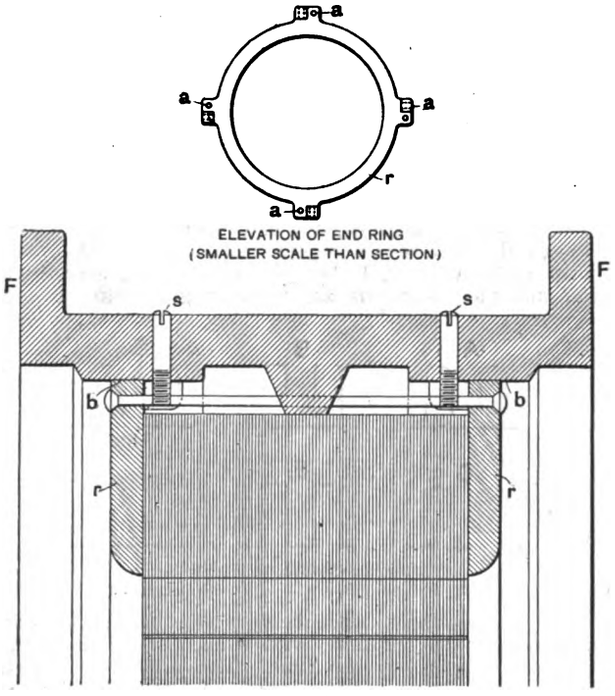

FIG. 2.

the case, the flanges on the latter, F F, are turned down, and must be, therefore, absolutely concentric and true with the stator bore, and true with the axis of the latter. Finally, the slots and end rings are heavily insulated, and the winding put in. The rotor cores are built up in the ordinary manner on the shaft, or on a spider, and are then put in the lathe, and the finest possible cut taken off them. In some cases even this cut is omitted, any slight irregularity or burr being removed by grinding. The method of building the core into possess several advantages. These are, firstly, that owing to the core being supported away from the case, leakage through the latter is minimised, and consequently wasteful eddy currents and other detrimental effects are avoided, and moreover a free circulation of air can take place all round the core; secondly, the eddy current losses in the core and teeth are reduced to a minimum, and approximate very closely to the value obtained by calculation; and thirdly, as the core discs are built up quite independently of the motor case, the width of core can be adjusted within certain limits to suit the output of the motor—a great advantage in practice, as it allows a given case to be used for motors of several sizes, and to a certain extent permits convenient variations to be made from standard designs. It is usual with some constructors, notably with Mr. Kolben, to make the end rings or cheeks of the stator cores of brass or gun metal. It is claimed that by doing this the leakage from pole to pole along the side flanks of the stator is sensibly diminished, or prevented altogether.

B. *Windings.*—The stator and rotor windings of all modern induction motors are always of the drum type, these windings consisting in all cases either of simple rectangular coils, or regular bar-windings, or modifications of the latter—for instance, the so-called squirrel-cage windings. A ring winding has three great disadvantages: firstly, it has an inherently large leakage coefficient, and secondly, its use necessitates the employment of a massive brass frame around the stator core (in order to minimise magnetic leakage) and it practically precludes the use of an external iron containing-case for the stator, thus making the mechanical construction of the motor difficult and expensive; and thirdly, there is much idle wire. As already stated, the stator coils of all motors are wound either in holes or slots, and for all usual sizes of motor these coils can be wire-wound with rectangular coils. With single and two-phase motors employing wire or cable-wound rectangular coils, there will be two ranges of coils, one range consisting of simple rectangular coils with straight ends, the other range consisting of precisely similar coils, but with bent ends. Thus each phase of the motor (with single-phasers the starting coils, occupying not more than one-third of the total winding space, may be regarded as the second phase of the motor) will be made up of coils of definite shape, the coils of one phase being bent, at the ends, up and over the coils of the other phase, in order to clear them; from this arises the workshop terms of the "straight phase" and the "bent phase," as applied to two-phase and single-phase motors. With the latter type of motor, the starting phase is invariably the bent phase, from motives of convenience in winding. With two-phase and single-phase motors, it is usual to wind all the poles; that is, considering one-phase only, the coils of this will be wound alternately right and left-handed with regard to the direction of the current in them, that is, they will be cross-connected in the usual manner. It is clear that for three phase stators having rectangular coils, it would be a great practical advantage if they could also be arranged for two sets of coils, as with three sets the

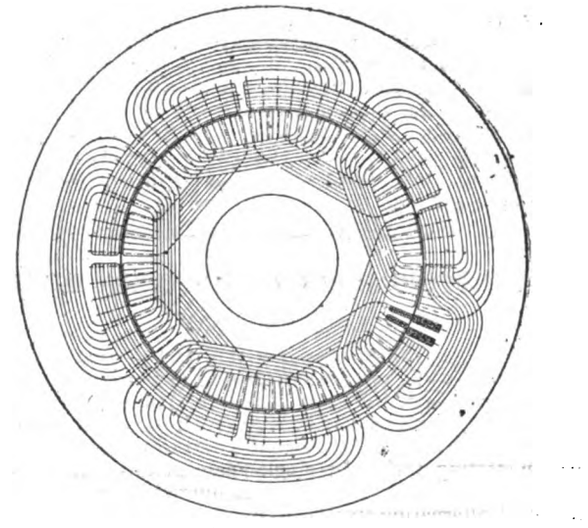

FIG. 3.

crossings of the phases at the ends are not only a source of danger (from the insulation point of view), but prevent damaged coils from being easily repaired. Moreover, if each set is in a different plane, there is no possibility of removing the rotor without removing the "bent down" coils, unless the stator core is built up in sections—a quite inadmissible construction. Consequently, for all three-phase stators for motors of standard sizes, and for all high-tension motors, the coils of the various phases are always arranged in two sets, just as for two-phase motors, the coils of a given phase being alternately bent and straight. But in order to do this, and at the same time preserve the proper phase-relation and pitch of the coils, an important modification of the winding has to be made, namely, only poles of the same sign are wound, in each phase. For instance, considering one phase only, there will be as many coils as there are *pairs of poles*, and all coils will be precisely similar with regard to the direction of winding and to the manner of connecting them up. This winding, which simply leaves each alternate pole unwound and doubles the number of turns on the wound poles, is obviously equivalent to the winding referred to above, both electrically and mechanically, but somewhat more copper is required with it, on account of the mean length of turn being greater. It is worthy of note that with such three-phase windings for stators having an odd number of pairs of poles, the winding becomes slightly unsymmetrical at one point, where the end connections of the phases cross one another. This can be readily seen from an inspection of Fig. 3, which shows a six-pole stator. Although for high tension motors, and for very large low-tension motors, this may be an inconvenience, it is not found to present disadvantages in practice for motors of standard sizes and voltages. As a general rule, too, the speeds of high-tension motors can be so chosen

* See, however, previous remarks regarding hole-windings.

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that the number of pairs of poles required is even, while for the large low-tension motors, having an uneven number of pole pairs with bar-windings, it is perfectly safe and allowable to wind the stator with three ranges of coils, the end connector being bent up and back as shown in Fig. 4. Or, should this mode of construction be deemed inadvisable, on account of space for the end connections being limited, or for other reasons, the stator for such large motors can be conveniently and effectively wound with a closed bar-winding. Such a bar-winding, drawn out schematically for a two-phase motor, is shown in Fig. 5, the four-pole case being taken for simplicity. Standard three-phase stators wound with rectangular coils invariably have the coils connected star fashion. Stator bar-windings for large low-tension motors can be, and very frequently are, used with the mesh connection. Combinations of star and mesh are rarely or never found with modern three-phase motors. The number of holes or slots per stator pole per phase has an important bearing upon the design of all induction motors. In order to keep the winding depth down, and to produce an even pole, this number is best made as high as possible—in practice it

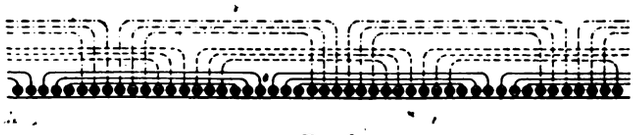

Fig. 4.

varies between four and eight. As is well known, with small motors, having squirrel cage rotor-windings, the number of stator holes or slots should be preferably prime to the number of rotor holes or slots, the latter being, if possible, more numerous than the former, as this tends to prevent a cogging acting action taking place between the stator and rotor fields. The point is, however, of small importance when wound rotors are used. Rotor windings for all induction motors are of two kinds, namely, permanently short-circuited rotors, and rotors having the ends of the windings brought to slip-rings for the purpose of inserting a resistance into the winding at starting. The design and arrangement of these rotors is independent of the number of phases and of the stator voltage, a given rotor serving for a single, two, or three-phase motor, provided that, if slip-rings are used, the number of stator poles is the same in each case, and that the flux per pole in the gap has the same value. There appears to be some difference

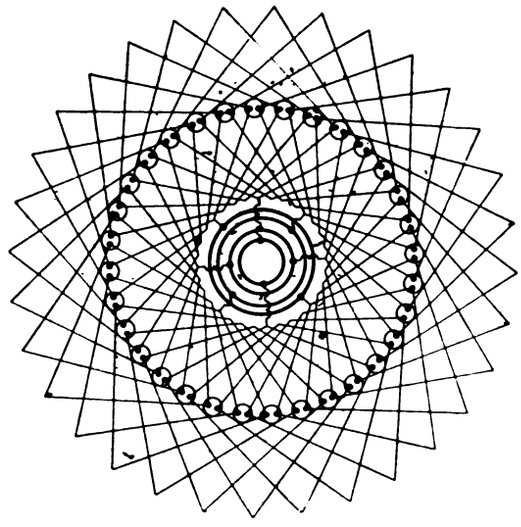

Fig. 5.

of opinion as to how far the permanently short-circuited rotor can be used with satisfactory results—that is, at what output of motor it is best to bring in the starting resistance. For motors having to start against load (apart from crane, elevator, and mining motors), the author is decidedly of opinion that the squirrel-cage construction, or its modifications, should be left behind with all polyphase motors above 5 B.H.P. With single-phase motors, which are usually arranged to start up light, wound rotors with slip-rings should be used after 7½ B.H.P. With the Heyland single-phase motors, referred to at length later on, a starting resistance in the rotor is used for all sizes. If the use of the permanently short-circuited rotor is pushed too far, the pressure regulation of the system, whatever the number of phases, is greatly impaired, owing to the excessive current consumption during the starting up of the motors. When it is considered that the best polyphase motors with squirrel-cage rotors, and starting under full load, require a momentary rush of current equal to at least two and a-half times the full-load current, this statement will be readily believed. It must not be forgotten in this connection, that under such circumstances, the power factor at the moment of starting will be low, with the result that the drop on the transformers, and perhaps even on the generators, is still further increased.

(To be continued.)

CORRESPONDENCE.

DAMAGE TO CABLES BY THE RECENT STORMS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On the 3rd inst. this district experienced the most severe storm known for 18 years. Amongst other damage done, a length of some 40ft. of the wall of our new works was washed away into a clay pit near. The cables supplying current to our foundries for both light and power were supported by this wall, and we enclose a photograph showing the damage done. This photo is particularly interesting at this time, when opinions are divided as to the best form of protection for cables. Simplex enamelled steel conduit was the protection used, and when the stress of the débris came upon the tubes they opened at the joints, and the cables were uninjured, motors giving some 50 H.P. running without interruption. We do not hold a brief for the Simplex Co., but we are of opinion that, if we had employed any form of tube with screwed joints, the cables would have been broken and work in our foundry completely stopped.

We may mention that our pattern stores, which were built next the wall, were completely carried away, the patterns, shelves, roof, &c., being swept through the gap over the cables.—Yours, &c.,

For C. & A. Musker (Ltd.), (W. Arthur Ker, Manager).

Liverpool, Aug. 14, 1900.

ENCLOSED ARC LAMP PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have noticed with surprise the publication in your issue of the 10th inst. of a letter from the secretary of the Jandus Arc Lamp and Electric Co. (Ltd.). The letter has been interpreted by some of my customers and friends as a threatening one, and as such is calculated to injure my business. Mr. Gillies complains that in your publication of the discontinuance of their action against me you have done his company an injustice, but I have every wish to do the fullest possible justice to the Jandus Company.

In the latter part of last year the Jandus Company commenced an action against me alleging infringement of certain of their letters patent, and claiming an injunction, damages, and delivery of the lamps made in infringement. My defence was that I had not infringed their letters patent.

While the matter was before the High Court the Jandus Company repeatedly applied for extensions of time, and apparently exhausted every possible legal method of postponing the date when the action could be set down for trial, and as they failed to set down the action for trial within the extended time allowed, an order was made dismissing the action, and in addition, on June 22, the Jandus Company served a notice (a copy of which I enclose) wholly discontinuing the action.

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Prior to serving the notice of discontinuance repeated efforts were made by or on behalf of the Jandus Company to induce me to accept a licence for a merely nominal consideration, or on a basis of "a union of interests." I absolutely declined to do anything that would involve my accepting, either directly or indirectly, a licence from the Jandus Company.

No proceedings in the nature of a test action or otherwise are at present pending against me; what the intentions of the Jandus Company may be in this respect, I neither know nor care.

The Jandus action against Johnson and Phillips is in no sense parallel with their abortive action against me, for I never was, and never shall be a licensee of the Jandus Company.—Yours, &c., W. J. Davy.

London, Aug. 15.

LEGAL INTELLIGENCE.

Workmen's Compensation.

At the Manchester County Court recently, before Judge Parry, a labourer named Statham applied for compensation, under the Workmen's Compensation Act, from Messrs. Galloways (Ltd.). It appeared that applicant was employed at the branch ironworks of Messrs. Galloway, at Ardwick. On Jan. 25 last he was at his work, which consisted in introducing red-hot rods, or liners, into a machine by which they were made circular in shape. While so employed an apprentice named Kirk, under whose orders he was working, called to him to "come and give him a pull." In order to get to Kirk the applicant passed near some cogwheels in motion, and his foot was crushed, and the injury he sustained would render him practically lame for life. The point for decision was whether, when the accident occurred applicant was acting within the scope of his employment. It appeared that applicant, who was a piece hand, had worked for respondents for six weeks, and his average earnings were 11s. 7d. a week. Applicant admitted that he knew Kirk had no right to ask him to do what he did.

Mr. COBBETT, for the employers, argued that an unauthorised person in the same employment could not, by giving an order, enlarge the scope of employment of the person to whom he gave such order.

In giving judgment, Judge PARRY said that the question, when a superior workman gave an order which, in relation to their work, an inferior workman knew, or ought to know, he should not obey—it being against the rules of the establishment—and injury followed obedience to the order, was the inferior workman outside the Workmen's Compensation Act? The applicant worked with an apprentice, and was bound to obey the apprentice's orders. In a general way, if Kirk, the apprentice, said "Do this," the applicant was bound to do it. He came to the conclusion, in fact, that, at the moment applicant was called and set out to obey the order, he had no idea what he was going to be asked to do, but that upon reaching the machinery and before he stepped over the low wall near the machine, he knew, or at least he ought to have known, that Kirk was meddling with machinery in motion, that Kirk ought not to have ordered him to give any assistance, and that he would be justified in disobeying Kirk's order. The man was not charged with serious and wilful misconduct, but it was said the accident did not arise out of and in the course of his employment. Judge Parry then referred to various decisions, but did not think any of the judgments given really concluded the matter. He understood the Court of Appeal to have said that if a man who knew the scope of his own employment chose to step outside it he stepped at the same time outside the provisions of the Workmen's Compensation Act. But where he was ordered by a superior to do something out of the scope of his employment the case seemed to him (the Judge) different. Supposing applicant had refused, and had pointed to the notice which was posted up, Kirk would probably have told him that the notice only applied to cleaning machinery and not to putting a breakdown in order; was he to argue the matter with Kirk? He thought not, and held that the accident arose "in the course of" his employment, and he thought also it arose "out of" his employment, because all workmen were employed to obey orders and not to argue about them. That the legislature intended such a case as this to be within their scheme of insurance no one could doubt for a moment, and he thought it was still open to him to so interpret the Act as to carry out its intention. There would therefore be judgment for applicant for 12s. a week during incapacity, and costs on scale B.

It was intimated that leave to appeal might be asked for.

At the Leeds County Court recently Judge Greenhow sat as arbitrator under the Workmen's Compensation Act in a claim made by the parents and relatives of a labourer named Briggs, aged 19, who was killed at the works of Messrs. Greenwood & Batley, Armley, near Leeds. There were no disputed facts in the action, but a claim for three years' wages at 10s. per week (being one-half the weekly wage of the deceased) was contested on the ground that the parents and brother of the deceased were not dependent upon him or his earnings within the meaning of the act. Messrs. Greenwood & Batley paid into court £10, the funeral expenses, and held that that was the limit of their liability. Evidence having been put before the judge, he held that the contention of the respondent firm had been made out, and that his finding must be for respondents. The judge ordered the £10 paid into court to be handed to the applicant (the father of the deceased). No costs being asked for by the respondents, there was no order made.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—In the financial estimate of the Watching and Lighting committee for the coming year the expenditure is put at £11,800, an increase of £1,955 over that of the previous year. The increase is due to the extension of electric lighting.

Alleged Theft of Telephone Wire.—At the Birmingham Police Court on Friday Wm. Smith, marine store dealer, Camden-street, Birmingham, was charged with stealing and receiving some copper-bronze wire, the property of the National Telephone Co. During the last 18 months a number of the company's employés have been engaged in taking down many miles of overhead telephone wire in Birmingham, Aston, and Small Heath, and it was alleged that the quantity named came wrongfully into the possession of the prisoner, who stated that he bought the wire. The case was adjourned until Wednesday, when Walter Fraser and Thomas Bishop were also charged with having stolen the wire. Mr. F. E. Smith, for the prosecution, said that it was not proposed to offer any evidence against Bishop, who was accordingly discharged. After hearing evidence, Smith was committed to the sessions, and also on a second charge of receiving a quantity of brass. Fraser was remanded.

Ashton-under-Lyne.—Mr. Robert Hammond has been appointed consulting engineer to report upon the present position of the electricity works. The maximum demand system of charging has been abandoned, and in future a uniform charge of 4½d. per unit will be made for current for lighting.

Aylesbury.—The District Council have petitioned the Local Government Board to allow local authorities to borrow money for electric lighting purposes for a longer period than 25 years, and to postpone the repayment of the principal for three years after borrowing.

Ayr.—Instead of erecting a separate generating station in connection with the proposed electric tramway scheme, it has been decided to accept the Electric Lighting committee's offer to supply current at 1½d. per unit for the first 200,000 units annually, and 1d. per unit above that quantity, the Lighting committee to pay the tramway department compensation at the rate of 9d. per car mile for any stoppages arising from any failure or deficiency in the supply of current. The question of the appointment of the burgh electrical engineer (Mr. A. J. Fuller) to carry out the electrical part of the undertaking is still under consideration, but the surveyor has been instructed to draw up a specification of the committee's requirements in regard to cars, and to invite tenders for 10 cars with complete electrical equipment. The car shed is to be erected at Bellesley Hill.

Ballymena (Ireland).—The Council have received a proposal from Mr. C. C. McCarthy to erect electricity supply works in the district at an estimated cost of £6,000, and a special committee has been appointed to report upon the subject at the next meeting of the Council.

Battle.—The Hastings Tramways Co. have decided to apply for a provisional order to supply electric current for public and private lighting in this district.

Benwell.—Proposals have been made by the Newcastle Tramways committee to extend their electric tramway system into Benwell, but discussion on the subject has been postponed by the District Council.

Beverley.—The Corporation have decided to apply for a provisional electric lighting order. This step has been taken on the advice of the consulting engineer (Mr. A. H. Gibbings).

Bowness.—The Council have decided, by a majority of one, to approve the modified electric tramway scheme recently submitted by the British Electric Traction Co.

Bradford.—The Markets and Fairs committee are to consider the question of lighting the Kirkgate market electrically.

The minutes of the Tramways committee presented at the Council meeting on Tuesday contained a statement with regard to the letters of Messrs. Robert W. Blackwell & Co. (Ltd.), alleging an irregularity in connection with the acceptance of tenders for electric tramway equipment (see *The Electrician* for August 10, p. 613), and with regard to the inquiry which had been made, Ald. Jowett asked whether the tenders referred to by Messrs. Blackwell & Co. had been opened at the Town Hall or elsewhere. The Mayor said that in consequence of great pressure of work the chairman of the Tramways committee (Ald. Cowgill) was unable to attend at the Town Hall, and to save time the tenders were taken on to his office by the Deputy City Surveyor, in order that they might be opened and tabulated for the next meeting of the committee. Ald. Cowgill said that, so far as he was concerned, everything had been as straightforward as possible, and he believed the committee accepted that view. He could not say when the Westgate tramway service would be running, but he expected that it would be within three months. The Listerhills service was practically finished, and an application would shortly be made to the Local Government Board to send down an inspector.

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An electric lighting installation is to be provided for the engineering department of the Municipal Technical College at £594.

Buenos Ayres.—The *Review of the River Plate* announces that La Capital Tramways Co. has acquired the New and the Grand National Tramways companies, and that both systems will be converted to electric traction.

Burgess Hill.—Owing to the differences with the gas company it has been decided to establish electricity works. The principle of electric lighting has been approved by the Council, but whether the works be erected by the Council or a company has not yet been decided.

Cardiff.—The Lighting and Electrical committee resumed the discussion on Friday last regarding the differences which have arisen between members of the electrical staff. Mr. J. E. Teasdel, the deputy electrical engineer, whose name figured prominently in the discussion last week, had written explaining his position in the matter. There seems a disposition on the part of the Council to accept responsibility for their past action in connection with staff appointments at the electricity works. Further discussion on the subject has been adjourned.

A meeting of the Electrical committee was held last week for the purpose of considering tenders for steam pipes. Only one tender was submitted, but Mr. Appelbee read letters from three firms which stated that the time allowed for preparing tenders was not sufficient, consequently it was decided to invite fresh tenders. The contract is advertised in another column.

Carnarvon.—The Council recently had under discussion two rival schemes—one by a London syndicate and the other by Messrs. Bennett & Ward Thomas, of Manchester—for the erection of electricity works and the construction of electric tramways in the district. It has been decided to entertain the proposals of the London syndicate.

Carnoustie.—The Burgh Commissioners have resolved to oppose any application of a company for a provisional order, and information is being collected as to the advisability of establishing municipal electricity works.

Central London Railway and the Omnibus Companies.—In a communication to the *Financial Times*, a correspondent states that the Central London Company's receipts for the first week were £4,323 obtained mainly at the expense of the omnibus proprietors, for the London General and London Road Car Companies between them showed a loss of £2,732, and no doubt the effect was similar with regard to the numerous small combinations of 'buses which run on this hitherto lucrative route. The effect of the new competition on the existing underground lines was hardly appreciable—the District Company had a small decrease of £260, while the Metropolitan continued its series of increases. At the meeting of the London General Omnibus Co. yesterday (Thursday) the Chairman took the matter lightly, and said that the effect of the new railway on them was not great and he anticipated that it would be only temporary.

Chatteris (Cambs.).—In reply to a second communication from the North British Electric Supply Co. for support in their proposed application for a provisional order, the clerk has been instructed to inform the company that the Council favour the principle of electric lighting, and that they would be pleased to meet a representative of the company to discuss matters.

Christchurch.—As the local gas company has declined to make a reduction in the price of gas, the Lighting committee have been instructed to approach the Bournemouth and District Electric Supply Co. in order to obtain estimates for electric lighting.

Crieff (N.B.).—The Town Council have decided to apply for a provisional order and to oppose the application of the North British Electricity Supply Co.

Dalry, N.B.—The Council will oppose the application of the North British Electricity Supply Co. for a provisional order.

Dublin.—A supplemental loan of £10,400, to cover the cost of additional work in connection with the renewal of electric lighting cables, &c., is to be applied for.

Electricity in Mining.—At a meeting of the Mammoth-Collins Gold Mines, Ltd. (Arizona, U.S.A.) last week the chairman (Mr. T. A. Meates) said the company was using wood as fuel. The Government objected to wood being cut on their properties, and they must either face the necessity of burning oil or resort, as he hoped they would, to electricity. Their estimates showed that if they adopted electricity as motive power it would save at least half a dollar per ton on all the ore won from the mine. The cost of an installation was estimated at about $67,000. They hoped to be in a position to put down the machinery by the end of the year. They had acquired water rights; and arrangements were well forward for installing the machinery by at latest the early part of next year.

Electrical Power Scheme in Victoria.—A company is being promoted to acquire certain concessions to generate and supply electric current for lighting, power, and traction in Melbourne and neighbourhood. It is estimated that an initial capital expenditure of £3,000,000 will be necessary, and that ultimately about £7,000,000 will be required. Before operations can be commenced Parliamentary powers and the sanction of the various local authorities to the scheme must be obtained. The company's generating station will be at Wyndham, 11 miles from Melbourne, on the shores of Port Phillip Bay, and mains are to be taken underneath the Yarra through a tunnel. It is also intended to construct 103½ miles of electric tramway in the district not already provided with cable cars.

Friern Barnet (Herts).—The District Council has decided not to join with the other North London local authorities in promoting a joint bill in Parliament embracing electricity supply but will apply for a separate provisional electric lighting order for the district.

Glasgow.—The annual report of the electricity department for the year ended May 31 gives the gross revenue as £59,762, and the working expenditure (including depreciation) £38,181. The balance of £21,580 has been utilised as follows: Interest on loans (£15,256) and sinking fund (£6,285). The net balance of £39 has been placed to reserve. Owing to the large sums paid as interest on money borrowed for new works which are as yet unproductive, it had not been found possible to write off as large an amount in respect of depreciation as in the previous year. The new power stations at Port Dundas and Pollokshaws are in an advanced state, and the report states that about 20 miles of new feeders and 20 miles of distributing mains have been laid during the year on the north side of the Clyde, and 7 miles of feeders and 5 miles of distributing mains on the south side. The undertaking of the Kelvinside Electricity Co. passed into the hands of the Corporation in August last, and the department were now installing new plant of about 1,000 H.P. to meet the rapidly-growing demand in the west end of the city.

The Corporation possess unexhausted borrowing powers under their Gas acts, both for electricity supply and gas, of £306,565 and a bill is to be promoted next session to increase these powers from £2,000,000 to £3,000,000.

Glossop.—An agreement has been entered into with Edmundson's Electricity Corporation, who have already taken a transfer of the electric lighting order, for the transfer of the tramway order. The Council retain power to purchase the tramway undertaking at the end of seven years. The overhead trolley system is to be adopted. The line will be about 4 miles in length.

Imports of Electrical Goods into the United Kingdom.—The accounts relating to the trade and navigation of the United Kingdom show that the value of electrical goods and apparatus imported during July was £129,022, against £86,171 in the preceding month. The total for the seven months ended July 31 was £549,275.

Ironmongery and Hardware Trades Exhibition.—The first annual exhibition of these trades is being held at the Agricultural Hall, London, N., from the 15th to the 25th inst. The exhibition is mainly devoted to the ironmongery, hardware and furniture trades, and the number of electrical exhibits is, consequently, limited. The General Electric Co. have, however, a well-fitted stall, and their exhibit includes electric bells, telephones, arc and incandescent lamps, electric light fittings, cooking apparatus, &c. In addition, a portion of their space is fitted with the necessary plant to show the actual process of manufacturing the "Robertson" lamp. The Renewable Electric Lamp Co. have also an excellent display of their lamps, and Messrs. N. Burt & Co., Coupier & Cie, and Escaré and Denelle (Ltd.) show a large assortment of French and English bronzes, fittings, and art metal work. Messrs. Gent & Co., of Leicester, and James Hinks & Son also exhibit electric light fittings and sundries, and the Meyra Electric Co. have their dry battery on view. Messrs. Crossley Bros., of Openshaw, also exhibit a 19 B.H.P. (type S), and a 12 B.H.P., (type O.E.), gas engine, the latter being used for driving a dynamo for lighting their stand, and is especially suitable for electric lighting work. They also show a 2½ B.H.P. L.L. oil engine.

Light Railway.—The Board of Trade have confirmed the Bourne Valley Light Railway Order.

Luton.—The question of obtaining powers for the construction of tramways has been postponed for twelve months by the Town Council.

Maidenhead.—An inquiry was held here last week into the application of the Council to borrow £25,000 for electric lighting.

Maldon and Coombe (Surrey).—Mr. F. J. Warden-Stevens attended a recent meeting of the Electric Lighting committee to give particulars of the proposed electric lighting scheme. The surveyor has been instructed to supply information as to the number and position of the lamps in the district in order to enable the syndicate for which Mr. Warden-Stevens is acting to submit estimates.

Middlesbrough.—Electric current will be available early in October.

Molesey (Surrey).—The East and West Molesey District Council have received proposals from Callender's Cable Co. and Edmundson's Electricity Corporation for the supply of electric current in the district. Callender's Company are already erecting works in the neighbouring town of Surbiton.

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Morecambe.—Plans and estimates are being prepared by the engineer and manager of the electricity works (Mr. C. F. Parkinson) for the equipment of the lines of the Morecambe Tramways Co. on the overhead trolley system.

Munich.—Electric traction on the overhead system is fast superseding the old horse-traction lines in this city. A uniform charge of 10pf. is made for a journey of any length where no change of cars is involved. The introduction of electric traction on two lines has led to a large increase in car-mileage and traffic, as shown by the following figures :—

	Line A.		Line B.	
	Car-kilometres.	Passengers.	Car-kilometres.	Passengers.
1891-95	322,124	1,190,807	342,671	1,098,163
1895-96	401,230*	1,940,962	400,299†	1,853,897
1896-97	409,021	2,009,674	569,349	2,368 686
1897-98	431,796	2,126,216	672,746	2,791,041

* Electric traction introduced July 1, 1895. † Oct. 23, 1895.

The gas, electric light, water and tramway systems are in the hands of the municipality. At Höllriegelsgereut, on the river Isar, a few miles above Munich, electric supply works, with four turbines, develop 2,000 H.P., provision being made for a further 4,000 H P. The creation of these works has called into being an entirely new industrial district, which is supplied with electric light and power. First Sendling was served, and now 21 other localities near Munich benefit by these works. The experiment of the Isar works has proved a great success, as there are now 90 undertakings, including 25 farms, supplied with light and power. In all there are 151 electric motors aggregating 1,062 H.P., and 21 motors of a total of 267 H.P. in course of erection, besides 13,500 incandescent lamps and 329 arcs for lighting. 86 miles of cables are laid.

Municipal Telephony.—The Glasgow Corporation has, it is announced, already obtained over 2,800 subscribers to their proposed municipal telephone exchange. The subscription is £5. 5s. per annum for an unlimited service.

The General Purposes committee recommend the Huddersfield Corporation to borrow £30,342 for establishing a municipal telephone exchange.

New Storage Battery Company.—A company, entitled the Akkumulatorenwerke Progress (Gesellschaft m.b.H.) with a capital of 300,000 marks, has been formed at Berlin for the purpose of manufacturing and exploiting the Pallavicini accumulator.

Paris Exhibition.—The royal commission has instituted a commercial information office, open daily from 10 a.m. to 5 p.m., for the use, without charge, of British exhibitors, visitors and members of congresses. A spacious office on the Quai d'Orsay is at the disposal of English members attending congresses. A writing room is provided for members of congresses, and information on trade matters will be given. A comprehensive set of customs tariffs, information as to transport by land and sea, books of reference, directories, &c, are available. During the congress letters and telegrams can be addressed to members as follows : Telegrams, "care of 'Britpav,' Paris"; letters, "care of Commercial Information Office, British Royal Pavilion, Quai d'Orsay."

Messrs. Henry Gaze & Sons, tourist agents, under whose auspices the Society of Chemical Industry, the Iron and Steel Institute, and other societies are visiting Paris, will answer inquiries of visitors contemplating a visit to the show. Inquiries should be addressed to Messrs. Gaze at 142, Strand, London, W.C.

Perth.—Negotiations are proceeding between the Police Commissioners and the Caledonian Railway Co. as to the supply of electric current for lighting the company's railway station.

Plymouth.—It is expected that the Compton tramway route will be electrically equipped and ready for opening by the end of the current financial year (March, 1901). The existing car shed at Prince Rock is to be extended to provide accommodation for 28 electric cars for working the Prince Rock, Compton, Hyde Park, Beaumont-road, and (if necessary) the Union-street routes.

Private Bill Legislation, 1900.—During the past session 272 private or local bills were submitted to Parliament, and of these 231 were passed and received Royal assent. Among the rejected measures were the County of London and Brush Provincial Electric Lighting, the Manchester and Liverpool Electric Express Railway, the Shannon Water Power, the Dublin Electric Lighting, the Tyneside Electric Power and the Glasgow and District Tramways bills.

Provisional Order Transfer.—It is proposed to transfer the Borough of Harwich Electric Lighting Order (1892) to the Harwich Electric Lighting and Tramways Co. (Ltd.). The Corporation reserves power to acquire the undertaking at any time within 20 years on certain conditions, and the consideration for the transfer is payment of £300 and costs to the Corporation.

Railway and Tramway Competition.—At the meeting of the Great Northern Railway Co, last week the chairman (the Right Hon. W. L. Jackson, M.P) said there was a decrease in the Yorkshire district of more than 200,000 passengers, and inquiry showed that the loss was due to the opening of electric tramways in competition with the railway at Bradford, Halifax, Homefield, and Queensborough.

Royal Assents.—Royal assent has been given to the Tramways (Ireland) Act and the Manchester Corporation Tramways Act.

Ryde.—An inquiry was held here last week into the application of the District Council to borrow £30,000 for electric lighting purposes. Mr. C. C. Hutchinson appeared in support of the application. He said that up to July, 1896, seven companies had attempted to obtain a provisional order, and afterwards the Ryde Electric Light Co.'s application was rejected by the Board of Trade owing to the opposition of the Corporation. In 1898 the Corporation themselves applied for and obtained an order from which the usual transfer clause was, however, excluded. Evidence having been given by the town clerk (Mr. C. G. Vincent) and the chairman of the Electric Lighting committee (Mr. J. I. Barton), technical details were given by Mr. E. Manville (Messrs. Kincaid, Waller and Manville), who had no doubt as to the financial success of the Corporation scheme. He thought it would be a much more expensive process to purchase the works from a company. What a company distributed in dividends was devoted by a corporation to the relief of rates. The site proposed for the generating station was in a good place for getting coal. The result of the circular sent to ratepayers as to the demand for current was, in his opinion, very satisfactory. He had never had any doubt about the scheme paying in Ryde. Mr. F. W. Randall stated that 973 persons, representing a rateable value of £11,141. 10s. (more than half of the total), had petitioned against the scheme. His association did not object to electric lighting, but they did not wish the Council to take up what they considered a more or less speculative concern, the initial expenditure in connection with which ought, they thought, to be borne by a company. Mr. Hutchinson, in reply, characterised the opposition as instigated by those wishing to see a company in Ryde. The Board of Trade granted the order without a transfer clause evidently intending that the Corporation should not be able to depute their powers.

Rhyl.—Permission to borrow £15,250 for electric lighting, and £6,750 for refuse destructor works, has been obtained by the Council.

Salford.—Thirty-four applications were received for the position of borough electrical engineer, and from these the Electric Light committee selected five, viz. :—Mr. Neville Appelbee (Cardiff), Mr. H. Parker (Wolverhampton), Mr. S. J. Watson (Bury, Lancs.), Mr. A. A. Day (Manchester), and Mr. J. Moss (Eccles). It has been decided to recommend the appointment of Mr. Appelbee.

Scarborough.—A deputation, consisting of Ald. N. Smith, the Mayor (Councillor Darley), and the ex-mayor (Councillor Pirie), has been appointed to meet the directors of the Scarborough Electric Supply Co. (Ltd.) to discuss the question of the purchase of the company's undertaking.

Ship Lighting.—The New Royal Indian marine steamer "Hardinge" has been provided with a complete electric lighting installation. In addition to the lighting, electric bells and telephones, electrically-propelled fans are employed for ventilating.

Smethwick.—A committee has been appointed to report upon the question of erecting electricity supply works and of constructing electric tramways in this district.

South Africa Telegraphs.—In the Cape Colony Budget for 1900-1901 the allowance for the maintenance of telegraphs is put at £14,500. This is an increase of £10,000 over the previous year, and includes a portion of the cost of repairs to wires destroyed during the war.

Southport.—Sanction is sought for a loan of £1,900 for lighting London, Chapel, and Eastbank-streets by arc lamps.

Stretford.—The Council have come to an arrangement with the Manchester Corporation with regard to the construction and working of electric tramways in the district. The lease of the existing and authorised tramways is to be for 21 years, the cost of buying out the Carriage Company, together with the cost of reconstruction, to be repaid to the Stretford Council by the Manchester Corporation during the period of the lease, the Corporation, in respect of electrical equipment, to pay 6 per cent. per annum on the capital outlay, the Corporation to pay all rates and maintain the tramways and electrical equipment, any dispute to be decided by the Board of Trade.

Sudbury.—The Town Council have committed themselves to an electric lighting scheme, and application is to be made to the Local Government Board for borrowing powers. The Council recently sent out 1,200 circulars to ratepayers on the electric lighting question, but only 255 replies were received. Of these 186 (representing an equivalent of about 4,000 8 c.p. lamps) were in favour of the work being carried out by the Council, 20 were neutral, and 49 against.

The "Journal."—Part No. 146 of the *Journal* of the Institution of Electrical Engineers is now ready. The list of contents is given in an advertisement.

Water-power Utilisation in Bohemia.—Electricity works are to be erected in Thurmitz, North Bohemia, by Messrs. B. Egger & Co., Vienna. Water-power will be utilised in the generation of current.

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Wellingborough.—A provisional electric lighting order is to be applied for by the Council.

Weston-super-Mare.—Contracts for plant, &c., have been placed by the Weston-super-Mare and District Electric Light Co., and the work of laying mains is being proceeded with.

Worsley.—Application is to be made for a provisional electric lighting order, and inquiries are being made as to the advisability of also applying for powers to construct electric tramways.

Yeadon.—The Town Council had a conference with their consulting engineer (Mr. W. C. C. Hawtayne) on Tuesday, in regard to the electric lighting question, and eventually it was decided to take a plebiscite of householders in the compulsory area to ascertain the number of lights likely to be taken up and the whole subject will shortly be discussed at a ratepayers' meeting. Electric current would be supplied at 5d. per unit.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date) a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made quite complete. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is the most complete and correct book of its kind ever published in any language.

"THE ELECTRICIAN" READING CASE.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"THE ALTERNATE CURRENT TRANSFORMER."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"LABORATORY NOTES AND FORMS."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"ARMATURE WINDING OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

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"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—Edited by F. C. Raphael. *Nearly ready.*

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TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]

TENDERS INVITED.

Aberdeen Town Council invite offers for 35 tons steel tie-bars for tramway rails; also 20 tons 1in. diameter fish-bolts and nuts, as per specification, &c., which may be obtained from the engineer (Mr. Wm. Dyack). Tenders must be lodged at the burgh surveyor's office, Town House, Aberdeen, by noon of 24th inst. An advertisement contains further particulars.

Aberdeen Town Council also invite tenders for 650 tons of steel girder straight-track tramway rails, 150 tons steel girder curve track rails, and 60 tons fish plates. Specifications may be obtained from the engineer (Mr. William Dyack), Town House, Aberdeen. An advertisement contains further particulars, and tenders must be lodged at the borough surveyor's office by noon of Friday, 24th inst.

Aberdeen Electric Lighting committee invite tenders for 12 months supply of paper or fibre insulated lead-covered feeder, distributing and service cables, electricity meters and house main fuse boxes. Specification may be obtained from the city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, and tenders must be in by 28th inst. An advertisement contains further particulars.

Aberdeen Tramways committee also invite tenders for the supply of steel poles, bases, and brackets for extensions of their overhead system of tramways. Tenders by noon 25th inst.

Southampton Guardians invite tenders for the erection and completion of electrical plant, and an installation for the lighting of the new workhouse infirmary at Shirley Warren, in accordance with the plans of the consulting engineer (Mr. J. G. W. Aldridge), 9, Victoria-street, Westminster, S.W. Plans, &c., may be inspected at the offices of either the electrical engineer or the architects (Messrs. W. H. Mitchell, Son, & Goddard), 9, Portland-street, Southampton. An advertisement contains further particulars, and tenders must be delivered at the offices of the clerk (Mr. David P. Gwillim), St. Mary-street, Southampton, by noon of Tuesday, Sept. 11.

Whitby District Council invite tenders for the supply and erection of electricity generating plant, some particulars of which are set out in an advertisement. Specification may be obtained at the offices of the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster. Tenders, addressed to the clerk (Mr. Wm. Seaton Gray), Council's offices, Whitby, must be in before noon of Sept. 3.

Hackney (London) Electric Lighting committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, arc lamps, meters, travelling crane, and workshop equipment. Specification, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, S.W., after 22nd inst, and tenders, addressed to the vestry clerk (Mr. George Grocott), Town Hall, Hackney, must be in by 4 p.m. of Sept. 12. Further particulars are given in an advertisement.

Newcastle-upon-Tyne New Tramways committee invite tenders for conduits and holes for poles. An advertisement contains further particulars, and specifications may be obtained after 17th inst. from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester. Tenders (addressed to committee) must be delivered at the office of the town clerk (Mr. Hill Motum) by noon of 31st inst.

Newcastle-on-Tyne Corporation invite tenders for constructing about 5 miles of double-track tramway. Tenders to New Tramways committee by 22nd inst.

Shipley (Yorks.) District Council invite tenders for steam and exhaust pipes, storage battery, switchboard and connections, and cables. An advertisement contains additional particulars, and specifications may be viewed (but not obtained) at the offices of the consulting engineer (Mr. Robt. C. Quin), Electricity Works, Blackpool. Tenders must be addressed to the clerk (Mr. Jno. Rhodes), and be in by 27th inst.

Cardiff Corporation invite tenders for the supply, delivery and fixing of sundry pipes, feed water heater, &c., at the Corporation electricity works. An advertisement gives further particulars, and tenders must be delivered at the offices of the town clerk (Mr. J. L. Wheatley), Town Hall, Cardiff, before Friday, 31st inst.

Nelson Corporation invite tenders for a 200kw. steam dynamo. Specifications, &c., may be obtained from the engineer (Mr. A. Allen), Gas Works, Nelson, and tenders must be sent to the town clerk (Mr. R. M. Prescott), Town Hall, Nelson, by Sept. 8. Further particulars are set out in an advertisement.

Ilford District Council invite offers from firms willing to take up "free" wiring in their district. An advertisement contains some further particulars, and applications, addressed to the clerk to the Council (Mr. John W. Benton), must be delivered before noon of 29th inst.

Hanley Electric Lighting committee invite tenders for two Lancashire boilers and fittings; water-tank, girders, and pumps; fuel economiser, with engine or motor; smoke chimney, exhaust fan, with engine, &c; feed water heater, forced draught fittings, fire bars or other appliances to boiler furnaces, and coal conveyor and bunkers. Tenders to borough engineer and surveyor before 25th inst.

Central Electric Supply Co. invite tenders for dry back marine boilers with mountings, feed and drain pipes, &c. (or, alternatively, water-tube boilers). Tenders to general manager (Mr. F. J. Walker), 19, Carnaby-street, London W., by 10 a.m. Aug. 20.

Manchester Electricity committee invite tenders for work and materials required in the erection of the electricity generating station at Bloom-street. Tenders to chairman of committee by 21st inst.

Manchester Tramways committee invite tenders for cast-iron bases for tramway poles. Specification can be obtained from the general manager (Mr. J. M. McElroy), and tenders, addressed to chairman of committee, must be in by 25th inst.

Bristol Electrical committee invite tenders for foundations, &c, at their new Avonbank electricity works. Tenders to secretary, Temple Bock, Bristol, by Sept. 4.

Salford Corporation invite tenders for the supply and erection of lighting switchboard, traction switchboard, and balancing transformer. Tenders to town clerk by Sept. 3.

London County Council Asylums committee invite tenders for boilers, engines, dynamos, &c., at Horton Estate, Epsom, Surrey. Tenders to committee, 6, Waterloo-place, S.W., by 10 a.m. of Sept. 22.

Portsmouth Corporation invite tenders for plant and apparatus for the equipment of their proposed tramway power station. Tenders to town clerk by 10 a.m. of Sept. 4.

Fulham (London) Vestry invite tenders for wiring the Town Hall. Tenders to clerk, Town Hall, Walham Green, London, S.W., by 4 p.m., 24th inst.

Worthing Corporation invite tenders for the supply and erection of electricity generating plant. Tenders to town clerk's office by noon of Sept. 3.

Plumstead (London) Vestry invite tenders for electricity generating plant. Tenders to Vestry Clerk, Vestry Hall, Maxey-road, Plumstead, S.E., by Sept. 19.

Glasgow Corporation invite tenders for the reconstruction of tramways, and the construction of new tramways. Tenders to town clerk by 24th inst.

Newport (Mon.) Guardians require tenders for the electric lighting of their new workhouse, Stow Hill. Tenders to clerk by 22nd inst.

Luton Town Council require tenders for watt and demand meters. Tenders to town clerk by Sept. 14.

Dorking District Council invite offers for leasing their provisional order. Tenders to clerk by 30th inst.

Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment. Tenders to clerk by 31st inst.

Worksop Council invite tenders for the erection of electricity station buildings. Tenders by noon 27th inst.

Rochdale General Purposes committee invite tenders for wiring Town Hall. Tenders by 22nd inst.

Tenders are invited for the public lighting of *Limavady* (Ireland) from Sept. 1 to April 15. Tenders to clerk by 18th inst.

Tenders are invited until 30th inst. by *Dusseldorf* Municipal Council for two 4-ton and two 3-ton overhead electric travelling cranes. Tenders to Die Oberbürgermeister, Stadtbauamt III., Dusseldorf.

The *French Post and Telegraph authorities* invite tenders until 23rd inst. for 430 tons of bronze or copper wire. Particulars from and tenders to le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

The *Roumanian Post and Telegraph authorities*, Bucharest, invite tenders until 24th inst. for 40 tons of galvanised iron wire.

TENDERS RECEIVED AND ACCEPTED.

Blackpool Corporation have accepted the following tenders for the supply of apparatus for the equipment of the Marton electric tramway:—

Leeds Steel Works, rails.
Askham Bros. and Wilson, points and crossings.
Leonard Cooper, patent jointing materials.
Lowdon Bros., trolley poles, storage battery, boosters and switchboard.
St. Helens Cable Co., cables and trolley wire.

The total amount of the tenders is about £27,000.

Larne District Council have entered into an agreement with the Larne Electric Light Works (Ltd.) for the lighting of the town for three years from the 1st inst.

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Portsmouth Corporation have decided to purchase a new Parsons 500kw. turbo-alternator at £5,360, to meet the winter load of 1901.

The tender of Messrs. Shalders and Davis has been accepted by the Southampton Council for the electricity generating plant, wiring, &c., for the electric lighting of Brookwood Asylum at £5,600.

Sheffield Corporation have accepted the tender of the Electric Construction Co. for the supply of transformers for twelve months at schedule rates.

We learn that no tenders were received by the Barnes District Council for the wiring of premises in the district on the easy payment system.

APPOINTMENTS VACANT AND FILLED.

A demonstrator is required to take charge of the laboratory classes in elementary electrical engineering and physical laboratory work, &c., at the City and Guilds Technical College, Leonard-street, London, E.C. Applications to Prof. Silvanus P. Thompson.

The tramways department of the Glasgow Corporation require a first-class mechanical engineer to take charge of the steam plant and general oversight of the tramways power station. Salary £250 per annum. An advertisement gives further particulars, and applications have to be sent to Mr. John Young, general manager, 88, Renfield-street, Glasgow, by Aug. 20.

Hull Electric Lighting committee have vacancies for two electrical improvers. Applications to the Chairman of committee, Town Hall, Hull, by noon of 23rd inst. Mr. A. S. Barnard is city electrical engineer. See advertisement.

A meter reader is required at Sunderland electricity works. Applications to borough electrical engineer, Mr. J. F. C. Snell. See advertisement.

An assistant is required in the distributing engineer's department of the Charing Cross and Strand Electricity Supply Corporation (Ltd.). See advertisement.

A demonstrator and assistant lecturer in physics is required at the University College, Sheffield. Applications by 25th inst.

Mr. R. W. Liddell, Leith, has been appointed chief clerk at the Fulham (London) electricity works at £140 per annum.

BUSINESS NOTICES.

Mr. A. R. Bennett, consulting telephone engineer, has removed from 44, Manor Park, Harlesden, London, N.W., and until further notice his address will be 55, West Regent-street, Glasgow.

Messrs. W. A. Shaw and E. A. Shaw (trading as William A. Shaw & Co.), electrical engineers, Warren-street, Stockport, have dissolved partnership. Debts by Mr. W. A. Shaw.

The Renewable Electric Light Co. (Ltd.), Brunswick-place, City-road, London, N., announce that the equipment of their factory, and the preparations for the supply of renewable lamps of from 8 c.p. to 50 c.p. are now completed, and they are in a position to supply lamps in large quantities.

Though Mr. W. H. Chantrey (Messrs. Blakemore, Chantrey & Co.), 57, Moorgate-street, E.C., was recently appointed receiver and manager of the British Blahnik Arc Light Co. (Ltd.) we are informed that the works are being continued as hitherto.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of W. C. Bersey & Co. (Ltd.) will be held at 32, North-street, Manchester-square, London, W., on Sept. 17, to receive an account of the winding-up.

Meetings of creditors and contributories of the Gutta Percha Corporation (Ltd.) will be held on 24th inst., at 33, Carey-street, London, W.C., at 11 o'clock and 12 o'clock respectively.

The Sussmann Electric Miners' Lamp Co. (Ltd.) is to be wound up voluntarily for reconstruction purposes, and Mr. R. Warner has been appointed liquidator with authority to consent to the registration of a new company with the old name.

A meeting will be held at 17, Grey-street, Newcastle-on-Tyne, on Sept. 17, to receive an account of the winding-up of the Dargue Acetylene Gas and Electrical Co. (Ltd.).

In the bankruptcy of W. A. Charles and J. S. Blackwell (trading as the Central Electrical and Engineering Co.), 74 and 111, Church-gate, Leicester, and 22, Kennington-road, London, S.E., the trustee has been released.

Following are the principal creditors in the bankruptcy of Leonard Francis, electrical engineer, 13, Corporation-road, Southwold :—

Beanland, Perkin & Co...	£89	9 10	General Electric Co. ...	£15	0 0
A. C. Wells & Co...	73	0 0	Young and Marten	13	0 10
United Asbestos Co. ...	28	2 10			

The liabilities are £275. 13s. 7d., and assets £167. 9s.

Plant for Sale.—Messrs. Wheatley Kirk, Price & Co. announce in an advertisement the sale by public auction, at Ormonde Works, Hornchurch-road, Romford, Essex, on Tuesday and Wednesday 28th and 29th inst, of a large quantity of high-class engineering plant, machinery, shafting, loose tools and utensils, accessories, &c. Catalogues may be obtained of the liquidator, Mr. Wm. Hutton, 39, Bennett's-hill, Birmingham; of Messrs. Hargreaves & Heaton, solicitors, Waterloo-street, Birmingham; or of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester. The sale commences each morning at 11 a.m.

The Derby Corporation have two 60kw. sets, an exciter set and an exciter for sale. An advertisement contains additional particulars, and further information can be had from the borough electrical engineer (Mr. T. P. Wilmshurst), Electric Light Station, Sowter-road, Derby.

Messrs. Claridge, Son and Rennie, engineering, metal and allied trades auctioneers and valuers, 5, Waterloo-street, Birmingham, have been instructed by Thomas Smith's Stamping Works to sell by auction, at 176, Aston Brook-street, Aston, Birmingham, on Thursday, 23rd inst., at 11 o'clock, a quantity of electrical plant and machinery, including 27 electric motors, some cable, switchboards, voltmeters, raw-hide pinions, stamping and engineering plant, a 32 H.P. Robey steam engine, Lancashire boiler and boiler tank, pumps, engineers' tools, &c. Further particulars are given in an advertisement.

Works for Sale.—Freehold works, suitable for electrical engineering, motor car works, &c., are advertised in another column. Particulars from Mr. Goddard, auctioneer, Wolverhampton.

Patent Amendment.—Notice is given in an advertisement that Mr. H. C. Woltereck, 25, Whiteley-street, New York, U.S.A. (at present of 82, Victoria-street, London, S.W.), has applied for leave to amend specification of letters patent No. 2,382 of 1899 for "Improvements in the Manufacture of Pigments." Notice of opposition must be given by Sept. 1.

Chapman Voltage Regulator.—Messrs. Geipel and Lange inform us that they have been appointed sole agents in this country for the Chapman voltage regulator, which has been used here for keeping the voltage constant under the conditions met with in motor installations.

Engineers' Supplies.—Messrs. Poth, Hille & Co., of Leadenhall-street, E.C., forward particulars and prices of "Empress" self-vulcanising jointing, steam packings, belting, engineers' stores, &c.

"Fast-Grip" Vices.—We have received from Messrs. George Harrison & Co., Ure Bank Engine Works, Ripon, a new catalogue of improved "fast-grip" parallel vices, for which great holding power and quickness in opening and closing are claimed to be combined. These vices are now manufactured in batches to standard gauges. The illustrations accompanying the catalogue show the method of construction and the means adopted to secure the best results with a minimum of skilled labour.

General Electric Apparatus and Material.—We referred in our issue of July 27 to the sections of the General Electric Company's complete catalogue describing multipolar motors and lift controllers and motor driven starters for presses, lathes, tools, &c. We should have mentioned that copies of these two inserts for the main catalogue can be obtained by consulting engineers and contractors free on application pending the issue of a new edition of the complete catalogue now in preparation. A new catalogue of wires and cables, conduits, cases, and wiring sundries has just been issued. Copies of this well-arranged list will be forwarded to the trade post free on request.

B.T.H. Plant.—Pamphlet No. 71, issued by the British Thomson-Houston Co., describes the Thomson tramway and portable recording wattmeters.

Tubes and Fittings.—A revised edition of the price list of wrought iron and steel tubes and fittings, trolley poles, telegraph and telephone poles, &c., manufactured by Messrs. John Spencer (Ltd.), of Wednesbury and Great St. Thomas Apostle, London, is just issued and can be obtained post free on request.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 9 to Aug. 14, with the ports of destination :—

Africa—Beira, £4,510 (telegraph material); Cape Town, £252; Durban, £526; East London, £663; Port Elizabeth, £160. *Australasia*—Adelaide, £60; Fremantle, £415 (including £85 telegraph material); Launceston, £105; Melbourne, £1,206 (telegraph cable); Sydney, £968; Wellington, £253. *Brazil*—Rio Janeiro, £242 (telegraph material). *China*—Shanghai, £406. *Germany*—Hamburg, £1,450 (including £1,250 telegraph material). *Gibraltar*, £400 (telegraph material). *Holland*—Amsterdam, £60; Rotterdam, £250 (telegraph material). *Hong Kong*—£85. *India*—Bombay, £500; Calcutta, £61 (including £8 telegraph material). *Norway*—Christiania, £50 (telegraph wire). *Straits Settlements*—Singapore, £61. *Sweden*—Stockholm, £783 (telegraph material). *Turkey*—Constantinople, £45 (telegraph material). *West Indies*—Trinidad, £45. Total £13,556, against £11,887 for the corresponding six days last year (Aug. 10 to Aug. 15).

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PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

May 30, 1900.

9,962. G. W. MONEY. London. Improvements in or relating to alternate-current induction motors.
9,971. E. JAHR. London. An improved method of utilising electrical earth currents.
9,975. R. GRISSON. London. Improvements in electrical transformers.
9,988. G. D. MONACO. London. Electric signalling device for preventing railway collisions.

May 31, 1900.

10,001. C. W. DAWSON. Leeds. An improved method and means for controlling the speed of electric motors.
10,022. M. GAUGHREN. Glasgow. Improvements in electric tramways or railways on a conduit system.
10,026. J. GARVIE. London. Electrical appliance for working pile drivers.
10,029. N. W. STORER. London. Improvements relating to the distribution of electric current. (Date applied for under Patents, &c., Act, 1883, sec. 103, Nov. 1, 1899, being date of application in United States.)
10,031. E. W. BOHLE and H. BOHLE. Birmingham. Improvements in arc lamps and in the manufacture of the same.
10,074. F. C. NEWELL. London. Improvements in electric brakes.
10,075. J. W. MARTIN. Liverpool. Improvements in or in connection with trolley or like current collectors for electric railways and tramways.
10,081. I. KITSEE. London. Electric fuse.

June 1, 1900.

10,121. C. ADAMS-RANDALL. London. Improvements in electrically-propelled velocipedes, carriages, and other like vehicles.
10,124. J. E. KINGSBURY. London. Calling appliances for telephone switchboards. (The Western Electric Co., United States.)
10,133. T. DUNCAN. London. Improvements in and relating to electric meters.*
10,134. T. DUNCAN. London. Improvements in electric meters.*
10,137. R. KRAYN. London. Improvements in or connected with electric lamps.*
10,141. G. B. BOWELL. London. Improvements in or relating to electric switches.
10,142. D. MURRAY. London. Improvements in printing telegraph apparatus.*

June 2, 1900.

10,172. T. PREECE. Blackburn. Improvements in apparatus for starting and controlling electric motors.
10,181. C. E. GRIFFING. Glasgow. Electrical steam boiler.*
10,197. K. A. WILDE. London. Improvements in electrodes.
10,210. E. G. DAHL. London. Improved electrical apparatus for closing steam supply valves from a distance and giving an audible signal.*
10,214. J. A. MCMULLEN. London. Improvements relating to electrical ignition devices applicable to internal-combustion and like engines and to other purposes.
10,219. W. L. WISE. London. Improvements in electricity meters* (Lux'sche Industriewerke Actiengesellschaft, Germany.)*
10,221. E. CHADWICK. London. Electrical alarm for automatic fire-extinguishing sprinkler installations. (H. Tetlow, Russia.)
10,230. L. BACHELIN. London. An improved arrangement of underground mercury contact for electric railways and tramways.

June 5, 1900.

10,270. G. EVANS. South Wales. Improved low-tension exploder or electric shot-firing battery.
10,273. H. J. HADDAN. London. Improvements in controller regulators for electric motors. (The Garton Daniels Co., United States of America.)*
10,312. C. E. WILSON. London. Improvements in and connected with wireless telegraphy.*
10,318. J. C. FELL. London. Improvements in electric storage batteries and conducting plates therefor. (S. L. Wiegand, United States.)*
10,319. J. C. FELL. London. Improvements in electric storage batteries. (S. L. Wiegand, United States.)*
10,323. H. CASSIBER. London. Improvements in telephone cables and in apparatus for producing same.*
10,326. B. SHAW. London. Improvements in or relating to electrical stop-gear for steam and other engines or machinery.

June 6, 1900.

10,348. J. V. D. PLOEG. Glasgow. Electro-magnetic machine.*
10,357. J. J. HYNES and P. M. RANDALL. London. Improvements in and relating to electrical apparatus for surgical and other purposes.*
10,361. J. A. HALFORD. London. An improved flexible electrical conductor from any point of which a current may be taken.
10,362. J. A. HALFORD. London. Improvements in caps for glow lamps.
10,363. J. A. HALFORD. London. Improvements in electric contacts.
10,375. J. GARASSINO. London. Improvements in the construction of plates for accumulators or secondary batteries discharging heavy currents.

June 7, 1900.

10,423. S. F. EDGE and F. WILLS. London. Improvements relating to electric ignition devices for internal combustion or explosion engines.
10,437. A. MACKENZIE. London. Improvements in or relating to electrodes for batteries.
10,444. G. PATROUILLEAU. London. Improvements in or connected with electric incandescent lamps of the refractory conductor type.*

June 8, 1900.

10,451. A. H. MAYES. Hove. A containing box for electrical resistance material.
10,460. A. RIED. Liverpool. Improvements in or connected with electric cars.
10,476. A. BRAUN (trading as A. Braun & Co. and the Erste Osterreichische Motor-Fahrzeuge-Fabrik). London. An improved adjustable electric igniter or spark producer.*
10,498. W. R. RIDINGS and VERITYS LIMITED. London. Improvements in switches.
10,502. G. RITTER. Liverpool. Improvements in telephone systems.*
10,509. N. N. HAIGH and B. SHORE. London. Improvements in electrical switches.
10,511. THE ELECTRICAL POWER STORAGE CO. (LTD.), H. W. BUTLER, and J. H. MAY. London. Improvements in the manufacture of negative or spongy lead plates, or elements for secondary batteries or electrical accumulators.

June 9, 1900.

10,542. H. OPPENHEIMER. London. Improvements in and connected with electric wall plugs. (Actiengesellschaft Mix & Genest, Germany.)
10,543. H. OPPENHEIMER. London. Arrangement for limiting the length of the fuse of electric cutouts. (Actiengesellschaft Mix & Genest, Germany.)
10,544. H. OPPENHEIMER. London. Improvements in and connected with quick-break switches. (Actiengesellschaft Mix & Genest, Germany.)
10,545. H. OPPENHEIMER. London. Improvements in and connected with switches or keys for electric lampholders. (Actiengesellschaft Mix & Genest, Germany.)
10,550. W. E. EVANS. London. Improvements in and relating to ammeters. (Gaus & Goldschmidt, Germany.)
10,579. SIEMENS BROS. & CO. (LTD.). London. Improvements in and relating to electrically-controlled apparatus for shifting and locking railway points. (Siemens & Halske Actien Gesellschaft, Germany.)*
10,580. O. IMRAY. London. Improvements in electric furnaces of great power. (F. Morani, Italy.)
10,587. W. H. ARUNDELL. London. Improvements in feeding and regulating mechanism for electric arc lamps.

June 11, 1900.

10,606. A. D. SMITH. Bradford. Improvements in electrical fuse boxes.
10,612. F. W. MARTIN, F. STEWART, J. M. BROWN, and N. G. BOGGS. Canada. Improvements in arc lamps.
10,616. L. D. TILLYER and E. D. TILLYER. London. Electric bell striking apparatus. (Date applied for under Patents, &c. Act, 1883, sec. 103, Nov. 17, 1899, being date of application in United States.)
10,638. W. P. THOMPSON. London. Improvements in or appertaining to motor starters. (The Fraser Electric Elevator Co., United States.)
10,639. W. P. THOMPSON. London. Improvements in or appertaining to controllers. (The Fraser Electric Elevator Co., United States.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

11,172. VERITYS LIMITED and STEELE. Apparatus for controlling electric currents especially applicable for charging secondary batteries or accumulators.
11,506. FLEMING. Carbons for electric arc lamps.
12,789. WEINMAR. Telephone systems.
13,280. SMITH. Channel rails and current supply for electric tramways.
14,033. DUNN and BROMHEAD. Means for constructing a thermopile and for utilising solar rays and other energy for the purpose of generating, transmitting, storing, and using thermo-electricity.
14,235. HOEFT. Apparatus for measuring time by electricity.
14,569. SAYERS. Dynamos.
15,135. HOLLINS and LEAKE. Electrical clock arrangement and apparatus.
15,178. CHAPLIN. Brushes of dynamos.
15,440. VON RECKLINGHAUSEN, VOGT and NERNST ELECTRIC LIGHT (LTD.). Electric incandescent lamps.
15,644. KÜPPER and VORREITER. Electrical ignition apparatus.
15,720. CROMPTON & CO. (LTD.), HODGSON and TUBBS. Electrical arc lamps.
18,870. BOULT (Jungbluth). Manufacture of electrical insulating material.
10,682. ANDREWS. Telephonic appliances.
10,697. LE ROND. Rotary engines for continuous current applicable either as a motor or as a pump for gas vapour or liquids. (Date applied for under International Convention, Oct. 22, 1898.)
10,903. WISE (Crehore and Squier). Telegraphic transmitters and receivers.
11,345. FRIESE-GREENE and KNELL. Cartridges to be fixed by electrici

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COMPANIES' MEETINGS AND REPORTS.

Chili Telephone Co. (Ltd.).

The eleventh ordinary general meeting was held on Friday last, Mr. GEORGE KEITH presiding.

The SECRETARY (Mr. Edmund Petley) read the notice calling the meeting, and the report of the Directors and the accounts were taken as read.

The CHAIRMAN said: Gentlemen, our business in Chili has improved very considerably during the past year. The gross revenue has increased by $51,442, and the total expenses have been reduced by $10,681. The decrease in the expenses is certainly very satisfactory, more especially as the first half of the year was not favourable for economical working. The unprecedented storms and inundations which took place in Chili last winter—that is, our summer here—did great damage all over the country, and made the maintenance of our service both difficult and expensive. The decrease now shown in the expenses was effected during the second half of the year, and was accompanied with a large increase of revenue. The exchange was also in our favour. The mean rate for the previous year was 14¼d., and for the past year it was 15⅛d. With these improvements the income in Chili amounts to £18,130, showing an increase for the year of £4,764. The London expenses and charges remain practically unaltered, with the exception of the item in connection with the debenture issue. The bonds falling due on March 31 last year were renewed on the same terms and conditions for five years until March 31, 1904, and the cost of doing this, amounting to £347, now appears amongst the expenses of the year. The debenture issue remains unaltered at £56,000, and there is no change in the interest payable. The result of the year's business is that after deducting all expenses and charges and adding transfer fees and the amount brought forward from the preceding year, we have a credit balance of £12,847. Of this amount the Directors have placed £3,044 to reserve, and recommend a dividend for the year of 4 per cent., free of tax, absorbing £8,800, and carrying forward £1,003. All things considered I think you will agree that the result is very satisfactory. Much uncertainty existed during the year as to whether Chili would issue more paper money and give up the metallic conversion of the currency, the suspension of which was brought about by the monetary crisis of 1898. This had the effect of keeping down the exchange at which the profits of the year were remitted to this country. Fortunately, towards the end of the year the situation improved. Chili is now adhering to a sound money policy, and there is every prospect that the law of July 28, 1898, will be duly carried out, re-establishing in 1902 the gold currency with the value of the dollar at 18d. The exchange has lately been very firm and now stands at 17¼d., and our sterling profits for the same number of dollars are now much better than they were last year. As regards the plant, the capital outlay for the past year amounts to £1,798 expended on erecting and equipping new lines. Some considerable alterations have now become necessary in order to maintain the efficiency of our service at Santiago, which will increase our expenditure there for some time to come. Otherwise our plant as a whole is in very good order and requires no exceptional expenditure to be incurred upon it. As regards the management in Chili, you may be interested to know that a change has taken place during the past year. In October our former manager, being desirous to return home, resigned. Since then Mr. Antonio Huneeus, who was for some years connected with our business as legal adviser at Santiago, has been our representative, and arranging most successfully for us all matters affecting the interests of the Company; and Mr. William Johnston, our new general superintendent, has been in entire charge of the staff and practical working of the business. I have great pleasure in expressing our appreciation of the able and successful services which these gentlemen are rendering the Company. Altogether our business is in good form, and the present year, as far as it has gone, is showing very good results. I now move the adoption of the report and accounts.

The motion was carried unanimously without discussion.

A resolution approving the dividend was also carried.

Mr. J. R. BAILLIE said that he would like to ask whether the Company made any alteration as regarded the rates that they charged for subscribers to the telephone, in order to compensate for the fall in exchange, or whether they charged a permanent figure; whether, for instance, the subscribers in Valparaiso were only charged a fixed annual amount? He felt that the subscribers ought to pay more when there was a depreciated exchange in order to recoup the Company, because other business people made alterations in the prices under different circumstances to fit in with the fluctuations of the exchange, which affected the price of copper and nitrate and the various other products of Chili.

The CHAIRMAN pointed out that the Company dealt with people many of whom were not much affected by the question of the fluctuations in the rate of exchange. It was a matter which really only affected remittances between Chili and England. The people there looked upon a dollar as a dollar. If they charged a subscriber say $120 when they had only been in the habit of charging him $100, he would say that they had raised the price of the service, whether it was due to the fall of exchange or not.

Mr. George Keith was then re-elected a Director, the auditor was re-appointed, and a cordial vote of thanks to the Chairman and Directors terminated the proceedings.

LIVERPOOL OVERHEAD RAILWAY CO.—The half-yearly meeting was held at Liverpool on Tuesday. The chairman (Sir W. B. Forwood) congratulated the shareholders upon the satisfactory half-year's work. The overhead railway had, he said, been in operation for seven years, and they had steadily built up their prosperity until they had placed the company upon a permanent basis. They had done a great deal for the trade of the port, and had given increased facilities for moving about the docks and removing the congestion of the streets. They had carried 58,000,000 passengers, and their trains had run 5,000,000 miles, and this without any serious accident. During the past half-year they had earned £38,021, against £36,492 in the corresponding half of last year. They had spent £25,113, against £24,924. The proportion of expenditure to revenue was 61·71 per cent., against last year's 64·44 per cent. Now they carried forward to their net revenue account £12,909. From last half-year's account they had brought forward only £4,591. The balance they had to deal with was £17,602, and after paying debenture interest (£3,400) £14,202 was available to pay the dividend on the 5 per cent. preference shares, absorbing £3,000, and at the rate of 3 per cent. per annum on the ordinary shares, which would amount to £6,750. The balance forward to next half-year was £4,452, against £4,320. 8s. 3d. He felt he could congratulate the shareholders upon their being one of the three railway companies who had been able so far to pay an increased dividend for the past half-year. They had carried an increased sum to reserve for the renewal of boilers, machinery at the generating station, permanent way, &c., of £1,500, against £1,300. Their expenditure had increased a little on running and traffic expenses by the increased mileage they had run of 14,500. The increased cost of coal had not been felt during the past half-year, owing to their having had a cheap contract, but the present contract would tell upon them, because they were paying now almost double the price. The company was still holding the record for punctuality, 97·3 of their trains having during the past half-year been up to time. The tramway system taken over had been opened as far as the Five Lamps at Waterloo. They had been operating on this portion of the line for four or five weeks, with very satisfactory results, both in regard to local traffic and the extent to which the tram line had fed their own railway. They hoped to extend the line to Crosby towards the end of next month. The bill which the directors had received permission to promote in Parliament had received the Royal assent, but they had had to eliminate from it the power to increase the size of the Pierhead station, as the Liverpool Corporation offered strenuous opposition in regard to that clause, and they thought it better to drop it. Their idea was to introduce shortly a 2½-minute service of trains between the Pierhead and the North-end. They thought this would give practically a movable platform to the north end of the dock system, and give greater facilities to the trade of the port. However, the Liverpool Corporation did not take the same view of the matter as the directors had done, and they had had to abandon the scheme. He was pleased to state that the batteries which they were providing for improving the lighting of their service were nearly completed, and he hoped that next winter they would have all their trains thoroughly well lighted. Their new train for accelerating their traffic by 15 minutes was nearly completed. That would be an economy to them in working expenses, for they would employ fewer trains, whilst greater facilities would be given to the traders of the port. He thought no one would have cause for complaint as to speed when they covered a distance of 6½ miles with 15 stoppages, in 20 minutes. They had also to consider a proposal for working a mineral traffic over their line at night time, and he hoped that this would take practical effect.

NEW COMPANIES, STATUTORY RETURNS, &c.

JOHNSON ELECTRO-GERMICIDE CO. (LTD.)—This company was registered on Aug. 9, with a capital of £2,000 in £1 shares, to acquire from C. M. Johnson the benefit of an invention for destroying disease germs, together with the electrical generating machine and apparatus at his research laboratory, and to carry on the business of electrical and other apparatus manufacturers, &c.

PRIESTMAN BROS. (LTD.)—This company was registered on Aug. 9, with a capital of £13,000 in £1 shares, to acquire the business of Priestman Bros., and to carry on the business of electrical and general engineers, electricians, founders, tool makers, &c. The first directors are Sir James Reckitt, Bart., I. Milner, C. Wardlow, G. V. Maxted, E. Hanger, and J. R. Whamond.

SPENCER AND COOK (LTD.)—This company was registered on Aug. 11, with a capital of £5,000 in £1 shares (4,000 preference), to carry on the business of mechanical, electrical, and consulting engineers, boiler makers, &c. The first directors are D. R. Spencer, T. Cook, N. Spencer, W. H. Cook, and B. Goodfellow.

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)—The annual return to July 20 gives the capital as £400,000, in 80,000 shares of £5 each, 40,000 of which have been taken up. £5 has been called up and paid on each of 26,800 shares; £65,000 is considered as paid on the remaining 13,200 shares. The capital was increased from £200,000 to the present amount on the 6th ult.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—According to the annual return to July 10, the capital is £200,000 in 39,900 ordinary and 100 founders' shares of £5 each, of which 20,000 ordinary and all the founders' have been taken up. £1 has been called up on each ordinary and £5 on each of the founders' shares.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The annual return to July 17 has been filed. The capital is £500,000 in 40,000 preference and 60,000 ordinary shares of £5 each, of which 40,000 preference and 58,000 ordinary have been taken up. £5 per share has been called up on 16,639 preference and 42,000 ordinary, and £2 on 23,361 preference shares.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The annual return to July 3 gives the capital as £400,000, in 40,000 shares of £10 each, 23,109 of which have been taken up. £10 has been called up and paid on each share.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28 1/8d. per oz. (Aug. 16). Consols (2¾ per cent.) 98 1/16—98 3/8 for money, 98 7/8—99 for account; 2½ per cent. 97½—98 (Aug. 16). Stocks and Shares Continuation Days, Aug. 28 and Sep. 12; Ticket Days, Aug. 29 and Sep. 13; Pay Days, Aug. 30 and Sep. 14; Mining Share Carry-over Days, Aug. 27 and Sep. 11.

BLACKPOOL AND FLEETWOOD TRAMROAD CO.—The report for half-year ended June 30, states that, including last half-year's balance the profit, after paying debenture interest, is £4,265. 5s. 11d., and the directors recommend a dividend at the rate of 4 per cent. per annum, absorbing £3,000, writing off £100. 19s. 1d. from Parliamentary expenses £169. 7s. 6d. from preliminary expenses, and £500 for depreciation, leaving £494. 19s. 4d. to be carried forward. The number of passengers carried during the half-year was 660,006, and the gross receipts were £10,125. 17s. 2d.

CAVE HILL AND WHITEWELL TRAMWAY CO. (LTD.)—An extraordinary meeting was held at Belfast last week, when the proposal of the British Electric Traction Co. for the conversion of the line to electric traction was approved.

FRISWELL'S AUTOMOBILE PALACE (LTD.)—During the week this company, which has a share capital of £40,000, has invited subscriptions for capital.

LEAMINGTON AND WARWICK TRAMWAYS CO. (LTD.).—The report of the directors for the year ended June 30 states that a provisional order for the working of the tramway by electric traction in Warwick has been obtained, and negotiations are pending with the Corporation of Leamington with a view to acquire a similar order for that borough. When the requisite powers had been obtained the arrangements for converting the line into an electric tramway would involve the winding-up of the existing company.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has been asked to allow the further issue of 1,600 £10 fully-paid 5 per cent. non-cumulative preference shares (Nos. 37,001 to 38,600) of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Aug. 11	4,399	+ 427	5	22,994	+ 1,024
Blackpool Corporation...	„ 9	1,374	+ 59	19	14,087	+ 2,979
Blackpool and Fleetwood	„ 11	1,904	- 263	6	7,787	- 194
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 12	503	+ 32	19	9,503	+ 1,779
Brisbane Trams	June 27	1,672	+ 293	25	45,910	+12,839
*Bristol Trams & Carriage	Aug. 10	4,061	- 428	6	21,487	- 476
*Buenos Ayres & Belgrano	July 15	2,376	+ 109	2	4,602	- 130
Central London Railway	Aug. 11	5,042	+ 719	2	9,365	...
City & South London Ry.	„ 12	1,555	+ 522	6	9,001	+ 3,314
Cork Elec. Trams	„ 9	521	- 24	32	12,662	+ 1,198
Dover Corporation	„ 11	316	- 18	19	4,287	+ 313
Dublin & Lucan Rly. ...	„ 11	102	- 4	6	697	+ 125
Dublin United	„ 10	3,758	+ 130	6	23,754	+ 2206
Dublin Southern Dist....	„ 10	999	- 285	6	6,591	
*Glasgow Corporation ...	„ 11	8,827	- 242	...	...	...
Hull Corporation	„ 11	1,356	+ 661	6	8 076	+ 5,626
*Liverpool Corporation...	„ 4	8,596	- 79	31	232,376	+27,077
Liverpool Overhead Rly.	„ 12	1,876	- 198	6	10,375	+ 308
*Sheffield Tramways	„ 12	2,515	+ 987	32	68,063	+23,522

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 8.		Price Wednesday, Aug. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 15. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	...		...		...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£832,720	Stock	15/0	Anglo-American	59	62	58	61	6 0 11	Feb., May, Aug., Nov.	...	...
£2,068,640	Stock	20/0	Do. Preferred	110⅛	111½	110½	111½	5 7 7	„ „	111⅝	110½
£2,068,640	Stock	27/0	Do. Deferred	12	12⅛	12	12⅛	10 16 0	„ „	12⅛	12⅛
$12,333,300	$100	$1½	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101	103	101	103	3 17 0	„ „	101½	...
16,000	10	6/0	Cuba Submarine Ordinary	6⅛	7⅛	6⅛	7⅛	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15	16	15	16	6 5 0	„ „	15	...
12,981	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	100⅞	101⅞	100⅞	101⅞	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	11½	11⅝	11	11½	6 1 9	Jan., Apr., July, Oct.	11⅝	11½
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	101	99	101	4 8 0	June and December ...	...	...
£4,000,000	Stock	6⅝/0	Eastern Ordinary	145	150	145	150	4 13 4	Jan., Apr., July, Oct.	147½	145
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	93	99	93	99	3 10 8	„ „	...	...
£1,482,266	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111	116	111	116	3 9 0	May and November ...	111½	...
260,000	10	2/6	Eastern Extension.....	14⅛	15	14½	15½	4 11 10	Jan., Apr., July, Oct.	15½	14½
£330,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110	115	110	115	3 9 7	February and August	..	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 6	February and August	99	...
£300,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) ..	103⅞	103⅞	103⅞	104⅞	3 17 8	May and November ...	...	...
120,227	10	4/6	Globe Telegraph and Trust x1	11⅛	11⅜	11	11⅛	4 11 10	Jan., Apr., July, Oct.	11⅜	11⅛
120,042	10	3/0	Do. 6 per Cent. Preference	15	15⅛	14⅞	15⅛	3 19 0	„ „	1 ⅛	15
150,000	10	5/0	Great Northern of Copenhagen	31	33	31	33	3 15 9	January and July.....	32	...
£94,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	99	101	99	101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	52	56	52	56	4 9 3	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105	109	105	109	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100	103	100	103	3 17 9	June and December ...	...	...
11,839	8	4/0	Reuter's.....	7⅛	8⅛	7⅛	8⅛	4 14 1	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125	130	125	130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2⅛	3⅛	2⅛	3⅛	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	93	101	93	101	5 0 4	March and September	...	...
30,000	2½	...	West Coast of America.....	⅛	1	⅛	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 14 7	January and July.....	...	...
32,321	10	1/0	West India and Panama	⅜	⅞	⅜	⅞	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6⅛	7⅛	6⅛	7⅛	8 0 0	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6	7	6	7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102	103	102	103	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	...		...		4 15 3	June and December ...	...	...
207,980	10	2/0	Western Telegraph (late Brazilian Submarine)	14¾	15¼	14¾	15¼	4 11 10	Mar., June, Oct., Dec.	15⅛	15
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103	106	103	106	4 14 4	June and December ...	...	...
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid) x1	2⅜	3⅛	2⅜	3⅛	5 14 4	August	...	...
324,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...		...		...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛	¼	⅛	¼	5 0 0	November	...	...
98,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„ „	...	...
490,000	5	3/0	National	4⅜	5	4⅜	4⅞	6 3 1	February and August	4⅞	4⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	12	14	13	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12	14	12	14	4 5 9	„ „	1 ⅛	13½
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	4⅛	5⅛	4⅛	5⅛	4 17 7	„ „	5 1/16	4⅛
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97	100	97	100	3 10 0	June and December ...	93½	99
171,504	1	0/6	Oriental	⅞	1⅛	⅞	1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4¾	5⅛	4¾	5⅛	6 13 4	July	5 1/16	...
16,639	5	2/6	Do. 5% Cumulative Preference.....	5	5⅛	5	5⅛	4 10 11	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104	107	104	107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Aug. 8.		Price Wednesday, Aug. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 15.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'n & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾	¾	¾	¾	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref. xd	10	11	9½	10½	4 5 9	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord xd	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference ....xd	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6	6½	6	6½	...	...	6¼	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp. xd	9½	10	9	10	4 12 6	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference ....xd	5½	6½	5	5½	4 1 10	,, ,,	...	...
24,000	5	2/6	Chelsea Electricity Supply Ordinary	6½	7½	6½	7½	4 0 0	March	...	...
£180,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108	111	103	111	4 1 6	June and December...	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) ...	100	110	100	110	4 10 11	April and October.....	...	...
70,579	10	9/0	City of London Electric Lighting Ord.	8	9	7½	8½	4 14 2	February and August	8 7/8	7½
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 16 0	January and July.....	12¾	12½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) ...	123	133	123	128	3 18 5	June and December ..	135	...
40,000	10	4/0	County of London and Brush Prov. Ordinary... ..xd	8	9	8½	9½	6 6 4	...	9⅛	8⅛
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference.....	12	13	11	12	5 0 0	March and September	11¾	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107	110	107	110	4 1 3	...	109	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½	7	6½	7	4 2 7	January and July.....	...	...
110,000	3	...	London Electric Supply Ordinary	1	1½	1	1½	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	4 1/16	...
£260,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98	102	93	100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord.	14½	15½	14	15	3 13 4	April and October	15½	15½
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage xd	111	114	111	114	3 18 11	June and December ...	...	...
£135,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96	99	93	98	3 11 6	...	93	93
6,452	10	6/0	Notting Hill Electric Ordinary ....xd & nxw	15½	16½	15	16	4 7 6	March	...	..
10,000	5	5/0	Oxford Electric Ordinary	5½	6½	5½	6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric .... xd	7/8	1 1/16	7/8	1 1/16	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb....	75	85	75	85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165	185	165	185	4 6 6	April and October.....	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures ...	104	107	104	107	4 4 1	,, ,,	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14	15	14	15	4 16 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8	9	8	9	3 17 8	,, ,,	8½	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85	95	85	95	4 4 3	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3	4	3	4	...	...	3 7/16	...
79,200	5	5/0	Westminster Electric Supply Ordinary .....xd	12	13	12	13	5 0 0	March and September	12¾	12½
29,437	5	...	Do. £1 10s. paid	8½	9½	8½	9½	...	...	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.								
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.....xd	¾	1⅛	¾	1⅛	4 8 11	...	...	...
20,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	2	3	2	3	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	...		...		...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	...		1/16	1/8	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	...		97	99	4 4 2	...	...	...
140,000	5	5/0	British Insulated Wire Ordinary	11½	12½	11½	12½	4 0 0	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5½	6½	5½	6½	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4½	5½	4½	5½	...	...	...	...
90,060	2	1/3½	Brush Electrical Engineering	1½	1⅝	1½	1⅝	4 5 4	September	...	...
50,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum. ....xd	2½	2⅝	2	2½	5 6 8	,,	2⅝	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108	113	108	112	4 1 1	February and August	...	...
$108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	103	101	103	4 7 5	June and December ...	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13	14	13	14	5 7 2	,, ,,	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	5⅝	5½	5⅝	4 6 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	114	110	114	3 19 11	November and May ...	...	...
100,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1	1⅛	1	1⅛	6 8 0	...	...	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97	100	97	100	4 10 0	...	90½	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1	1¼	1	1¼	5 6 8	...	...	...
32,098	3	2/6⅜	Crompton and Co. (Nos. 1 to 32,098) .....xd	3½	4½	3½	4½	5 5 10	January and July.....	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.) ..	99	102	99	103	4 19 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref..... ..	¾	1⅛	¾	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid) xd	2	2½	1⅞	2⅛	8 0 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid) ....xd	3½	4½	3⅝	4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91	93	91	93	4 6 0	June and December ...	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	63	73	63	73	...	...	...	...
26,100	5	6/0	Edmundson's Electric Corporation Ord. (fully pd.)...	4½	5	4½	5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	103	4 8 3	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	1⅞	2⅛	1⅞	2⅛	5 13 11	January and July.....	2	1⅞
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛	3⅛	2⅛	3⅛	4 6 2	July	...	...
£162,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104	105	102	105	3 16 2	January and July... ..	103	102½
30,000	5	11/0	Henley's Telegraph Works Ordinary	13	14	13	14	6 15 9	February and August	...	...
20,000	5	1/6	Do. 4½ per Cent. Preference	5½	5⅝	5	5⅛	4 1 10	,, ,,	1⅛	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) ...	110	114	110	114	3 13 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	,, ,,	2 1/16	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101	104	101	104	3 17 10	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	35	39	35	39	4 12 4	March and July	39⅜	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101	104	101	104	3 18 11	January and July	...	...
30,000	5	9/0	Do. Manufacturing Ordinary	10	11	10½	11½	5 4 4	...	11	10⅜
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	5⅝	5½	5⅝	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½	11½	10⅜	11⅜	5 4 4	April and October.....	11½	10⅜
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½	7	6⅜	7	4 5 9	,, ,,	6⅝	6⅜
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures ...	105	107	105	107	4 0 4	May and November ...	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	10/0	Blackpool and Fleetwood Tramways	17	19	17	18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures.....	103	105	103	105	4 17 1	...	10⅝	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary .....xd	22	23	22	23½	3 3 10	February and August	23	23
25,000	10	4%	Do. Cumulative Preference (fully pd)	10½	11½	10⅜	11⅜	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	120	118	120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½	10⅝	10⅜	10⅝	4 13 0	May and November ..	10⅝	...
45,000	10	1/0	British Elec. Trac. Ord.	14	15	14	15	4 0 0	...	14⅜	...
50,000	10	6/0	Do. 6% Cum. Pref. ....xd	12	13	12	13	4 12 4	February and August	12⅝	12 1/16
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123	123	123	123	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	121	124	121	124	...	...	13⅜	12⅜
40,000	5	2/8 3/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref..... ..	4⅞	5⅛	4⅞	5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4	4⅛	4	4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	105	103	103	4 15 0	...	106	...
£120,000	Stock	18/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) ..	95	99	96	99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10	10⅛	10	10⅛	2 17 2	June and December ...	10⅛	10⅛
£855,000	Stock	1¾%	City and South London Railway Con. Ordinary xd	56	58	55	58	2 7 2	February and August	56½	55
37,500	10	1/5 1/16	Do. (Nos. 22,501 to 60,000)	6	7	6	6	2 9 4	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) xd	140	145	138	143	3 9 11	,, ,,	...	...
£200,000	Stock	5%	Do. (1898) ....xd	132	137	130	135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120	125	120	125	3 4 5	May and November ...	...	...
20,000	10	8½%	†Imperial Tramways Ordinary .....xd	22	23	21	23	3 6 8	March and September	23½	21
10,000	10	6%	† Do. 6 per Cent. Preference .....xd	14½	15½	14½	15	3 17 5	,, ,,	15	14½
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July.....	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	1/16	⅛	1/16	⅛	...	March and October ...	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.....	1/16	⅛	1/16	⅛	...	,, ,,	...	...
30,000	10	1/8	Kidderminster & District E. L. & Tr'ct'n 5% Pref. ...	...		...		4 17 7	May and November ...	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary.....xd	9½	9⅝	8⅞	9	4 8 11	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference.....xd	13½	13⅝	13	13½	3 15 6	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103	105	103	105	3 16 2	January and July.....	...	...
24,000	5	...	New General Traction Ordinary	3½	3⅝	3½	3⅝	...	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4⅝	5⅛	4⅝	5⅛	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.....	...		...		...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	...		...		...	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½	12½	11½	12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£440,000	Stock	3%	Waterloo and City Ordinary ....xd	90	93	89	92	3 5 3	June and December ...	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote them.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,162. [No. 18. Vol. XLV.] FRIDAY, AUGUST 24, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 30c., or 70pf.

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NOTES.

THE POSTMASTER-GENERAL'S annual report, just issued, for the year 1899–1900, is very satisfactory reading so far as the public service of posts and telegraphs is concerned. But in respect of the latter, its financial condition is as discouraging as ever. Summed up briefly, although the telegraph revenue increased by £200,847, the expenditure also increased by no less than £266,916, resulting in a net deficit of £288,438—or £66,569 more than last year's deficit. On this the customary comment is added: "If allowance be made for interest on the capital created for the purchase of the telegraphs, the deficit on the year is raised to £587,326." Every year this painful fact is rubbed in with unsparing reiteration, but without the least attempt at explanation or expectation of amendment. The returns of revenue and expenditure throw little light on the main subject, though the figures are plain enough—so plain indeed that they may be called ugly. For example, whilst the percentage of salaries, &c., to total revenue in the postal service is 44·52, that in the telegraph service is set down as 65·87. A similar comparison between the cost of conveyance of mails and that of telegraph maintenance gives a percentage respectively of 11·00 and 20·39. A still more remarkable contrast would be shown if the percentage of expenditure on the erection of buildings were furnished for the two services. For sites and buildings last year the telegraphs are credited with over £76,000—a sum which, large as it is, is smaller than any set down under those heads ever since 1894-5. One would like to know where and what those sites and buildings are. These items are over and above those charged under the head of "Telegraph Extensions," which alone amounted to £277,133—nearly £50,000 more than the previous year.

AGAINST these financial shortcomings there is abundant evidence that the telegraph service continues to grow both in efficiency and popularity. The number of telegrams forwarded was 90,415,123—an increase of more than three millions over the previous year. A still greater augmentation of business has taken place over the trunk telephone system, the revenue derivable from which was £191,701—an increase of 14·44 per cent. on the preceding year. The offices open for this class of business now number 299, the trunk lines in use consisting of about 68,657 miles of wire; and 7,250 miles of fresh wire are in course of construction. In this connection the POSTMASTER-GENERAL announces that, besides the license granted to the Corporation of Glasgow last March, he anticipates that in several other places municipal exchanges will shortly be established under licenses. As we have animadverted on the expenditure side of the telegraph account, it is only fair to record that upwards of 870 new telegraph offices were opened during the year, and that the cost of repairing the lines after the great gales and snowstorms of February last amounted to £12,000. The number of telegrams classed under the head of "Foreign" was the highest on record, chiefly due to the South African war. With reference to this the POSTMASTER-GENERAL makes graceful mention of the liberality of the Eastern Telegraph Co., who reduced their rates from 4s. to 2s. per word for telegrams to and from HER MAJESTY'S naval and military forces in the field. That this is no small concession is evidenced by the fact that the average daily number of such telegrams is nearly 150. The same privilege has been recently extended to telegrams between South Africa and India and Australasia.

THE Paper by ROBERT LANG, a translation of which we publish to-day, marks an important advance in that theory of electrons which appears likely to triumph all along the line. It is somewhat strange that after the victory of the wave-theory of light, a corpuscular theory of electricity should oust all its rivals. Yet such an occurrence appears about to take place. Ionic theories are masters of the field in electro-chemistry. The ion has proved one of the most useful

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conceptions of modern physics. It is formed from the molecule by splitting it up into its electro-positive and electro-negative constituents. It promises to be the connecting link between chemistry and electricity, and thus realise the dreams of DAVY and FARADAY. Nobody interested in electrolysis or primary or secondary batteries can nowadays dispense with a thorough knowledge of ionic idiosyncrasies.

BUT when we have no longer to deal with chemical processes, and yet have to account somehow for electric conduction, for cathode rays, Becquerel rays, thermo-electricity, electro-optics, and magnetism, the ion forsakes us, and a new conception has to be introduced. This conception is that of the electron, which stands to the atom in the same relation as the ion does to the molecule. The conception of the electron has been worked out by THOMSON, POYNTING, DRUDE, and others, and may now be said to be fairly concrete. These electrons appear to be able to account for almost every electric phenomenon known. A current in a wire consists of two streams of electrons moving in opposite directions, thus recalling the old two-fluid theory. About 1 atom in every 5,000 is split up into a larger and a smaller portion. The larger portion is positively charged, and the smaller portion negatively. The ratio of the masses is about 9 : 1, and they move about 200 times as fast as the electrolytic ions, the average speed being half a centimetre per second. Their motion produces in the ether the magnetic field with which we are long familiar. When electromagnetic vibrations impinge upon the metal, the electrons are set in violent motion, and in this vibration the incident energy is frittered away—the metal is "opaque." In insulators, the electrons if existing at all, have only a very limited range of vibration. When the metal is an electrode in a vacuum tube, the electrons are projected from the surfaces with velocities comparable to the velocity of light. The negative electrons constitute cathode rays, the positive electrons constitute "canal rays."

IT is when magnetic phenomena, however, are approached that the electron becomes really fascinating. AMPÈRE explained magnetism by the existence of small currents circulating round the molecules of the magnetic metal. These currents, according to ROBERT LANG, are simply convection currents produced by the revolution of the negative electrons round the heavier positive electrons, just like the moon revolves round the earth. Such rotations can only be carried out by electrons having many degrees of freedom, hence magnetism can only be shown to any intensity by substances having spare "valencies" or "links." The explanation of certain chemico-magnetic effects, as well as the Zeeman and thermo-electric effects, follows without much difficulty, and magnetism as a phenomenon distinct from electricity is abolished for ever.

IT remains to follow the electron through all its life history, and to gain some insight into the secret of its charge and motion. LENARD'S production of negative electrons, *vulgo* cathode rays, from a negatively-charged surface by means of ultra-violet light should aid this study considerably. But the greatest help will no doubt be furnished by the phenomena of Becquerel rays, for in this case we have a class of bodies which freely give off negative electrons without being charged at all, and indeed without being supplied with any visible source of energy.

WE are now in the midst of what is sometimes called the "silly season" in the newspaper world. It is a long time, however, since we have seen anything more egregiously silly than the announcement in the *Daily Mail* of last Saturday as to an alleged new discovery by NIKOLA TESLA. We do not know what proportion of the startling announcements frequently made in connection with the name of this electrician is authorised by him, but we hope that for his sake it is a very small one. In the present instance TESLA is reported to have discovered a method of perfectly insulating an electrical conductor by surrounding it with a frozen mixture of water and sawdust in a thin metal tube. This amazing insulator, TESLA is reported to declare, renders possible the transmission of electric power from New York to London. A short while ago TESLA'S schemes were in the ether above the earth's atmosphere. Now they appear to be at the bottom of the Atlantic ocean. We wonder where they will turn up next.

Rathmines Electricity Works.—We are informed that, owing to the indisposition of the Lord-Lieutenant of Ireland, the inaugural ceremony of the new Rathmines electricity works has been postponed from the 24th to the 31st inst.

Electric Light in Pit Sinking.—At an inquest held at St. Helen's on Monday last in connection with an explosion in a colliery, the jury added a rider to their verdict recommending the use of safety lamps or electric lights in pit-sinking.

Lightning and Powder Magazines.—The French Minister of War has invited the Paris Academie des Sciences to advise as to the precautions to be adopted in selecting and planting trees in the neighbourhood of powder magazines in order to protect the magazines from lightning.

Personal.—We note that among the names on the International Board for the Congress on Psychology at the Paris Exhibition are those of Sir William Crookes and Prof. Oliver J. Lodge. It is satisfactory that the physical side of this recondite science is thus safeguarded.

Chefoo-Taku Cable.—The Eastern Extension and Great Northern Telegraph Cos. announce the laying of a submarine cable between Chefoo and Taku, which is now open for traffic, and that arrangements have been made for the early laying of a cable between Chefoo and Shanghai. This will provide submarine telegraphic communication—available for international traffic—entirely independent of the Chinese land-lines, and without any addition to the existing tariffs.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Serena—Valparaiso	Aug. 2, 1900 ...	Aug. 21, 1900
Iquique—Valparaiso	Aug. 2, 1900 ...	Aug. 17, 1900

Wireless Telegraphy at Dover.—The Dover Chamber of Commerce have received promises of support in the action they are taking to get the wireless telegraphy installation connecting the East Goodwin lightship and the shore reinstated. The Chamber have memorialised the Board of Trade and Trinity House, and will bring the question forward at the autumn meeting of the Association of Chambers of Commerce to be held at Paris next month.

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A Substitute for Celluloid.—A new substitute for celluloid for engineering and other industrial purposes is described in a German contemporary. The name of this new substitute is "Marloid," and it seems that it is manufactured from untanned leather boiled in oil. The product is said to resemble celluloid in every respect.

The Calcium Carbide Industry in Bavaria.—In a recently issued Consular report from the second secretary in Her Majesty's Legation at Munich, particulars are given of the growing industries in calcium carbide and acetylene in Bavaria. It is stated that a well-known electrical firm in Nuremberg has acquired water-power at Sarpfoss, in Norway, and also at Glommens, and that other firms have acquired similar rights representing from 20,000 H.P. to 40,000 H.P. for the electrical production of calcium carbide. Acetylene gas is largely used in Bavaria for various lighting purposes. The first acetylene gas works for lighting small towns were erected at Hassfurt, a town of 2,500 inhabitants. There are no less than 26 small towns in Germany thus lighted.

A Boiler Record Book.—A publication which steam users whether on a large or small scale, should find of considerable utility has recently been brought out by the National Boiler and General Insurance Co., of Manchester. This consists of a number of strongly-bound ruled pages for entering particulars of boiler plant, the columns being for records of, among other things, cleanings, inspections, repairs, &c. Between the pages are guard slips for gumming in the Insurance Company's reports from time to time, and also any reports of external or working inspections connected with the history of the boiler. The specimen book sent to us contains 52 pages, with room for 20 entries under each column on each page. It is recommended that a separate page be used for each boiler. The price of the book is 4s. 6d. post free.

Electrical Power Transmission in Sweden.—A large power transmission plant at the Trangfors waterfall at Vöstmanland, Sweden, is described in *Engineering*. The Kolböck river there forms a waterfall of about 33ft. in height, and the installation comprises six 800 H.P. radial turbines each having four wheels of 700 mm. diameter on a horizontal shaft, and making 250 revs. per min. The shafts are direct-coupled to the electric generators. The floor of the engine-room is 10ft. above the lower surface of the water, and the shafts of the turbines are located 4ft. above the floor. The water is led to the turbines through three pipes of 8ft. in diameter. Three turbines directly coupled to the exciters also have horizontal axes, and are each of 25 effective H.P. at 560 revs. per min.; they are otherwise of the same construction as the larger ones. The current from all six generators is conveyed to 18 transformers, where the pressure is raised from 800 volts to 14,000 volts. The transmitting line consists of three 6·75mm. copper wires, supported on porcelain insulators attached to poles placed a ta distance of 166ft.; the poles are of a height making the minimum distance from the lowest wire to the ground 27ft.; lightning dischargers are placed at both ends of the line. On reaching the boundaries of the town of Vesteras, a distance of some 14 miles, the pressure is again reduced by a similar battery of transformers, and distributed to the various consumers. The Northern Metal Company head the list of the consumers, their new works requiring no less than 900 H.P., divided amongst 14 motors, varying from 300 H.P. to 3 H.P. capacity. The motors are all of the inductor type, and the large ones are principally used for the working of rolling mills. The works of the General Swedish Electric Company receive 300 H.P. The power station belongs to the Trangfors Power Company. The water power and the site of the station have been leased for a period of 50 years from the owners, the Hallstahammar Co., Ltd.

Profits on Tramway Undertakings.—At the recent meeting of the Tramways and Light Railways Association at the International Tramways and Light Railways Exhibition, Mr. C. H. Gadsby read a Paper with the above title. As an instance of the increase of receipts by a gradual and judicious adoption of more frequent services, he gave a table showing that on a certain steam tramway, by doubling the mileage in seven years, the number of passengers had been more than doubled as had also the gross receipts, while the working expenses had only increased by about 70 per cent. and the resulting net receipts had been multiplied by 8½. The receipts per car mile had increased from 16·5d. to 17·6d., whilst working expenses had fallen from 11·3d. to 9·3d., and the ratio of working expenses from 68 per cent. to 53 per cent. It was not, however, to be expected that the gross receipts could be increased in the same proportion as the mileage, and consequently as a general rule the receipts per car mile were reduced. This fact, he thought, had in many instances led tramway managers to adopt the policy of restricting the mileages in an endeavour to secure high receipts per car mile. Receipts per car mile on British tramways varied from about 7d. to 2s., and he considered that for electric and cable lines "any rise in receipts per car mile above 9d. should be at once checked by an increased mileage." The author illustrated his argument with the following example:—

> Suppose a system running 1,000,000 car miles per annum with gross receipts at 12d. per car mile. The total gross receipts will then be £50,000 per annum; suppose the working expenses are at 60 per cent., and therefore amount to £30,000 per annum; the net receipts will be £20,000 per annum. Let, now, the mileage be increased 20 per cent., to 1,200,000 car miles per annum, and suppose the total gross receipts increase only at the less ratio of 15 per cent., and that, in consequence of standing and managerial charges being spread over a greater mileage, the working expenses increase only 15 per cent. also. We shall then have the total gross receipts, £57,500 per annum; the total working expenses, £34,500 per annum; and the net receipts, £23,000 per annum. In this case the gross receipts per car mile work out at 11½d.; that is by increasing the mileage 20 per cent. we have reduced the receipts per car mile from 12d. to 11½d., but have at the same time made an extra £3,000 per annum clear profit.

A table was also included in the Paper showing the working expenses for eight (unnamed) electric tramways in this country, some worked by companies, others by municipal owners, but all on the overhead trolley system. The car mileages in one year varied from 135,740 to 1,160,279, the aggregate being 3,016,761, and the average operating expenses in pence per car mile as follows: Maintenance of permanent way, 0·765; motive power, 1·38; repairs of general plant, 0·305; repairs of cars, 0·576; traffic expenses, 2·67; all other expenses, 1·15; total, 6·896. The cost of motive power was, Mr. Gadsby pointed out, much lower than with horses or steam, being only 1·36d. per car mile, or, including engine and dynamo repairs, 1·685d. Car repairs per car mile were about the same as for horse or steam traction, in spite of the repairs of motors and electrical equipments being included, probably because, although the expenditure on each electric car was greater, the daily mileage run by an electric car was also greater. The item for traffic, consisting chiefly of drivers' and conductors' wages, was much the same for all three systems. The total expenses of 6·8d. per car mile was somewhat higher than was generally expected with electric traction, owing to the inclusion in the list of a number of small undertakings recently started. He expected from the many larger municipal undertakings an average total expense between 5d. and 6d. per car mile. On the line in the table with the mileage of 1,160,279, in fact, the total costs were but 5·8d. per car mile, on one with the next largest car mileage of 564,389 they were 5·75d., whilst at Leeds, which was not included in the list, the total working expenses were reported well under 5d. per car mile. Another table giving in detail the operating expenses for 23 American electric roads agreed closely with the results of English working, notwithstanding the very different conditions. Finally, the following table was given of the sizes and number of units of generating plant the author has found suitable for various number of cars in service on electric lines under English conditions:—

No. of cars	5	10	15	20	25	30	35	40	45	50
No. of sets of generating plant including reserve	2	2	2	2	2	2	3	3	3	3
Power of each set in kw.	60	125	175	225	275	300	175	200	200	225

No. of cars	55	60	65	70	75	80	85	90	95	100
No. of sets of generating plant including reserve	3	3	3	3	3	3	3	3	3	3
Power of each set in kw.	250	250	275	275	300	300	325	325	350	350

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SUNDERLAND CORPORATION ELECTRIC TRAMWAYS.

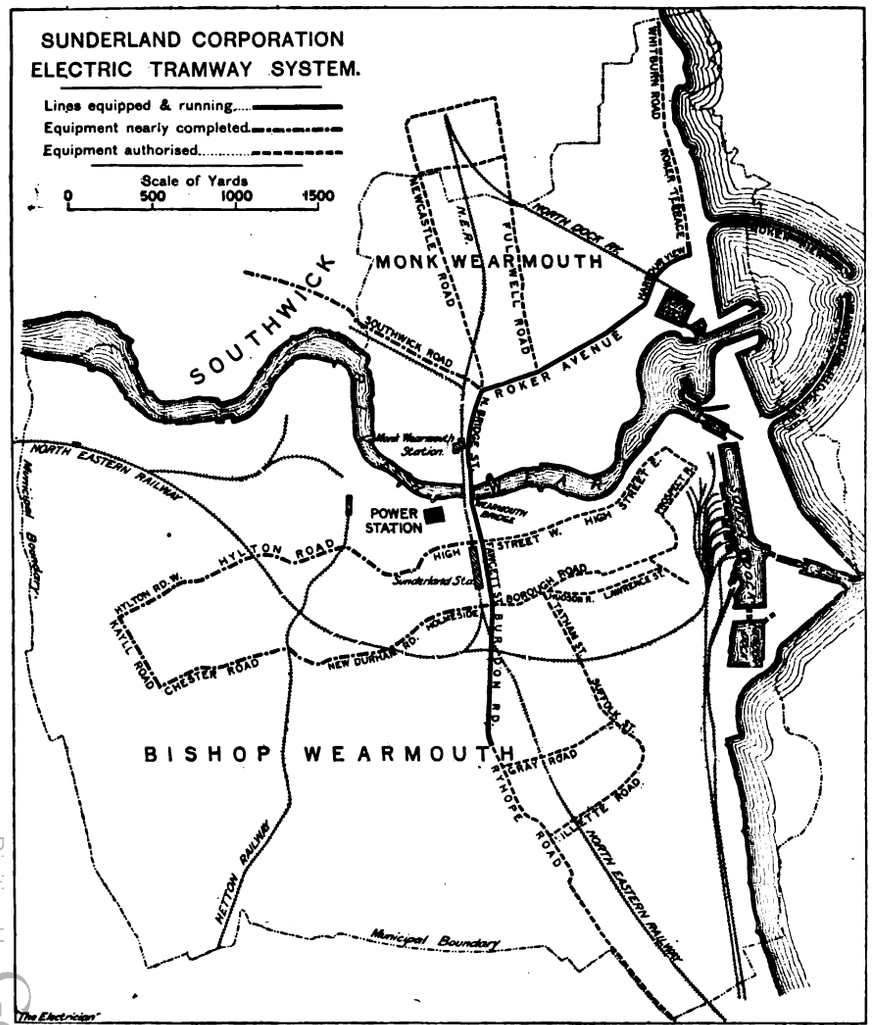

FIG. 1.—MAP OF SUNDERLAND CORPORATION ELECTRIC TRAMWAYS.

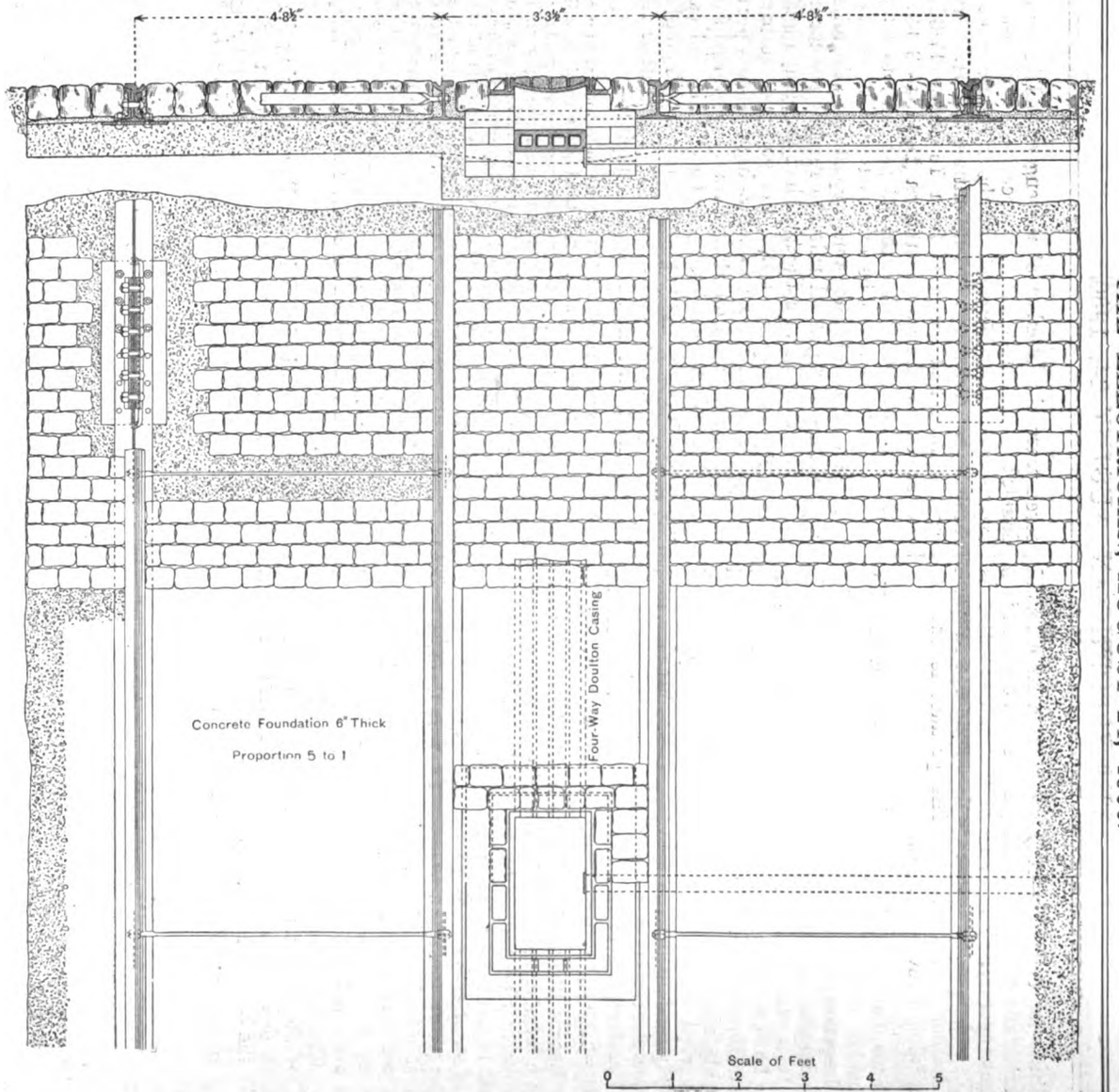

FIG. 2.—PLAN AND SECTION OF TRACKS.

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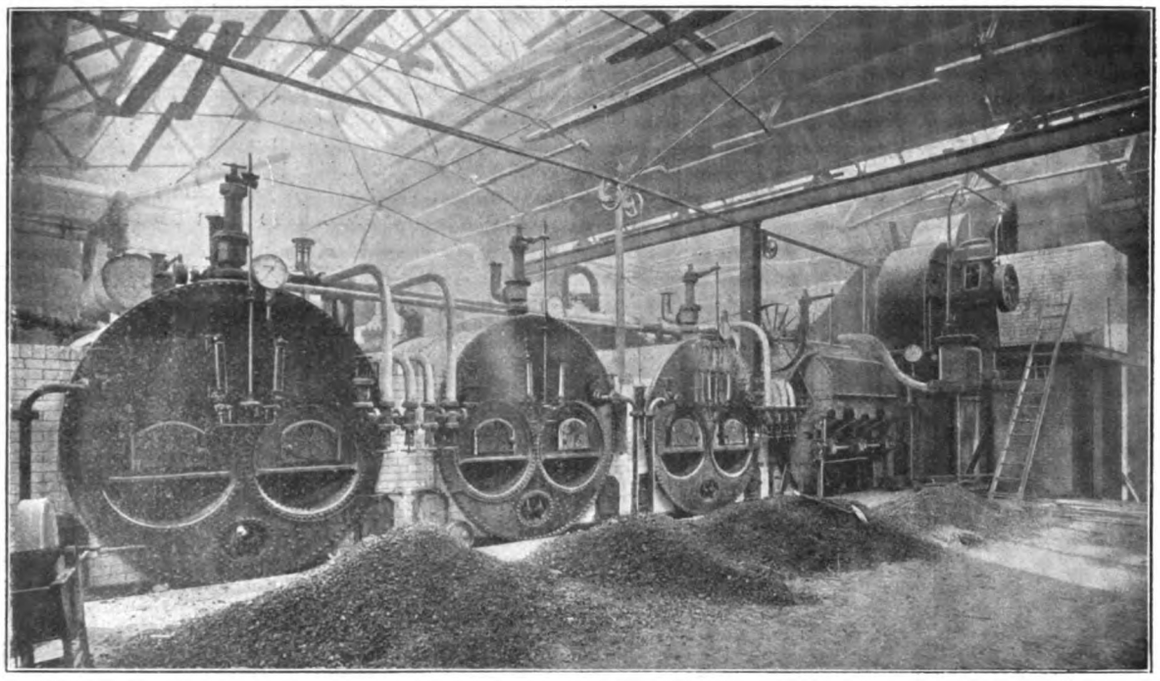
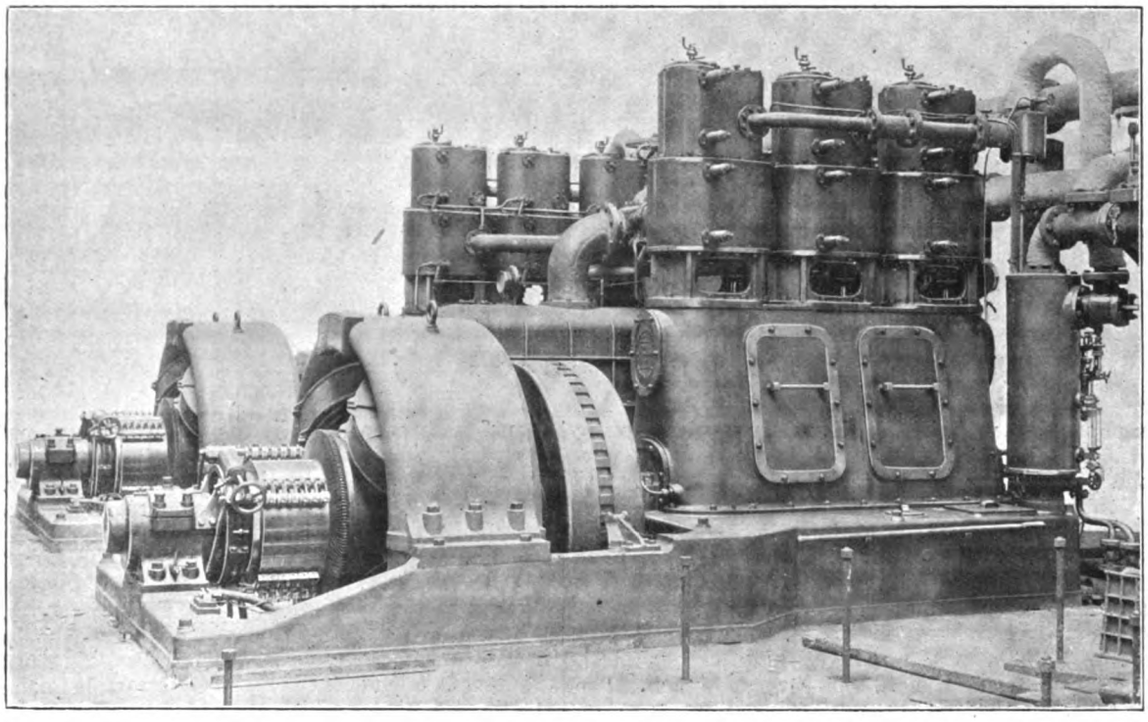
SUNDERLAND CORPORATION ELECTRIC TRAMWAYS.

The nucleus of what will ultimately be an extensive system of municipal electric tramways was formed on Wednesday, the 15th inst., at Sunderland by the opening of some 12·5 miles of electrically-equipped tramway track. Sunderland is an important seaport town situated at the mouth of the River Wear in Durham. It possesses an extensive shipping trade in coal and timber, besides numerous engineering and other industries. The tramway system, when completed as now projected, will connect a large number of busy thoroughfares in the centre of the town and link these with the suburban and seaside districts surrounding the town. Tramways have been in existence in Sunderland since 1879, when the Sunderland Tramways Co. commenced running a few horse cars on a portion of the existing system. The company having acquired powers in 1878 it will be seen that the local authority received powers to compulsorily take over the tramways in 1899. Accordingly in 1898 the Corporation commenced to pay serious attention to the question of municipalising the tramways. A tramways committee was formed and a deputation, including the Mayor of Sunderland and the Corporation electrical engineer, Mr. J. F. C. Snell, visited Hamburg, Brussels, and other cities on a tour of inspection of electrical systems of traction. At the conclusion of this tour the deputation unanimously supported Mr. Snell's recommenda-



SUNDERLAND: INTERIOR OF BOILER HOUSE.



SUNDERLAND: TWO OF THE TRACTION GENERATORS.

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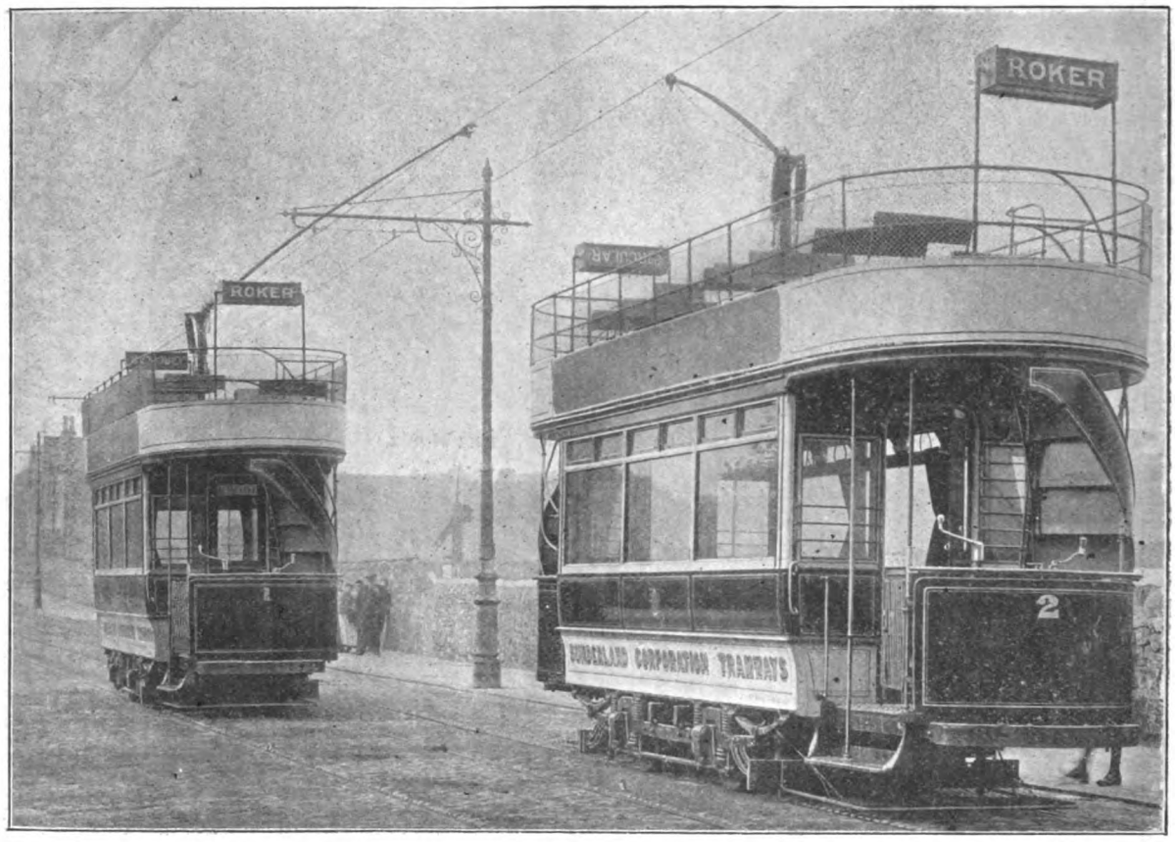
tion to adopt the overhead trolley system, and plans for carrying out this were put in hand. On September 21st of that year the Council formally accepted the proposals of the Tramways committee, and it was decided to seek the necessary powers in a bill then being drafted. The Sunderland Corporation Act, 1899, granted, among other things, powers to work electrically 23 miles of single track extending over 12½ miles of route. The act allowed a period of five years for the completion of the scheme, but it was decided to proceed immediately with about half of the total mileage, the greater part of this portion of the scheme having now been completed and the remainder being nearly completed. It should be mentioned that at the time of the compulsory purchase of the tramways the capital of the company stood at £74,000 paid up, and that the entire undertaking was acquired by the Corporation for £35,000, the discrepancy being explained by the immortal section 43 of the Tramways Act.

between each pole. The track bonds, supplied by Messrs. Askham Bros. and Wilson, are of crucible cast steel. The crossings are set up with the 7in. track rails, and are set at 1 in 8. The draining of the track has been carried out by cutting the rail and placing drain boxes connected by pipes and intercepting chambers to the nearest gulley. The track has been paved over a considerable length with creosoted Scotch fir laid direct on concrete floated up to level and pitch grouted. The remaining portions of the track are paved with Norwegian or Aberdeen 6in. by 4in. granite setts laid on a 1in. bed of sand, and pitch grouted.

The entire contract for the equipment of the track has been carried out by Messrs. Dick, Kerr & Co. Span wires with rosettes have been used in one of the principal streets, viz., Fawcett-street. In North Bridge-street and Roker-avenue centre bracket poles have been used, and for the remaining portion of the track short side poles are employed. Where bracket poles have been used the trolley wires have



SUNDERLAND: CARS AND SIDE-POLE CONSTRUCTION.

The accompanying map, Fig. 1, shows the routes already working, those nearing completion, and the remaining portions of the system which come under the scheme embodied in the Act of 1899. The tramways now running extend from the seaside suburb of Roker through the town to Christchurch. In converting from horse to electric traction the track has been entirely reconstructed, more solid foundations and a heavier type of rail having been laid down. The general section of the track is shown in Fig. 2. The track is laid throughout with 96lb. girder rails of high carbon steel, possessing a tensile strength of 46 tons per square inch. The rails are in 30ft. lengths. It is regrettable that owing to the inability at the time to obtain immediate delivery of English rails, a German firm—viz., the Phœnix Rail Co., of Ruhrort—were engaged to supply these rails. The fish-plates are of 64lb. steel, and the sole-plate weighs 34lb. The rails are bedded on to 6in. of 6 to 1 concrete, packed up with 3 to 1 cement mortar. The tie rods are placed 8ft. apart, and are of 2in. by ⅜in. wrought iron. The joints are bonded with double 000 Columbia bonds, the cross bonds being placed opposite to each pole, and the track bonds

been flexibly suspended by the fiddle bow suspension now so deservedly popular. The trolley wire is of No. 0 S.W.G. gauge and is duplicate throughout. The poles, made by Messrs. Stewart and Menzies, are three-section steel poles of three descriptions—viz. (1) poles tested for 1,000lb. strain, (2) poles for 1,500lb. strain, and (3) poles for 2,000lb. strain. The brackets are of Mannesmann tubes. The span wires throughout are of 7/13 galvanised steel wire. It should be mentioned that the details of the bracket work instead of being of cast-iron are of gunmetal, painted.

Messrs. Callender's Cable and Construction Co. have supplied the traction cables, which are laid throughout on the "drawn-in" system. This company has also supplied the section pillars. The cables are laid in Sykes' earthenware conduits placed in the clear-way between the tracks as shown in Fig. 2. There are four traction feeders—viz., one of 0·35 sq. in. section divided into two branches each of 0·122 sq. in. section and three feeders each starting with 0·2 sq. in. section, and reducing to 0·122 sq. in. section. The line wires are of 19/18 lead-covered cable. The return cables are laid in the following manner: There are first two cables of 0·4 sq. in.

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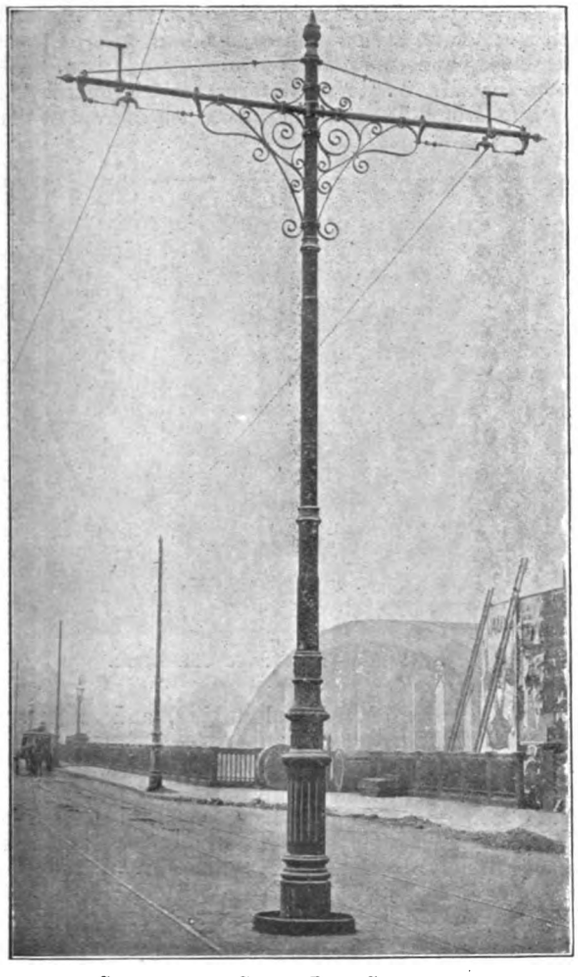
section, connecting the power station to the nearest point on the track, and these cables are connected to the track as follows: The track is crossed by four 000 bonds which are clamped together in a draw-box in the clear-way; the cables are connected to these clamps by means of thimbles. In addition to these return cables one point near one terminus is brought back to a negative booster at the station through a 0·8in. cable. Another point near the other terminus is brought back in the same manner through a 0·25 sq. in. cable. The negative boosters are made self-regulating by carrying the outgoing current through the series windings of the boosters, thus making the boosted negative volts proportional to the load on the traction generators. For the telephone and test leads three-core and four-core cables have been laid. The draw-boxes which, as shown in Fig. 2, are



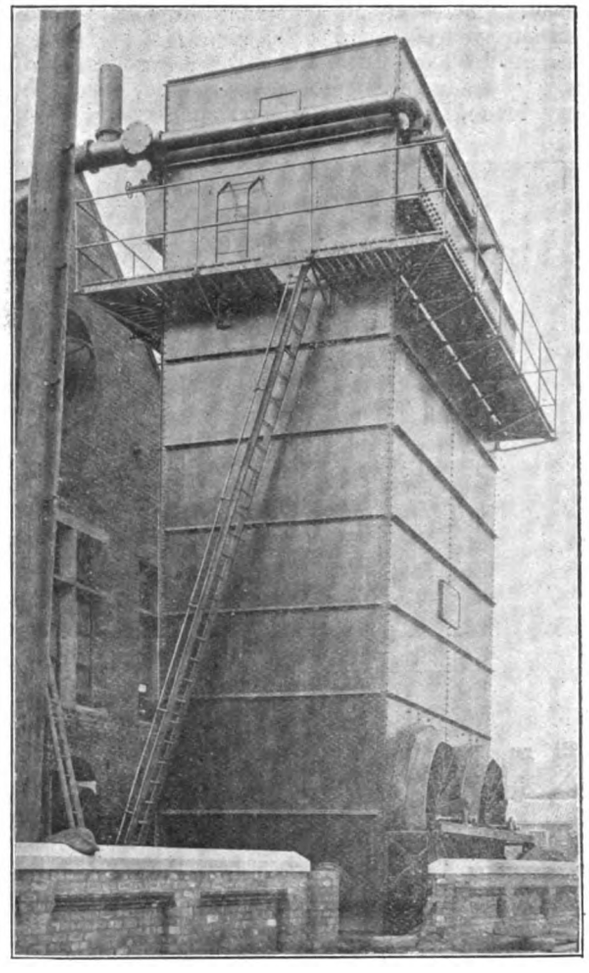
SUNDERLAND: CENTRE-POLE CONSTRUCTION.

placed in the clear-way between the tracks, are of cast-iron with heavy cast-iron covers, the spaces being filled with beech blocks. They are built on 9in. walls, cement rendered.

There will ultimately be 70 cars running on the tramways, and of these 26 are on order, but only eight have at present been delivered. The cars have been built at the Electric Railway and Tramway Carriage Works, Preston, and have been electrically equipped at the neighbouring works of the English Electric Manufacturing Co. Those at present delivered are equipped with Brill trucks and are double-decked, having a carrying capacity of 56 passengers. It is, however, intended to use six double bogey trucks, also eight single deck trucks for one of the routes on which there is a low over-bridge. On some of the cars "Standard" air brakes have been fitted, and all the cars are fitted with emergency electric brakes besides the usual ratchet hand-brake. A striking and useful feature of the cars, as shown in the illustration, is the illuminated destination boxes carried at each end. These boxes are fitted with three 8 c.p. lamps which render them conspicuous after dark. The headlight on the cars is not electric but oil, as owing to the darkness of some of the streets traversed it was thought desirable not to use electricity in case of a breakdown. The trolley standard is placed in the centre of the car deck and carries a swivel type of arm. The greatest overhanging, however, is only 7ft. The trolley wire has a 22ft. clearance from the ground.

The electric car sheds at present have been built out of part of the old horse sheds, and the work of reconstruction is still going on. At present there are four tracks, each with a continuous inspection pit. The present capacity of the sheds is about 20 cars.

Electric power for these tramways is being supplied from the Corporation electric supply station, which has been in operation since 1896. The traction plant, however, is distinct from



SUNDERLAND: CONDENSER COOLING TOWER.

the lighting plant with the exception that the new boilers are interconnected with the old boilers originally installed for lighting purposes. The new steam generating plant includes four Galloway boilers, each 28ft. by 8ft. 6in., raising steam at 130lb. pressure. There are also two Green's economisers each with 286 tubes and two steam-driven "Buffalo" draught fans, each 72in. in diameter for producing the induced draught for the entire boiler plant. The boilers are fed from two Weir direct-thrust vertical steam-feed pumps. The steam ranges are of 6in. lap-welded steel. At present the boilers are fired by hand with cheap slack fuel, but it is intended to carry out a system of mechanical coal conveyance and stoking, two or three types of mechanical stokers being about to be introduced for purposes of trial. The chimney is but 45ft. in height from the base level, and on this account mechanical induced draught has been adopted. It is found that with the existing arrangements for draught the highly bituminous slack fuel employed can be burned without producing smoke.

Within the machinery room the lighting and traction sets are arranged in one long row, each set being placed

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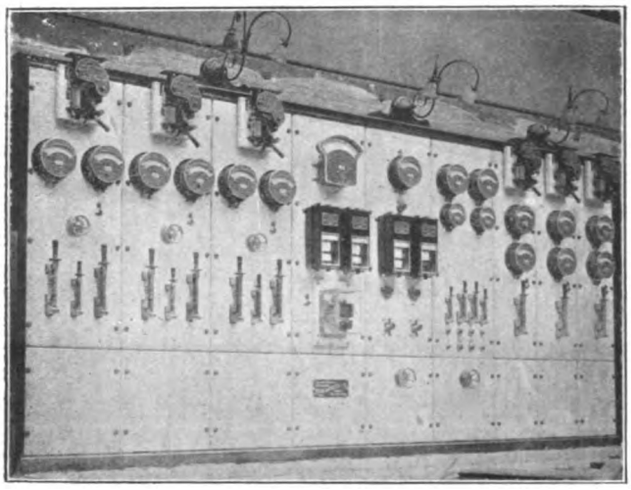
transversely across the length of a somewhat narrow room. The utmost use has been made of the small space available. At one end of the room is the original lighting switchboard, while facing the sets along one side of the room near the centre is the new tramway switchboard erected on a spacious platform. The lighting sets comprise the following items—viz. (1) two Holmes-Willans direct-coupled two-crank 60 H.P. balancers; (2) three Belliss-Silvertown direct-coupled two-crank 200 H.P. generators; (3) two Belliss-Parker direct-coupled two-crank 200 H.P. generators; (4) one Belliss-Holmes direct-coupled three-crank four-pole 450 H.P. generator; (5) one Belliss-Sunderland Forge direct-coupled three-crank four-pole 450 H.P. generator. All these generators run at 220 volts. The traction sets are four in number, each consisting of a Belliss-Sunderland Forge three-crank four-pole 450 H.P. direct-coupled set, running at from 500 volts to 550 volts according to the load. These four sets are coupled in pairs to two Wheeler the surface condensers, the condenser foreach pair being erected immediately between them. The tramway switchboard, which is of a plain but serviceable construction, was erected by Messrs. Moon, Loughlin & Co., of Manchester.



SUNDERLAND: TRAMWAY SWITCHBOARD.

The following is a list of the contractors, sub-contractors, and manufacturers who have supplied plant for this tramway undertaking:—

Entire equipment of track	Dick, Kerr & Co.
Cables	Callender's Cable & Construction Co.
Traction generating sets, condensers, pumps, and cooling tower	Sunderland Forge & Engineering Co.
Switchboard	Moon, Loughlin & Co.
Steam and other pipe work	Wearmouth Foundry Co.
Steam engines	Bellias and Morcom.
Condenser, &c.	Wheeler Cond. and Engineering Co.
Feed pumps	G. & J. Weir.
Boilers	Galloways.
Economisers	E. Green & Son.
Cars	Elec. Rail and Tram. Carriage Wks.
Cars, motors, &c.	English Electric Manufacturing Co.
Conduits	Albion Clay Co.
Rails	Phœnix Rail Co. (Germany).
Points	Askham Bros. and Wilson.
Poles	Stewart and Menzies.
Bracket tubes	Mannesmann Tube Co.
Buildings	T. P. Shafcoe.

For the section of the tramways now completed or nearing completion the following are the items of expenditure:—

Four boilers, &c.	£4,490
Steam and other piping	2,080
Generators, condensers, cooling plant, &c.	14,190
Switchboard	685
Draught fans (including erection)	870
Buildings	44,915
12·8 miles of permanent way	96,000
Overhead equipment (including cables)	14,000
26 cars and spares	15,800
Car shed alterations	5,200
Approximate total..	£158,230

Since the inauguration of a section of these tramways on the 15th inst. the public has shown in a very practical way its appreciation of the facilities afforded. On the first half-day 14,747 people were carried, the receipts amounting to £67 and on the next day 16,900 passengers were carried, the receipts being £74. The fares have been reduced 40 per cent., being now 2d. for the entire distance with 1d. sectional fares. No small share in the success of this undertaking must be attributed to the energetic and able Corporation electrical engineer, Mr. John F. C. Snell, and it is greatly to his credit that the undertaking has been carried out in the short space of time since it was decided to electrically equip the line. Mr. Edward White, the station superintendent, has ably assisted Mr. Snell in supervising the erection of all the plant at the station, and Mr. J. R. Crisp has acted as resident inspector of the permanent way and electrical equipment. Mr. G. L. Andrews, B.Sc., is the tramway superintendent in charge of the sheds, rolling stock, and completed portions of the line. We may mention that Mr. W. Morrison, formerly the general manager of the Sunderland Tramways Co., was transferred at the time

SUNDERLAND: ELECTRIC CAR SHEDS.

of the taking over of the undertaking, and is now traffic manager for the Corporation.

A scheme is now being developed, and will shortly be brought before the Sunderland Council, for the erection of a much larger power station and car sheds, to enable the electric tramway and supply systems of Sunderland to be still more extensively developed. We hope at an early date to present our readers with further particulars of this scheme, which we trust will be brought to maturity.

In conclusion, we acknowledge our indebtedness and express our thanks to Mr. John F. C. Snell for his courtesy during our recent visit to the tramway system and for the assistance he has rendered us in the preparation of this article.

Wireless Telegraphy on Borkum Island.—Her Majesty's Consul-General at Hamburg reports that a station for wireless telegraphy has been erected by the North German Lloyd Steamship Co. of Bremen on the Island of Borkum, off the north-western coast of Germany, for the purpose of communicating both with passing vessels and with the mainland. Experiments for testing the capabilities of the apparatus at the Borkum station have been proceeding during the last few months, and it is stated that, owing more especially to improvements made in the apparatus by the North German Lloyd, the results have been very satisfactory. Experiments made lately by the express steamer of that company, the "Kaiser Wilhelm der Grosse," resulted in quite readable messages being sent from that vessel to Borkum, and received on board from Borkum, at a distance of 40 nautical miles; whilst it is stated that messages which were fairly clear were received at the Borkum station from on board the steamer even at a distance of 50 nautical miles.

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THE PARIS EXHIBITION.—IV.*

(BY OUR SPECIAL CORRESPONDENT.)

The generating sets built by the French firms offer, as a whole, a strange contrast to the typical English ones already described, and, it must be said, to the detriment of the former.

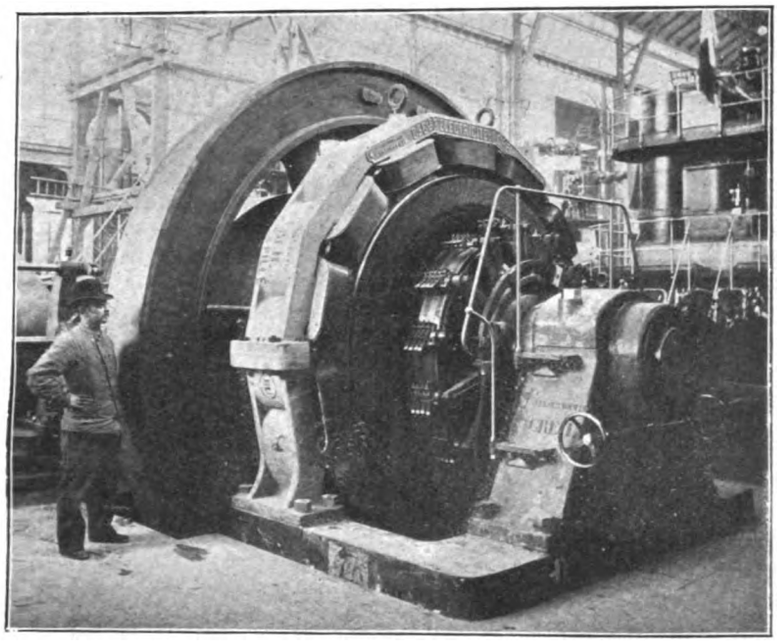

FIG. 12.—700KW. DAYDÉ PILLÉ DYNAMO.

Instead of the compact fast-speed engines, we find slow-running mill engines employed to a large extent, and in many cases single-cylinder machines, some of the latter being used even for alternators. Of course, as the exhibition alternators are not paralleled, an even turning moment is not so essential, but one looks to an exhibition of this sort to find an indication of the typical practice of the country. I will, however, first describe some of the continuous-current sets, and will commence with the 700kw. Daydé et Pillé dynamo (manufactured by the Compagnie Générale d'Electricité de Creil), which is driven by a 1,000 H.P. single-cylinder Weyher et Richmond engine of peculiar construction. The dynamo, which may be regarded as a good example of French manufacture, is illustrated in Fig. 12. It is a shunt machine, designed for 700kw.

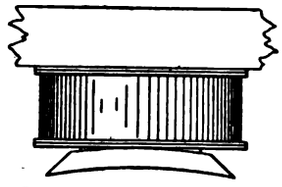

FIG. 13.—POLE-PIECE OF DAYDÉ PILLÉ DYNAMO.
(One-twentieth size.)

at 250 volts. The field magnets consist of a mild steel ring, from which 14 magnet cores radiate inwards. The shape of the pole-pieces, which are of forged iron, and are not in one piece with the cores of the magnets, is shown in Fig. 13. The armature, 2,250mm. (7ft. 4½in.) diameter and 510mm. (1ft. 8in.) wide, is formed of discs insulated from one another by paper and carried on a cast-iron spider. Copper cable of rectangular section is employed for the winding, and the armature being a smooth surface one, the windings are held in place by binding wire and by distance-pieces fixed in slots in the core. The end connections are made by curved strips, wood being employed to maintain these in position. The commutator has a diameter of 1,600mm. (5ft. 3in.) and a useful width of 185mm. (7¼in.), and the brushes, of which there are four per pole, or 56 in all, each oppose two surfaces—copper and carbon—to it. The efficiency of the machine at full load is stated to be 94 per cent.

As already noted, the engine is of the single-cylinder type, its valve gear being its most interesting feature. This is placed at the end of the cylinder and is shown in Fig. 15, Fig. 14 being a general view of the engine with the gear hidden. The cylinder diameter is 1,050mm. (3ft. 5⅜in.), the stroke 1 metre (3ft. 3⅜in.), the speed 120 revs. per min., and the steam pressure 7kg. per square centimetre (100lb. per square inch), a reducing valve being employed to reduce down from the 10kg. per square inch (142lb. per square inch) pressure of the steam mains. The general characteristics of the carcase of the engine are apparent in Fig. 14 and do not need enumeration. The cylinder casting is in three parts. Of these the middle one may be considered the cylinder proper and is steam-jacketed, while the other two contain the admission and exhaust steam ports, the first-mentioned of which is also jacketed. The admission and exhaust valves are flat and self-closing and are very light; they bear directly upon orifices in the ends of the cylinder, this disposition diminishing clearance to a minimum. They have the shape of sectors of circles, and move backwards and forwards along a circular path in their own plane. The admission valves are controlled by wiper shafts actuating a trip motion regulated by the governor. The exhaust valves are actuated by a link motion, the link being partly straight and partly curved. As the slide moves along the straight part of the link, the exhaust valve opens and then quickly closes; when the slide is on the curved extremity of the link, the lever fixed to its end and controlling

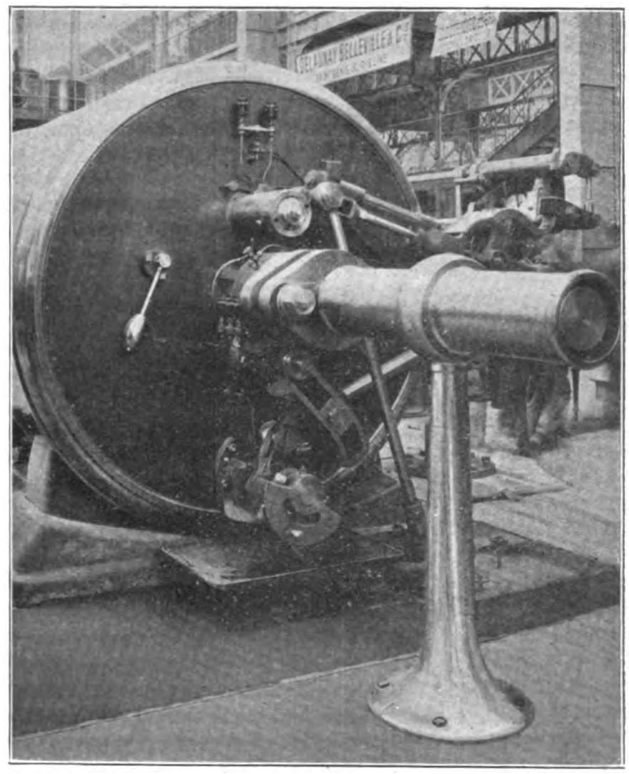

FIG. 15.—DETAIL OF VALVE GEAR OF WEYHER AND RICHEMOND 1,000H.P. SINGLE-CYLINDER ENGINE.

the valve is at rest. The various parts of the valve gear and its action can be traced out on Fig. 15.

The engine is provided with a heavy crank-shaft governor, actuating directly the trip motion. A special knock-off is

* Previous articles appeared in *The Electrician* of July 20 27, and August 3.

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provided in addition, which shuts off steam in the event of the main governor being deranged. The flywheel weighs 30 tons. The barring gear, another important necessity in a single-cylinder engine, is seen in Fig. 14.

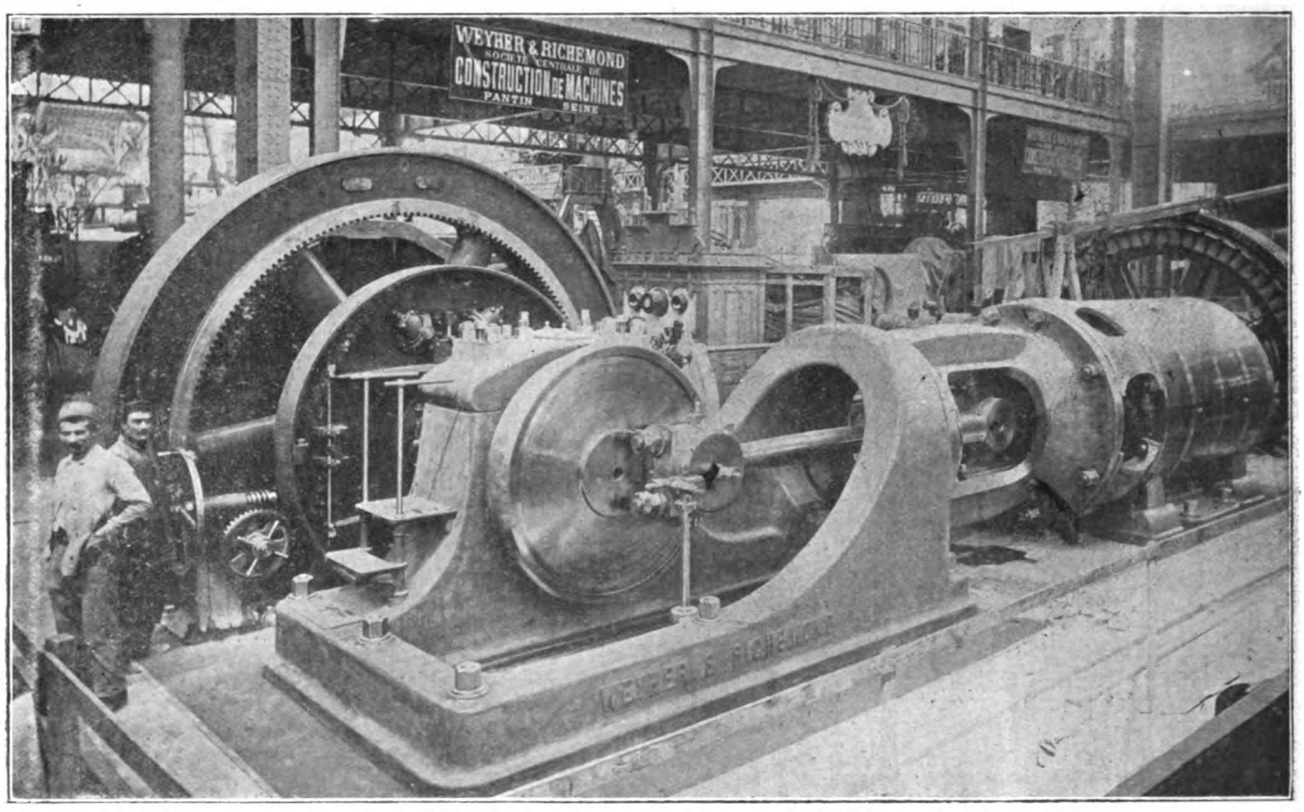

FIG. 14.—1,000H.P. SINGLE-CYLINDER ENGINE BY WEYHER AND RICHEMOND.

In the generating set of the Société Alsacienne de Constructions Mécaniques, it is the dynamo that presents the most interesting features, although the design is not a new one. The machine is destined for the supply station of the Compagnie Parisienne de l'Air Comprimé on the Quai de Jemappes, where several other machines, similar in design and size have been erected during the last few years. The striking peculiarities are the employment of a Gramme ring for the armature which revolves past stationary field magnet poles placed within it, the outer side of the ring serving as commutator. In fact, at a first glance the machine resembles a huge revolving commutator, and one may wonder why it need be driven by the large vertical cross-compound engine which is coupled to it. Figs. 16 to 19 show the general arrangement of the engine and dynamo, and from the first of these the construction of the combined armature and commutator is evident. The field magnets are 12-polar, and are made up of a steel casting with wrought-iron pole-pieces each of which is fitted with a coil wound on a sheet-iron former. The field magnet casting is bolted to the bed plate of the

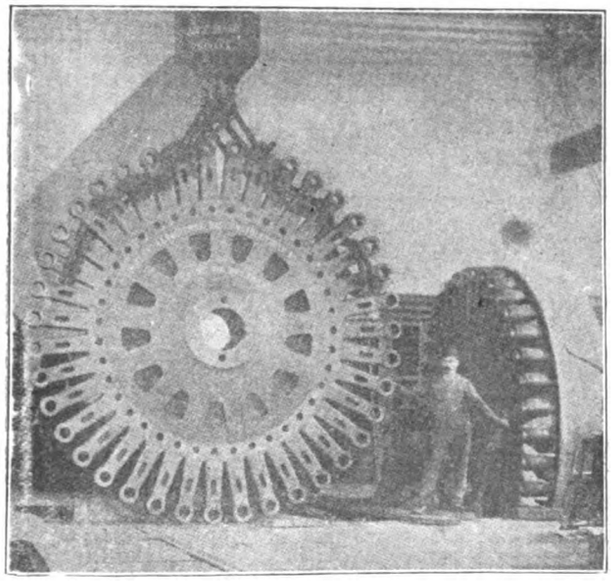

FIG. 20.—CASTING SUPPORTING THE ARMATURE OF SOCIÉTÉ ALSACIENNE DYNAMO.

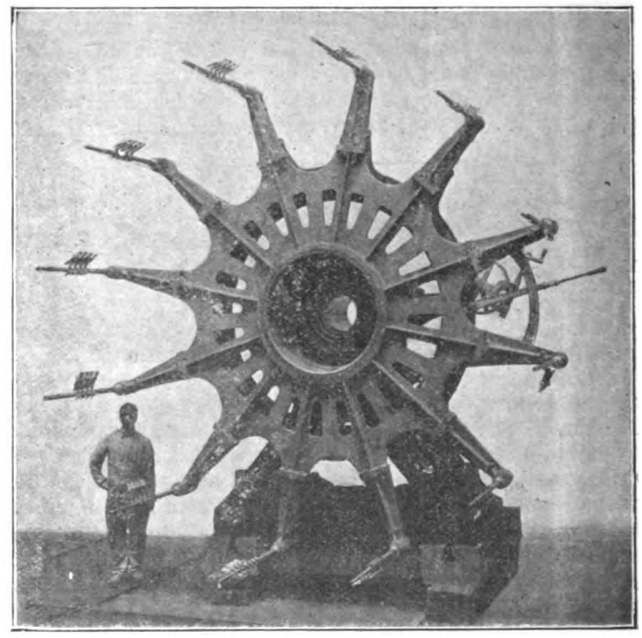

FIG. 21.—BRUSH-HOLDER CASTING OF SOCIÉTÉ ALSACIENNE DYNAMO.

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engine. The armature, as is seen, is of large dimensions, and is formed of an annular core of steel stampings, the whole being maintained by a star-shaped casting (Fig. 20) with 89 arms, which is keyed to the main shaft of the engine. The diameter of this casting is about 18ft., and it weighs 7½ tons. Each arm of this carries a horizontal steel bar fitted with a bronze sleeve, which serves to support the core discs, and at the same time regulates the distance between the core and the plane of the star-shaped casting. These bars are prepared is insulated with a layer of asbestos paper, and is then wound with paper-insulated copper bars of rectangular section, some U-shaped and an equal number of straight ones. The U-shaped bars are placed from inside across the core and the straight ones are on the outside and form the commutator bars, connecting the right-hand of one U to the left-hand of the next to form a completely closed Gramme ring. The 12 brushes are carried on the casting shown in Fig. 21 —an enormous brush-holder, for its diameter is 14ft. 9in.—

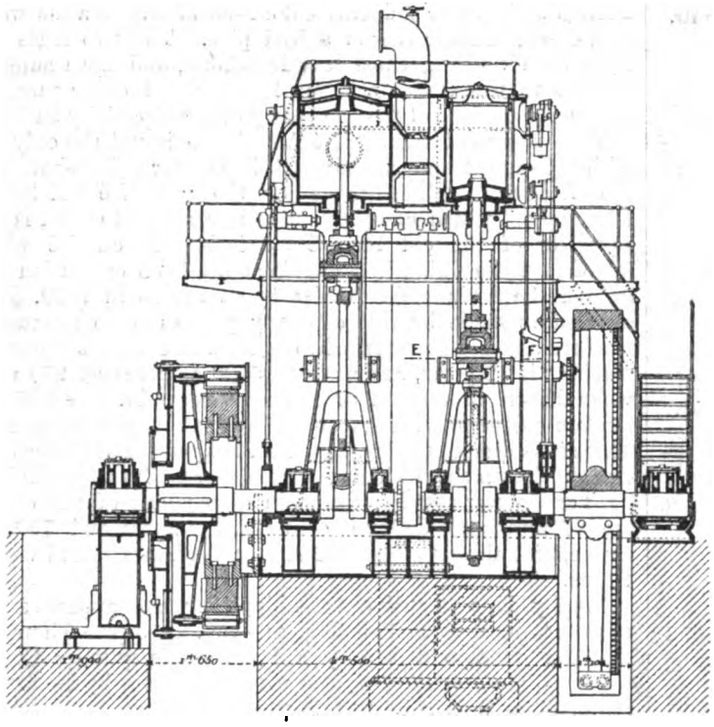

Fig. 16.—Sectional Elevation of Dynamo and Engine (section on A B).

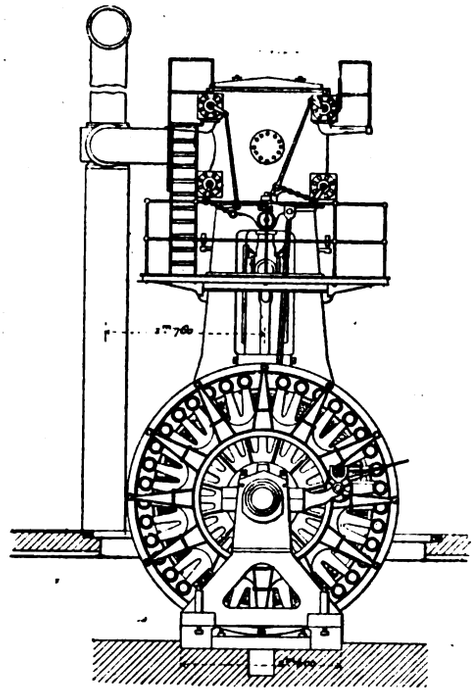

Fig. 17.—End Elevation, showing Dynamo and H.P. Cylinder.

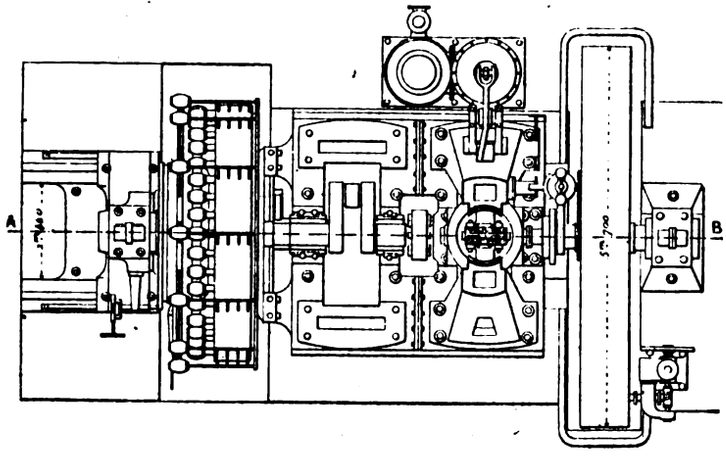

Fig. 18.—Plan of Engine and Dynamo (section on E F).

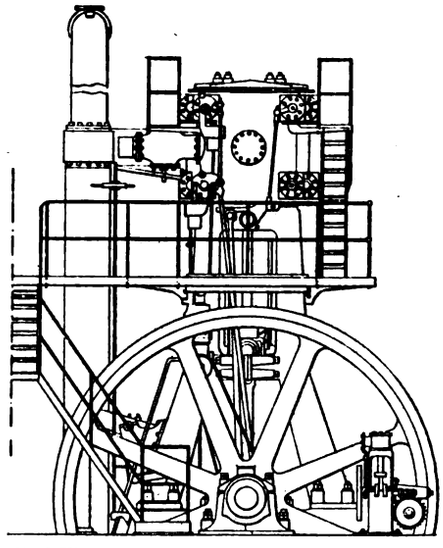

Fig. 19.—End Elevation, showing Flywheel and L.P. Cylinder.

Continuous-Current Generating Set built by the Société Alsacienne de Constructions Mécaniques.
700kw. at 500–600 volts; 60 revs. per min.

insulated from the casting itself by means of insulated tubes and washers. The core is formed of stampings of soft steel 0·5mm. thick, these bars passing through holes in the stamping. Thirteen core sectors make up the complete annulus, being placed end to end, the joints in one layer being covered by the metal of the next. The core, when built up on the support in this way and with paper between the layers, undergoes a strong compression and is held together with bronze nuts and washers. On the right of Fig. 20, in the background, is seen a completed armature core ready for winding. The core thus and the rods carrying the brush-holders proper are mounted on ebonite sleeves on rods projecting from this spider in a similar way to those from the armature spider. A handwheel in connection with worm gearing turns the whole casting to adjust the brushes. The data for a similar machine running in the Quai de Jemappes station, given on next page, are of interest.

The engine valve gear is of the Wolf-Corliss type. The cylinders are jacketed, the jacket of the high-pressure cylinder receiving steam direct from the boiler, that of the low-pressure

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Armature.

Speed (revs. per min.)	70
External diameter of armature core (metres)	3·81
Internal ditto ditto	3·42
Peripheral speed (metres per sec.)	14
Potential difference at brushes (volts)	500 to 600
Sectional area of armature core (sq. cm.)	710
Total number of turns	2,268
Sectional area of each winding (sq. mm.)	60
Current in each armature coil (amperes)	125
Current density (amperes per sq. in.)	2
Resistance of armature at 40°C (ohms)	0·006

	At 500 volts.	At 600 volts.
Power expended in the armature:—	kw.	kw.
C^2R loss	13·5	8·7
Hysteresis	6·8	8·9
Foucault currents	1·0	1·4
Total	21·3	19·0

Field Magnets.

Section of iron core (sq. cm.)	2,100
Length of core (cm.)	45
Polar surface (sq. cm.)	3,600
Air gap (cm.)	4
Maximum current in field coils (amperes)	25
Total resistance of field coils (ohms)	24
Section of wire (sq. mm.)	21
Current density (amperes per sq. in.)	1·2
Maximum power spent in field magnets (watts)	1,500

	At 500 volts.	At 600 volts.
	kw.	kw.
Power supplied to external circuit	750	720
Power spent in the machine:—		
Field magnets C^2R	1	1·5
Armature C^2R	13·5	8·7
Hysteresis	6·8	8·9
Foucault currents	1·0	1·4
Total	22·3	20·5
Electrical efficiency per cent.	$\frac{750}{772·3}=97$	$\frac{720}{740·5}=97·2$

cylinder, however, constituting the receiver. The cylinder diameters are 85cm. and 185cm., and the stroke 120cm., and the general design is seen in Figs. 16 to 19. There is a ball governor acting on the cut-off of the high-pressure cylinder. The flywheel is on the opposite side to the dynamo. Its diameter is 5·7 metres, and it weighs 31 tons.

A generating set consisting of an engine made by MM. Crepelle & Garaud, and a dynamo by the firm of Décauville Aîné is another type of French design. The dynamo is 10-polar, and its field magnet poles project inwards from a polygonal frame, the coils being wound on the sides of the polygon. This may be described as of the Thury pattern. The engine is a horizontal cross-compound Corliss machine, rated at 1,200 H.P. Its flywheel is placed between the two cylinders, and a 250-volt 1,800-ampere dynamo is placed on each side of the flywheel. Considering its output, the machine appears rather bulky. Providing current for the exhibition supply, the two dynamos are usually connected in series, but they can be put in parallel if desired. A drum winding is employed on a smooth core.

Two small Bréguet dynamos driven by de Laval steam turbines have been placed among the larger French generating sets, and do not seem to attract as much attention as they deserve. This is probably because of their small size, combined with the fact that their working parts are not visible; and, moreover, the gentlemen attending the French exhibits are not always as attentive in answering questions as they might be. The de Laval steam turbine is an impulse wheel, unlike the Parsons' which is a reaction turbine. Steam is simply directed against the blades of the wheel by nozzles, being allowed to expand on its way from the throttle valve to the directing nozzles. Thus the speed at which the wheel revolves is very great, varying from 7,500 to 30,000 revs. per min. (representing a peripheral speed of from 175 to 400 metres per second) according to the type and size of the turbine. The specimens in operation at the exhibition have wheels of about 70cm. diameter, making about 7,500 revs. per min. These high speeds necessitate the employment of a double helical gearing between the turbine and the dynamo shaft, this gearing being enclosed in a cast-iron case which forms part of the main casting of the engine.

Two generating sets of still smaller capacity may also be mentioned in passing—viz., two 60 H.P. Charon gas engines belted to continuous-current dynamos made by the Compagnie Générale Electrique of Nancy. These each generate current at 250 volts, and are employed together with the larger 250-volt machines to supply make-up current to one side of the three-wire network. They have proved of great service on an emergency, as, for instance, when the water supply to the French boilers was suddenly cut off one afternoon a few weeks ago, due to the bursting of a feed pipe. The two little sets have been running since last December, and have supplied current to the cranes and for lighting and other purposes during the erection of the machinery in the electricity building.

The dynamo of the Société Alsacienne is not the only one with a Gramme ring armature, this honour being shared by the Labour machine made by the "Société l'Eclairage Electrique," which company, it is interesting to note, is the successor of the old Société Générale d'Electricité which introduced the Jablochoff candle at the 1878 exhibition and lighted the Avénue de l'Opéra by its means in 1879. The alternators made by this company possess some interesting features and will be returned to later. The continuous-current machine is 12-polar, and generates 800 amperes at 250 volts when driven at a speed of 120 revs. per min. by a 300 H.P. tandem compound Biétrix engine with Collmann valve gear. This set is direct-coupled, as are all the machines (except the two gas-driven ones) which generate current for the exhibition light and power supply; the main dimensions of the engine are 365mm. and 600mm. cylinder diameters and 750mm. stroke, and the armature is 2 metres in diameter, and weighs 4 tons.

Finally, I may mention a combination which appears somewhat incongruous to British eyes—viz., an 8-pole Thomson-Houston dynamo driven by a large single-cylinder Corliss engine. The dynamo has been made in France by the firm of Postel-Vinay for the French Thomson-Houston Co., and has a very workmanlike appearance. It has evidently been prepared in accordance with the American model, and differs from the American machine in a few details only. In type it is a tramway generator with a capacity of 325kw. at 550 volts and 90 revs. per min. The engine that drives it has been built by MM. E. Garnier & Faure Beaulieu.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

The Platinum Gas Thermometer.—For work at high temperatures the air thermometer with a platinum-iridium vessel is superior to a porcelain thermometer owing to the absence of softening, and the permeation of the gas, which in the case of hydrogen is troublesome, is obviated by substituting nitrogen for air or hydrogen. In continuation of their previous work on the subject, the authors have determined the correction to be applied on account of the expansion of the vessel. This expansion, which demands a correction of 10deg., 30deg. and 40deg. respectively at 500deg., 1,000deg. and 1,150deg., is not regular, and a further error of 1·5deg. to 7deg. is occasioned by the irregularity. The curve of expansion was determined by measuring the expansion of a rod made of the standard alloy, containing 80 per cent. of platinum and 20 per cent. of iridium. With a nitrogen thermometer subjected to the new corrections a number of melting points of metals were determined, so as to render future tests, especially those of thermo-elements, independent of the nitrogen thermometer. Thus the melting point of lead was found to be 326·9deg., of pure silver 961·5deg., and of gold 1,064·0deg. The last value was verified by an optical method, the refractive index of air exposed to the temperature of the melting point being measured. This also gave 1,064deg.

[Holborn and Day, *Ann. der Physik*, No. 7, 1900].

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Magnetic Intensity Variometers.—The magnetism of a bar and the directive force of a bifilar suspension are not free from changes in the course of time, and are greatly affected by temperature. M. Eschenhagen has therefore adopted quartz fibres in order to obtain a simple torsional suspension. The systems of magnets and suspensions usually employed with magnetometers weigh at least 20 grammes to 30 grammes, and are therefore not suited for quartz fibres, as the latter would have to be too thick for the proper sensitiveness. The author has therefore provided a light system of magnets weighing about 1·5 grammes, and has found them to possess several distinct advantages, such as easy accessibility, adjustable damping, and a fixed mirror for photographic registration, which can be displaced with ease and certainty. For intensity variometers a quartz fibre, not too thin, about $\frac{1}{10}$mm. to $\frac{1}{20}$mm. thick, is selected, and the upper end is twisted until the magnet lies perpendicularly to the magnetic meridian. The author employs a simple expedient for increasing the sensitiveness of an instrument. He uses a fixed directive magnet parallel to the needle and below it. If the poles of the directive magnet are placed opposite the like poles of the needle the instrument becomes more sensitive, if in the contrary position it becomes less sensitive.

[M. Eschenagen, *Terr. Magnetism*, June, 1900.]

Cause of Terrestrial Magnetism.—An interesting attempt to reduce the phenomena of terrestrial magnetism to electric convection currents has been made by W. Sutherland. He supposes that the primary magnetic field of the earth is produced by a surface charge of negative electricity, which revolves with the earth, and whose motion through the ether produces the magnetic field. Astronomically, however, the earth does not act as a negatively-charged body, as its surface charge is compensated by an equal positive charge at the centre. The author shows that the surface density required would be 51,000 electrostatic units. The magnetic field outside the earth would be the only external evidence of the existence of the electrostatic field within. Secular variation is accounted for by a dissymmetry of the conductivity of the earth's crust, which induces a transverse field, and produces a potential similar to that of Barons's hypothetical transverse magnet. As regards the daily variation, the author points out that the process of dissociation induced by the sun in the upper strata of the atmosphere would produce a downward current of positive ions, and this would be the earth-air current to which the diurnal and other short-period variations have already been attributed. The currents are closed by flowing along the surface of the earth from equator to pole, by the glow discharge of the aurora in polar regions, and in the upper atmosphere by flowing from the pole to the equator.

[W. Sutherland, *Terr. Magnetism*, June, 1900.]

Dielectric Strain.—The expansion of a dielectric in an electrostatic field has been adduced as an experimental proof of the theories of Faraday and Maxwell, but the results described are anything but concordant. Röntgen ascribes the observed changes of volume to the electric compression of the electrodes and the heating effect of the free charges on the surface of the glass or liquid. L. T. More has endeavoured to meet this criticism by a special arrangement of three concentric tubes, the inner one being brass, enclosed in a glass tube surrounded by another brass tube. The results of his experiments, however, lead him to the conclusion that the stress occuring in the ether when a dielectric is electrostatically charged causes a mechanical deformation of the substance. At least, if there is such an action it must be extremely minute—perhaps a slight re-arrangement of the molecular structure—as an effect so large as one expressed by the formula $KH^2/8\pi$ would be very appreciable. Though it might have been expected that such ethereal stresses would change the length of a dielectric both along and at right angles to the lines of induction, yet as one of these is a tension and the other a compression of equal amount, it is difficult to see how any change of volume other than a differential effect would result; whereas Quincke finds that the change of volume is nearly three times as large as the linear expansion. A strain as indicated is not met with in any allied field of investigation.

[L. T. More, *Phil. Mag.*, August, 1900.]

IMPROVEMENTS IN THE CONSTRUCTION OF BATTERY MOTOR CARS.

In an article contributed to No. 11 of the *Centralblatt für Accumulatoren und Elementenkunde* Herr Zechlin states that there are two principles in the construction of motor carriages which he has already advocated—namely, that the weight of the vehicles should be reduced as much as possible, and that frictional resistance should be minimised by the employment of ball bearings. Diminishing the weight of the car reduces its traction resistance and lessens the shocks caused by the inequalities in the road; but there is a limit beyond which the weight cannot be reduced, even if the requisite mechanical strength could be obtained, and this is fixed by the weight necessary to give the adhesion requisite for continuous motion. This adhesion depends both on the weight of the vehicle and on the nature of the surface of contact between the wheel and the road, and if it is unduly reduced the ascent of an incline becomes difficult, and the steering is irregular whichever axle the driving impulse is applied to. The reduction of the weight of the vehicle is of special importance in the case of battery cars, and it should be the object of the designer of such vehicles that the total weight of the battery and car should not exceed the weight requisite to give the necessary adhesion. Most of the recent cars exhibit a marked improvement in the direction of weight, and thus also in reducing traction resistance and effecting a saving of energy. But from the result of the last few years' experience it does not appear that the weight either of the motor or of the batteries can be further materially reduced, so that it is only by improvement in the design and construction of the vehicles themselves that greater economy in working can be expected. If the weight is evenly distributed between the four wheels, it is more economical to allow the greater proportion of this weight to the battery rather than to the vehicles, provided always, of course, that due regard is paid to the strength of the latter. Allowing a larger proportion of the weight to be utilised in the construction of the battery permits of the employment of cells of the Planté type, which yield two or three times more discharges than do the lighter pasted plates.

Another method by which the economy of battery cars may be increased is by enlarging the diameter of the wheels. This method was first employed by Dr. Luxenberg at the Eisenach carriage factory. Small wheels are generally employed in benzine motors, because they are advantageous in going up and down inclines when the driving power is limited as it is in their case. The number of the revolutions, however, of the electric motor can be varied without sacrificing economy, and it can be overloaded, and therefore larger wheels can be employed with it, and the advantage which they confer in diminishing resistance be secured. The advantage of large wheels lies in the diminution of traction resistance which, according to Morin, is in the inverse ratio of the square root of the wheel diameter. For instance, if a wheel of 61cm. diameter is replaced by a larger wheel of 100cm., the traction resistance decreases in the proportion of one-eighth to one-tenth. A larger wheel also turns less frequently on its axle in a given distance, and friction and wear and tear are correspondingly diminished. The foregoing considerations point to the advisability of abandoning the old small-wheeled motor, which was based on the benzine type, and of substituting for it another especially designed to suit the conditions of electric motive power.

The value of ball bearings in reducing friction is recognised, but it is not equally well known that by paying due attention to the proportioning of their parts they may be made equally as economical as a well-finished ordinary bearing. The diameter of the balls should preferably be chosen so large that not more than 12 or 16 of them are required to form the ring; and for further details Herr Zechlin refers his readers to his articles on the subject in the journal *Der Motorwagen* for 1899. He also discusses the best form of tyre for electromobiles, and is in favour of a pneumatic tyre inflated to a pressure of 6 atmospheres.

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Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

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THE EDUCATION OF AN ELECTRICAL ENGINEER.

Much has been written about the education of youths for an electrical engineering career, and from platform and printed page there has been frequently given to the world a multiplicity of advice on the subject. We ourselves are often asked to point out the course of education and training which a youth should go through in order to become a qualified electrical engineer. It is, however, impossible, either in writing or verbally, to lay down any rigid rules, or to recommend any fixed scheme; for it is essential that each case should be considered on its own individual basis, and what may safely be advised in one case will differ in many essential details from what should be followed in another. This being so, it might appear superfluous to discuss the subject further on the present occasion. Much has already been put into print, and the utmost that could be printed could never settle the matter: why, then, spill more ink? Nevertheless, there are a few general considerations which may usefully be placed before anxious parents and guardians, many of whom are quite out of touch with even the outermost of electrical circles. And the present season being the one when this problem most generally presses for solution, it may be appropriate for us to make a few remarks upon it now, both as offering suggestions to electrical engineers who are being consulted on the matter, and as giving direct advice to the interested parties themselves.

We have said that each case must be considered in its individual circumstances. Those who have had to do most with technical education will appreciate most the force of this remark. The aspirants, to begin with, are of diverse ages, some being mere boys, others men who have abandoned a different career of some years standing; some possess abundant means for a full course of study, others require to enter the doors of the profession with a minimum expenditure of time and money. Then again—and this is noticeable even among the boys—some bring with them a grounding in mathematics and the physical sciences, while others have nothing but classical lore and must not only be taught the elements of mathematics and physics but also require the laborious drilling in thought which is necessary before they can even

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get into a mathematically exact way of thinking. We do not wish here to raise the question as to the merits of classical education; all we are contending now is that of two youths of equal ages, fresh from school, that one will be better prepared to commence a course of study for an electrical profession who brings with him a foundation of elementary mathematics and physics, than will be the one in whose mind these subjects are replaced by Latin and Greek. In other words, the classical scholar will require to add an extra year or two to the term of his technical studies, in order to make up the deficiency. He will enter the profession at a later age, but we do not contend that he will not be the better man in the end.

It is a matter for surprise to us that so much difference of opinion exists in the electrical profession as to whether a youth should take first his studies at a technical college and then the more practical training of the workshops or power station, or should reverse the order of these two things. To us it appears that the former is by far the better course to adopt. We are aware that the opponents of this plan contend that it allows the pupil to go through his classrooms and laboratories without knowledge of the practical work for which he is fitting himself. In these days, however, of students' "visits to works" a youth has abundant opportunity to learn enough of the practical side to perceive the drift of his studies. Moreover, there is an immense advantage in entering the "works" stage of his studies with a thorough knowledge of the theoretical and scientific bearing of what goes on in workshops. Besides all this it is a more natural transition to pass from the school-room to the lecture-room and laboratory, and from the works to whatever may be the practical occupation with which his career is commenced, than to transpose this order of things.

According to the qualifications with which he commences, the first year or two of a student's college course should be practically independent of the special branch of the electrical profession he will ultimately enter. Up to this stage the majority of aspirants, and their parents or guardians with them, display the liveliest ignorance of what that special branch is to be. There is great anxiety for the young man to enter the profession, but not the faintest idea exists as to whether he is to be an electric light engineer, or an electro-chemist, or a telephone engineer, or a telegraphic engineer, or a tramway engineer. Even if it were possible to predetermine the special branch at the earliest stage, it would probably not be advisable to modify the early studies very much though possibly an electro-chemical career would call for greater attention to chemistry and less to mechanics than would, say, electric traction. On the whole, however, the broad foundation should be the same for all branches, and it should be made as broad as possible. Even to an electro-chemist a liberal knowledge of mechanics will be useful, and the tramway engineer will not regret an acquaintance with electro-chemistry however much he may deplore the evidence of it in the electrolysis on his lines. The later years of study at a technical college are of course determined wholly by the nature of the chosen branch of the profession, and little need be said here on this part of the subject. We would, however, warn students against a too early and too exclusive absorption into what is termed research work. Professors are sometimes far too prone to use their best pupils as handy assistants in working out some one line of research in which the teachers happen to be interested. Students attend technical colleges to lay a sound and broad foundation for their life's work, not to aid professors in preparing Papers for scientific societies.

When the college course is ended, the student should regard it as almost, if not quite, essential that he should pass completely through the workshops of an electrical or mechanical engineering works; and only a firm of high standing, doing a variety of work of an electrical or kindred character, should be selected. As this stage must occupy several years, it is sometimes curtailed or, unfortunately, omitted altogether. No student, however, can regard his training as complete unless he has acquired a practical insight into workshop methods; but we are glad to observe that the notion is now gradually dying out, that no one is an engineer who has not been duly articled and passed through engineering works. When it is impossible to devote any time to the workshop, a student will sometimes commence his practical training by being articled as the pupil of a central station engineer. For a youth intending to become a station engineer this is an excellent introduction, even after two or three years have been devoted to workshops. But that a thorough training in engineering works renders this unessential is proved by the strikingly successful example of the Corporation electrical engineer at Glasgow. That gentleman, it will be remembered, went to this important and responsible post straight from the works of Messrs. Crompton & Co. at Chelmsford. In conclusion, we may point out that the old days of rule-of-thumb engineering are gone, never to return, and that the education of an electrical engineer to-day consists in a solid foundation of scientific facts and principles, with a substantial superstructure of intelligent practice.

THE USE OF ALUMINIUM FOR ELECTRICAL CONDUCTORS.

BY JOHN B. C. KERSHAW, F.I.C.

Introduction.—The issue of *The Electrician* for Sept. 8, 1899, contained an editorial note dealing with the offer of a continental firm of manufacturers to supply aluminium wire for electrical purposes at 1s. 2½d. per pound. In America the Pittsburg Reduction Co. have been vigorously pushing the use of the new metal for electrical transmission lines since 1897, and have supplied large quantities of aluminium for this purpose at the low price of 1s. 2½d. per pound. As a result of these offers, and as a result also of the high price of copper, G.M.B.s of which have now for 18 months remained over £70 per ton, numerous trials of aluminium for electrical work have been made in Europe and America. On this side of the Atlantic these trials have been experimental and tentative in form, and one can point to no *large* installation of electricity, either for power or lighting purposes, in which aluminium has supplanted copper. In the United States, however, the trials have been carried out on a very large scale, and transmission lines of aluminium varying from 20 to 40 miles in length, carrying 1,000 H.P. to 5,000 H.P., at 10,000 to 20,000 volts pressure, have been erected at several places on the Pacific Coast. Time alone will show which is the wiser policy. It is not yet possible to state definitely whether aluminium possesses all the qualities necessary to make it a successful rival of copper; and if these aluminium transmission lines should ultimately require to be replaced by the older metal, the losses incurred will be exceptionally heavy. The importance of the subject, therefore, justifies a special article dealing with it alone, and in the following notes the writer has gathered together all recently-published facts and figures relating to the use of the new metal as an electrical conductor, supplementing them in some cases by his own figures.

Relative Conductivity of Copper and Aluminium.—The relative conductivity of 99·6 per cent. aluminium, taking copper 100, and equal sectional areas, is 61·5 according to Northrup,*

* *Electrical World* (New York), Dec. 3, 1898.

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and 60·5 according to Lord Kelvin.* Since it is customary to alloy the aluminium designed for use in transmission lines with copper or iron in order to increase its strength, it is obviously unfair to use these figures in general calculations regarding relative costs, yet this mistake is constantly being made by those interested in the subject. Thus C. T. Child in a recent article has based all his calculations upon a conductivity ratio of 63 : 100† ; and another writer has used the ratio 61 : 97 in similar calculations.‡ Northrup has shown that the conductivity of aluminium falls rapidly with increasing percentages of copper, and the following are figures obtained by him with special brands of aluminium manufactured by the Pittsburg Reduction Co. for conducting purposes :—

Aluminium alloyed with 0·50 per cent. copper	58·16
Do. do. 0·75 do. do.	56·37

It is evident, therefore, that calculations based upon a ratio of 63 : 100 will yield erroneous results for all cases in which copper or iron has been added to the aluminium in order to increase its strength ; and only in such cases as that of the Niagara Falls Power Co.'s aluminium transmission line, running from the power-house to No. 2 works of the Pittsburg Reduction Co., is a relative conductivity of over 60·5 : 100 attained. In this case the line is short, and, as little tensile strength was required, the writer believes that the metal was not alloyed with copper.

In the Blue Lakes and Stockton transmission line, one of the latest installations of aluminium for long-distance transmission, the wire used had a conductivity of 59·9 as compared with copper at 100, but the total resistance of the line was 10 per cent higher than calculated, owing to impure metal in certain sections of the line.§ Taking the former figures, it would appear from Northrup's tests that the aluminium was 99·6 metal, alloyed with about 0·30 per cent. copper.

The writer has had tests made of aluminium wire supplied to him for experimental purposes by firms in this country, with the following results :—

		Aluminium.		Copper.
No. 1 }	Conductivity of equal sectional areas	51	:	100
No. 2 }		54	:	100

These figures show that each lot of aluminium wire or cable ought to be tested separately for conductivity before erection on any power transmission line, and that the percentage of copper and iron added to the metal ought to be kept as low as is consistent with the desired strength of the line.

Relative Strengths of Copper and Aluminium.—The tensile strength of hard-drawn copper wire is between 62,000lbs. and 65,000lbs. per square inch. The tensile strength of aluminium wire is much lower, and varies from 18,000lbs. to 40,000lbs., according to the impurities present, and the annealing it has undergone. The tensile strength of aluminium and copper alloys varies greatly, since as pointed out above, a slight variation in the percentage of copper present has a marked effect upon the physical properties of the metal. In the majority of instances no special analysis of the alloy is made at the time of carrying out the physical tests, and the percentage of copper present is a matter of pure conjecture. Thus the tensile strength of 99 per cent. aluminium is stated by one authority to be from 80,000lbs. to 55,000lbs. per square inch when drawn into wire, but no reference is made to the amount of copper present. The wire used for the Blue Lakes and Stockton (California) transmission line possessed a tensile strength of only 82,700lbs. per square inch, and as the conductivity was 59·9 we may assume it contained 0·30 per cent. copper.§ Prof. Carpenter, of Cornell University, has published tests which give 15,000lbs. per square inch, as the maximum tensile strength for 99 per cent. aluminium ; but the metal used no doubt contained other impurities in place of copper,‖ and it was not in the form of wire. Drawing into wire always increases the strength of metals, and aluminium is no exception to the rule ; but several annealing operations are necessary in the course of this drawing-down operation.

The writer has obtained the following figures for aluminium wire supplied to him by firms in this country :—

No. 1. 99 per cent. aluminium	32,490lbs.	per square inch.
No. 2. Alloy containing 1 p.c. iron ...	38,080lbs.	do.
No. 3. Composition not stated	31,600lbs.	do.

The breaking strains fixed by the authorities for overhead electric wires in different countries are as follows :—

United Kingdom..	31,360lbs.	per square inch.
United States	32,000lbs.	do.
France	31,218lbs.	do.

Aluminium used for overhead lines must therefore be alloyed with sufficient copper or iron to give it a tensile strength of over 32,000lbs. per square inch, and, as stated above, on the Stockton line this has been attained with a percentage of copper not exceeding 0·30 per cent.

As evidence of the great increase in strength which is conferred by increase of the percentage of copper, it may be stated that the Pittsburg Reduction Co. have produced a wire the breaking strain of which is 65,000lbs. per square inch, or equal to that of hard-drawn copper. The conductivity of this wire is, however, only 50 per cent. of that of electrolytic copper, and for long distance transmission work, it is therefore of little value.

Relative Costs of Copper and Aluminium.—It has been stated above that aluminium has been offered and sold in rod or wire form in America, for electrical transmission work, at 1s. 2½d. per pound, and in Europe at only a slightly higher cost. Whether there is much, or any, profit for the producer on these transactions, it is not at the moment the writer's intention to inquire. Taking the latest quotation for copper in rod form, namely, £84 per ton, equal to 9d. per pound, and using the figures for relative conductivity given above, namely, 59·9 : 100, the relative costs of aluminium and copper for conductors of equal electrical capacity work out to

$$\frac{2{\cdot}68 \times 14{\cdot}5 \times 100}{8{\cdot}93 \times 9{\cdot}0 \times 59{\cdot}9} = \frac{3{,}886}{4{,}814} = \frac{100}{123}.$$

As an example of the error occasioned by the use of a wrong figure for the conductivity in such calculations, the above has been re-worked with C. T. Child's figures of 63 in place of 59·9. The cost ratio then comes out as $\frac{100}{130}$, a difference quite large enough to severely diminish the expected savings on a large scheme. Taking the figures first obtained as the more correct, we see that at the present high price of copper, aluminium is considerably the cheaper metal for electrical work, and that for equal carrying capacity £100 expended on aluminium will balance an expenditure of £123 on copper. It must be remembered, however, that these figures represent the relative costs of the metals *only*, and that costs of erection, &c., may help to equalise the total outlay as between the two metals.

Erecting and Jointing Aluminium Transmission Lines.—The jointing of aluminium has long been a difficulty in connection with the use of this metal for electrical work, and many methods of overcoming it have been tried. The difficulties are caused by the skin of oxide which covers aluminium surfaces, and by the tendency of all aluminium alloys to disintegrate on exposure to damp air. Hence a good soldered joint is difficult to make ; and when made, it is exceedingly liable to become rotten after a few months' exposure. In the States, where most experience in this direction has been gained, a mechanical joint has been adopted for small wires that can be bent and twisted without injury, and solder is only used for the larger and thicker wires and for bars. The usual form of mechanical joint consists of a thin aluminium tube through which the two ends of the wire are drawn in contrary directions. The tube is then crushed in on the wires, and the two free ends of the latter are bent back and twisted round the tube. A full description of this method of jointing will be found in the Paper named below.* It was the method

* The *Engineer*, Feb. 17, 1899.
† *Electrical Review* (New York), Aug. 30, 1899.
‡ *Aluminium World*, July, 1899.
§ *Electricity* (New York), May 30, 1900.
‖ *Engineering*, Aug. 19, 1898.

* *Aluminium World*, February, 1899.

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used on the original Blue Lakes and Stockton power line, and it is to be adopted for the line which is now being erected in place of the earlier one.

With regard to the precautions to be observed in erecting aluminium transmission lines, Messrs. Perrine and Baum give very full details in a Paper which they have recently read before the American Institute of Electrical Engineers, and as many of the points upon which they touch are of the highest importance the writer has thought it well to reprint some of their remarks in full below :—*

In carefully performing the test for tensile strength no exact point could be assigned for the elastic limit, as the metal seemed to take a permanent set almost from the first, but at a stress of from 14,500lb. to 17,000lb per square inch, there is a marked increase in the permanent set which indicates that the safe working load lies somewhere in this region. In this the characteristics of the aluminium do not differ materially from those of copper or other similar metals, and while this is a disadvantage it is not a singularity.

The fact that the wire will permanently elongate if seriously strained makes it necessary to use the utmost care in the erection of lines, and also the known high coefficient of expansion with temperature changes, taken in conjunction with this property, renders care in line stringing especially important and difficult.

Instructions to Line Foremen in Stringing Wires.

1. All spans are to be strung with deflections and tensions as specified.
2. Up-and-down hill spans to be sprung to correspond with level spans. In case level spans cannot be used, then employ dynamometer, and ease all wires over cross-arms.
3. All ties are to be made at one time by signal.
4. All ties are to be made crossing wires around insulator, serving three times around wire, and twisting behind insulators ; the ends of the tie wires are not to be cut but bent back toward insulators.
5. Tie all wires on the outside of the insulators, except at corners, where all are to be tied so that the strain is against the insulator.
6. Joints are to be made by means of sleeves twisted two and a-half times, the ends of the wires being given one turn by hand around the wire, no tools being used except in twisting the sleeves and cutting off the ends of the wires. Before inserting the wire in the sleeve the ends of the wire must be roughened by draw filing.
7. Barb wire is to be laid along the roof of the pole and held by three staples driven in tightly, but without kinking the wire. Ground wires are to be soldered to the barb wire, and at the bottom of the pole to the wire leading from the ground plate. All soldering acids must be carefully washed away after the soldering is done.
8. Beginning between poles 1 and 2, all wires are to be barrelled by shifting one pin, and same to be repeated between poles 21 and 22, and 41 and 42, and so on, barrelling always in the same direction of twist every 20 poles. A record must be kept of the location of every wire and every pole.

General Caution.

The greatest care must at all times be taken against kinking or scarring the wire ; wherever the wire is accidentally kinked or scarred it must be cut and spliced.

These directions would seem to indicate that the erection of aluminium lines is more troublesome than when copper is the metal used, and that therefore the cost of erection will be somewhat higher in the case of the lighter metal. Exact figures bearing upon this point, however, are lacking.

(*To be continued.*)

A Loud-Speaking Phonograph.—Mr. H. L. Short, of Brighton, has invented a loud-speaking phonograph, which in appearance is merely an ordinary phonograph, with a large trumpet, measuring 4ft. in length. Inside this trumpet there is a small and delicate piece of mechanism that looks something like a whistle. This is the tongue of the machine. Instead of the "records" being taken on wax in the usual manner, a sapphire needle is made to cut the dots representing the sound vibrations on a silver cylinder, and when the needle travels over the metal a second time the vibrations cause the whistle to produce a series of air waves and the machine thus becomes a talking siren, which transforms the human voice into a deafening roar. Experiments have been made near the Devil's Dyke, Brighton, where the inventor has his workshops. The instrument was placed on the roof of the laboratory and was made to repeat a number of sentences. At a distance of 10 miles, it is said, the sounds were plainly heard by a large number of people, every word being perfectly distinct; and at a second trial, with favourable wind, it was found that an unknown message could be taken down in shorthand at a distance of 12 miles.

* *Electricity* (New York), May 30, 1900.

BRITISH ASSOCIATION.

We give below a provisional list of the Papers to be read in Section G. (Mechanical Science) at the meeting of the British Association at Bradford :—

Thursday, September 6th.

Sir ALEXANDER BINNIE.—Presidential Address (11:30 a.m.).
JAMES WATSON.—"Bradford Waterworks" (2 p.m.).
JOHN MCTAGGART.—"The Disposal of House Refuse in Bradford."

Friday, September 7th.

Prof. HELE SHAW, F.R.S.—"Resistance of Road Vehicles to Traction."
W. H. H. DAWSON.—"Recent Tramway Construction, with special reference to the Demerbe system."
J. H. GLASS.—"The Coal and Iron Ore Fields of Shansi and Honan, and Railway Construction in China."
A. T. WALMISLEY.—"The Use of Expanded Metal in Concrete."
J. B. C. KERSHAW.—"Power Generation—Comparative Cost by the Steam Engine, Water Turbine, and Gas Engine."

Saturday, September 8th.

Prof. R. BEAUMONT.—"The Application of Photography to Textile Designing."

Monday, September 10th.

W. A. PRICE.—"Report of the Small Screw Gauge Committee."
A. MALLOCK.—"Measurement of the Tractive Force, Resistance, and Acceleration of Trains."
Sir W. H. PREECE, F.R.S.—"The Liverpool and Manchester Electric Railway."
A. H. GIBBINGS.—"The Design and Location of Electric Generating Stations."
T. BARKER.—"A Maximum Demand Meter."
J. W. BINNIE.—"An Account of a New Form of Self-registering Rain Gauge."
J. G. W. ALDRIDGE.—"The Automobile for Electric Street Traction."

Tuesday, Sept. 11th.

Prof. J. GOODMAN.—"A New Form of Calorimeter for Measuring the Wetness of Steam."
Prof. ARNOLD.—"The Internal Architecture of Steel."
E. E. CLARK.—"Shop Buildings."
H. R. ARMITAGE.—"Steam Raising and Smokeless Combustion."

ELECTRICITY WORKS ACCOUNTS.

Bristol Municipal Electric Supply Works.

The Bristol accounts for the year ended at March 25 last, which we analyse this week, exhibit figures indicating excellent results. The most striking feature is the reduced fuel cost per unit sold. It must be admitted that the fuel item for 1898-9 was materially above the average under similar conditions of output and load-factor. Still, to have effected a reduction in this charge in the face of the stiff coal prices which have ruled, especially in the West of England lately, is a matter upon which the engineer at Bristol is to be highly congratulated.

The generating costs in general show a decided diminution, but the management charges have increased, largely in consequence, we learn, of sundry items being charged to revenue that have not hitherto been so charged. Thus, the departments, engineers have been carrying out all new work themselves, and the salaries of certain members of the staff engaged almost exclusively on capital work are being charged against revenue account.

To a considerable extent the favourable generating and works costs attained during the year must be attributed to the improved output and load. The number of units sold in 1899-1900 mark an advance of 33 per cent. on the number of 1898-9, while the load-factor has made the sp'endid increase from 9·12 per cent. to 12·35 per cent. The lamp connections indicate an increase of nearly 24 per cent.

In the table on the next page some additional and interesting particulars are given relative to the undertaking.

Portsmouth Municipal Electric Supply Works.

Although a regrettable increase in the costs is noticeable in the accounts of this undertaking, the items which have risen are only three, of which, as was to have been expected, fuel was one. The increase of 0·22d. in this item represents by far the greatest proportion of the increase in the works and total cost items.

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	BRISTOL.		PORTSMOUTH.	
Undertaking Worked by	Bristol Corporation.		Portsmouth Corporation.	
Date of Commencement of Supply	August, 1893.		June, 1894.	
System of Supply	Alt.-curr. transformer sub-stations with 3-wire [distribution.		Alternate-current transformer sub-stations.	
Chief Engineer	H. Faraday Proctor.		E. Price.	
YEAR ENDED	MAR. 25, **1899.**	MAR. 25, **1900.**	MAR. 31, **1899.**	MAR. 31, **1900.**
QUANTITIES—				
Units generated	1,821,725	2,384,464	1,521,062	1,699,540
„ **SOLD (TOTAL)**	1,362,786	1,812,511	1,224,949	1,393,091
„ sold to consumers	1,033,324	1,330,670[l]	802,499	973,835
„ sold for public lighting, &c.	329,462	481,841	422,450	419,256
„ used on works	458,939[a]	571,953[m]	51,433	38,426
UNITS SOLD PER 8 C.P. LAMP CAPACITY	16·3	18·4	28·3	22·4
Maximum supply demanded	1,707 kilowatts	1,676 kilowatts	1,132 kilowatts	1,319 kilowatts
Number of public lamps	304 arc, 9 incan.[b]	308 arc, 3 incan.	261 arc	264 arc, 16 glow
Number of consumers	1,000	1,215	1,200	1,433
Connections to mains in 8-c.p. lamps	73,630	91,117	59,180	73,420
CAPACITY OF PLANT IN 8-C.P. LAMPS	83,800	98,600	43,300	62,100
CAPACITY OF PLANT IN KILOWATTS	2,681[c]	3,154	1,386	1,986
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£198,000 / £73·9	£254,950 / £80·8	£159,975 / £115	£159,975 / £80·6
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	198,000 / 73·9	254,950 / 80·8	159,975 / 115	159,975 / 80·6
RECEIVED (TOTAL)	189,763 / 70·8	228,730 / 72·5	129,651 / 83·6	159,975 / 80·6
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	189,763 / 70·8	228,730 / 72·5	129,651 / 83·6	159,975 / 80·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	8,237 / 3·07	26,220 / 8·31	30,324 / 21·9	nil / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	8,237 / 3·07	26,220 / 8·31	30,324 / 21·9	nil / —
REPAID (TOTAL)	22,520 / 8·40	30,110 / 9·55	— / —	3,973 / 2·00
RESERVE OR SINKING FUND	5,339[d] / 1·99	6,474[n] / 2·05	13,292 / 9·59	14,124 / 7·11
DEPRECIATION FUND	2,006 / 0·75	2,025 / 0·642	1,475 / 1·06	2,725 / 1·37
EXPENDED (TOTAL)	192,653 / 71·9	252,588 / 80·1	140,776 / 102·0	161,054 / 81·1
Lands and buildings	46,204 / 17·2	55,435 / 20·7	18,180 / 13·1	20,001 / 10·1
Plant	75,536[e] / 28·2	93,825[o] / 29·75	68,752 / 49·5	78,176 / 39·4
Mains	64,732 / 24·1	87,283 / 27·7	50,507 / 36·4	59,019 / 29·7
Miscellaneous	6,182 / 2·30	6,046 / 1·92	3,339 / 2·41	3,857 / 1·94
BALANCE OF CAPITAL ACCOUNT	−2,899[f] / −1·078	−23,858[f] / −7·57	−11,125[a] / −8·02	−1,079[a] / −0·544
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£26,117 / 4·600d.	£31,718 / 4·200d.	£20,197 / 3·958d.	£23,943 / 4·127d.
Revenue from supply	18,698 / 3·293d.	23,169 / 3·069d.	14,788 / 2·900d.	18,169 / 3·132d.
„ meters, &c.	875 / 0·154d.	1,118 / 0·148d.	589 / 0·115d.	777 / 0·134d.
„ public lighting	6,301[g] / 0·109d.	7,073[p] / 0·937d.	4,733 / 0·927d.	4,798 / 0·827d.
„ sale of lamps, &c.	34 / 0·006d.	149 / 0·020d.	43 / 0·008d.	139 / 0·024d.
„ miscellaneous sources	209 / 0·037d.	210 / 0·028d.	44 / 0·009d.	61 / 0·011d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£13,481 / 2·374d.	£17,962 / 2·378d.	£10,477 / 2·053d.	£13,320 / 2·296d.
WORKS COSTS	9,798 / 1·725d.	12,807 / 1·696d.	8,540 / 1·674d.	11,121 / 1·916d.
Generation of electricity	*8,048 / 1·417d.*	*10,022 / 1·327d.*	*6,860 / 1·344d.*	*8,742 / 1·507d.*
Fuel (including cartage, &c.)	4,901 / 0·864d.	6,231 / 0·825d.	3,798 / 0·745d.	5,616 / 0·967d.
Oil, waste, water, stores	364 / 0·064d.	511 / 0·068d.	920 / 0·180d.	856 / 0·148d.
Wages at station	1,908 / 0·336d.	2,190 / 0·290d.	1,081 / 0·212d.	1,103 / 0·190d.
Repairs and maintenance at station	875 / 0·154d.	1,090 / 0·144d.	1,062 / 0·208d.	1,168 / 0·201d.
Distribution of electricity	*822 / 0·145d.*	*1,342 / 0·178d.*	*452 / 0·089d.*	*976 / 0·168d.*
Wages, &c.	328 / 0·058d.	548 / 0·073d.	452 / 0·089d.	976 / 0·163d.
Repairs, renewals of mains, &c.	494 / 0·087d.	794 / 0·105d.		
Public lighting	*928 / 0·163d.*	*1,442 / 0·191d.*	*1,228 / 0·241d.*	*1,403 / 0·243d.*
Attendance	623 / 0·110d.	1,036 / 0·144d.	1,228 / 0·241d.	1,151 / 0·198d.
Renewals	306 / 0·054d.	356 / 0·047d.		252 / 0·043d.
MANAGEMENT AND PROPERTY CHARGES	3,682 / 0·649d.	5,156 / 0·683d.	1,937 / 0·380d.	2,198 / 0·379d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*1,362 / 0·240d.*	*1,767 / 0·234d.*	*473 / 0·093d.*	*488 / 0·084d.*
Management	*2,320 / 0·409d.*	*3,389 / 0·449d.*	*1,464 / 0·287d.*	*1,710 / 0·295d.*
Salaries	1,476 / 0·260d.	1,996 / 0·264d.	1,225 / 0·240d.	1,334 / 0·230d.
Stationery, &c.	122 / 0·021d.	179 / 0·024d.	85 / 0·017d.	71 / 0·012d.
Establishment charges	325 / 0·057d.	465 / 0·062d.	93 / 0·018d.	129 / 0·022d.
Law charges, &c.	397[h] / 0·070d.	749[i] / 0·099d.	61 / 0·012d.	176[c] / 0·030d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£12,636 / 7·48%	£13,756 / 6·18%	£9,720 / 7·69%	£10,623 / 7·03%
Sum carried to Depreciation Fund	2,006 / 1·19%	— / —	1,475 / 1·17%	1,250 / 0·828%
Sum carried to Reserve or Sinking Fund	8,400[i] / 4·97%	7,590 / 3·41%	3,610 / 2·85%	4,508 / 2·99%
Net interest on loans (incl. Debenture charges)	4,402 / 2·60%	6,020 / 2·70%	4,017 / 3·18%	4,867 / 3·22%
BALANCE FROM LAST ACCOUNT	5,038 / 3·01%	2,916 / 1·31%	384 / 0·30%	nil / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	2,916 / 1·72%	3,062 / 1·37%	1,000[b] / 0·79%	nil / —
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	51·6%	56·6%	51·9%	55·7%
Expenditure per kilowatt capacity	£5. 0s. 7d.	£5. 13s. 11d.	£7. 11s. 2d.	£6. 14s. 2d.
REVENUE PER KILOWATT CAPACITY	£9. 15s. 0d.	£10. 1s. 0d.	£14. 11s. 5d.	£12. 1s. 2d.
Expenditure per 8-c.p. lamp capacity	3s. 2½d.	3s. 7¾d.	4s. 10d.	4s. 3½d.
REVENUE PER 8-C.P. LAMP CAPACITY	6s. 2¾d.	6s. 5½d.	9s. 3¾d.	7s. 8½d.
REVENUE PER 8-C.P. LAMP CONNECTED	7s. 1d.	6s. 11½d.	6s. 10d.	6s. 6½d.
Price charged for lighting, per unit	5d. (max.)[j] 2½d. (min.)	5d. (max.) 2½d. (min.)	4½d.	4½d.
Price charged for power, per unit	1½d.[k]	1½d. (max.) 1¼d. (min.)	2½d.	2¼d.
Price charged for public lighting	£23 per lamp per ann.	£23 per lamp per ann.	£18 per arc per ann.	1¾d. per unit.

BRISTOL.—REMARKS—*a* Being 131,392 units at generating station and 327,547 units (estimated) by external system. *b* The glow lamps are of 25 c.p. each. *c* Of which 2,216kw. is of alternating plant and 465kw. continuous current plant. *d* Includes £339 balance of suspense account (from premiums received with improvers). *e* Includes £8,226 on public lamps. *f* Over-expended. *g* Includes £5,373 for electricity supplied and £928 attendance, carbon, and repairs. *h* Includes £128 to law and £168 to insurance. *i* £6,400 being instalment for redemption of loans and £2,000 being to reserve fund. *j* From October 1, 1898. *k* Minimum of £1. 5s per kilowatt per quarter, discount up to 20 per cent. *l* Of which 102,546 units (estimated) are used by day-load customers through controlling clocks and unregistered. *m* 216,219 units at generating station and 355,734 units (estimated) by external system. *n* Includes £5,000 balance of reserve fund and £1,190 balance of redemption account and £284 balance at credit of suspense account. *o* Including £8,300 on public lamps. *p* Includes £5,631 electricity supplied and £1,442 attendance, repairs and carbons. Includes £179 to insurance and £108 to electrical inspector,

PORTSMOUTH.—REMARKS—*a* Over-expended. *b* Applied in aid of local rates. *c* Includes £30 to insurance and £21 to auditing.

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Year to.	No. of public lamps. Arc.	Glow.	Equiv. 30 watt.	Motors. Agg. H P.	Equiv. 30 watt lamps.	To'al connections to mains 30 watt lamps (equiv.).	No. of consumers.	Plant capacity. KW.	Max. load KW.	Load factor %	Units sold to private consumers.	Units sold for public lighting.	Total units sold.	Total costs per unit sold.	Total revenue per unit sold.	Per cent. ratio of total costs to revenue.
December, 1893	90	...	1,500	...	...	9,403	120	700	226	†8·48	53,829	10,019	63,848	9·97d.	6·02d.	166
Do. 1894	97	...	1,616	...	...	16,146	240	930	322	10·41	143,106	150,417	293,523	5·04d.	5·41d.	93·1
Do. 1895	99	...	1,650	3·33	83	25,696	439	1,014	515	9·06	251,708	156,593	408,301	3·51d.	5·87d.	59·8
Do. 1896	105	...	1,750	3·33	83	38,049	593	1,216	766	9·70	483,527	167,231	650,758	2·75d.	5·55d.	49·5
*Mar. 25, 1897	105	...	1,750	3·33	83	40,586	617	...	656	17·8	188,357	47,607	235,964	...	...	...
Do. 1898	105	3	1,778	19·53	486	51,495	749	1,972	1,010	10·3	743,163	167,725	910,888	2·50d.	5·42d.	46·1
1899	304	3	5,094	60·53	1,504	73,630	967	2,589	1,707	9·11	1,033,324	329,462	1,362,786	2·37d.	4·60d.	51·6
1900	308	3	5,161	111·53	2,770	91,117	1,215	3,154	1,676	12·35	1,330,670	481,841	1,812,511	2·38d.	4·20d.	56·6

* 3 months. † Approximately.

We are glad to note that in spite of the advance in the aggregate costs, they are still well below the average 1898 costs in municipal stations of similar output and load-factor. This is saying a good deal when the greater cost of coal is taken into account.

The other items which have risen are those of distribution costs and management charges. The former have been added to by the expenditure on removable transformer switches and alterations to transformer pits to accommodate these switches.

Owing to a decrease in the rents, rates and taxes the collective management and property charges have fallen very slightly from the already low figure of 0·38d. per unit. in 1898-9.

The output has made but slight progress, the increase being only 13·7 per cent., and unfortunately there has occurred a falling off in the value of the load-factor from 12·35 per cent. to 12·06 per cent. In these circumstances the figures exhibited in the costs column are certainly most creditable, and it is unfortunate that the general position of the undertaking has been marred by the small advance in the business done.

THE MAGNETIC FORCE OF THE ATOMS.*

BY ROBERT LANG.

Ampère's hypothesis of molecular currents has in recent times acquired a more concrete form owing to the currents generating the magnetic field being regarded as convection currents of revolving ionic charges. F. Richarz† has more especially dealt with this question, and in his work we also find references to the previous work of W. Weber, Ebert, and Chattock. Since that work I have not met any which deals with the question in greater detail. Richarz has limited himself to examining the admissibility of the explanation of molecular magnetism by the rotation of valency charges, calculating the magnetic moment of saturation for iron direct, and finding it to agree as regards order of magnitude closely with the experimental value.

In what follows I intend to show (1) that this proof can also be brought while using values differing essentially from those employed by Richarz; (2) that thus we possibly obtain a connection between minimum atomic volume and magnetism which up to the present has also been empirically recognised; (3) that with regard to atomic magnetism the unsaturated valencies appear to play an important part; and (4) that the new hypothesis permits the consistent explanation of several phenomena hitherto imperfectly understood.

I.

From the consideration that revolving valency charges emit electrodynamic waves, and that their period must be longer than that of the extreme visible red light, and from a contemplation of the kinetic energy of this motion, Richarz finds for the period of revolution T the limits

$$3\times10^{-15} < T < 10^{-12} \text{ secs.}$$

and eventually puts as an approximation $T \backsim 10^{-14}$ sec. He further calculates the diameter of the orbit of an ion, and puts it equal to the edge of the elementary cube of the iron atom, $1·5\times10^{-8}$ cm. With the value 43×10^{-22} C.G.S. for the valency charge we have, therefore, by the theorem of equivalence between a circular current and a magnet, the magnetic moment of an iron atom as 2×10^{-22} C.G.S. units, and therefore, since the number of molecules in 1 gramme of iron is estimated at 4×10^{21}, the saturation moment of iron comes out as 8 C.G.S. units. Experiment gives 220 and 150 for cobalt and 60 for nickel. Richarz, therefore, considers the attempt to reduce the molecular magnetism existing before the orientation of the elementary magnets to a rotation of the ionic charges as admissible.

Now, very little is yet known concerning the inner structure of metals, whereas, on the other hand, our conceptions with regard to solutions of electrolytes have in recent years been widely extended. It therefore appears expedient to test the value of the hypothesis mentioned, not by a metal, but by solutions of its salts, and all the more since experiments with dilute paramagnetic solutions are capable of great accuracy, and have, indeed, been largely performed and published. Among the older ones there are more especially those of G. Wiedemann, and, recently, those of G. Jäger, S. Meyer, J. Königsberger, H. du Bois, and O. Liebknecht—which should be mentioned. We employ for the test the interesting results of the first two modern physicists, Jäger and Meyer,* obtained for solutions of chlorides, sulphates, and nitrates of the four magnetic metals nickel, cobalt, iron, and manganese, which show (1) that only the metallic contents determine the magnetic susceptibility, (2) that the atomic susceptibilities of Ni, Co, Fe, and Mn multiplied by 10^6 are 4·95, 10·0, 12·5, and 15·0 C.G.S. units respectively, and therefore are in the ratio 2 : 4 : 5 : 6. Both these results are confirmations or extensions of theorems already found by G. Wiedemann. The figures refer to 17·5°C. and to fields of 1×10^4 to $1·8\times10^4$ units. Within this interval no dependence of the magnetic susceptibility upon the field strength was shown, so that it may be assumed that saturation was attained.

Let us therefore calculate in Richarz's manner the maximum magnetic moment of 1cc. normal $FeSO_4$ solution (1 gramme-molecule in 1 litre of water). According to Nernst, it contains $5·4\times10^{19}$ molecules, and therefore as many iron atoms. With Richarz's number 2×10^{-22} for the magnetic moment of the iron atom we obtain for the saturation moment of 1cc. of $FeSO_4$ solution $1·08\times10^{-2}$ C.G.S. units. According to G. Jäger and S. Meyer, this moment is $4\pi\times12·5\times10^{-6}\times10^4 = 1·57$ C.G.S. units. Hence we may say that the accordance is about the same as in metallic iron; the calculated moment is 27 or 145 times smaller than the real moment.

If, therefore, we consider Richarz's explanation of molecular currents through central motions of the ionic charges as possible in principle, we must not forget that this reasoning requires certain arbitrary assumptions. In the first place, it is assumed that $T > 3\times10^{-15}$ secs., *i.e.*, that the rotations take place more slowly than the vibrations of the extreme red light, since otherwise they would be perceived as light.† But there is evidently another possibility, viz., that $T < 7\times10^{-16}$ sec., or that the rotations occur more rapidly than the vibrations of the extreme violet light. Again, Richarz puts the diameter of the orbit of the revolving ions equal to the edge of the elementary cube of the iron atom, for which he finds the value 10^{-8} cm. We see that this is also the average value which the kinetic theory of gases assigns to the size of molecules. Considering that the atoms only partially fill up their space, and considering the special circumstances, that it is just the magnetic substances which are distinguished by a minimum atomic volume, it appears very probable that the diameter of the ionic orbit is less than 10^{-8} cm. To investigate this possibility put $T \backsim 10^{-x}$ sec. and the diameter of the orbit $\backsim 10^{-y}$ cm. Then the magnetic moment of the di-valent Fe atom is

$$(2\times43\times10^{-22}/10^{-x})\times10^{-2y} = 8·6\times10^{-21+x-2y} \text{ C.G.S.}$$

Hence the moment of 1cc of normal $FeSO_4$ solution

$$= 5·4\times10^{19}\times8·6\times10^{-21+x-2y} = 4·6\times10^{-1+x-2y} \text{ C.G.S. units.}$$

Putting this equal to the experimental value 1·57 C.G.S., we obtain from a comparison of the orders of magnitude.

$$x = 2y + 1.$$

* Translated from the *Annalen der Physik*, No. 7, 1900, Vol. II., 3.
† *Wied. Ann.*, 52, pp. 410-415, 1894.

* *Wied. Ann*, 63, pp. 83-90. 1897.
† This does not follow—Translator.

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Hence for

$$y = 9 \text{ we have } x = 19,$$
$$y = 10 \quad " \quad x = 21, \text{ \&c.}$$

Here we have for the longest periodic time $T \backsim 1 \cdot 10^{-19}$ sec. We see, therefore, that these numbers fulfil the condition put down for T, and that even in the case of the largest value there is room for ultra-violet light.

For all correlated values of T and δ we have for the magnetic moment of a Fe atom considered as di-valent the value $8 \cdot 6 \times 10^{-20}$ C.G.S., and for the saturation moment of 1cc. of normal $FeSO_4$ solution 4·6 C.G.S., instead of 1·6 C.G.S. This shows that the explanation of the molecular currents by ionic revolutions is also possible on the basis of values which considerably differ from the order of those adopted by Richarz. Exactly the same value comes out for the magnetic saturation moment of 1cc. of normal solutions of $CoSO_4$, $NiSO_4$, $MnSO_4$, or the chlorides and nitrates of the four paramagnetic metals considered as di-valent. For in a physico-chemical sense, as far as is known, all these solutions are in the same condition. They are, for instance, probably dissociated to the same extent, and the atomic weight and atomic volume for all the four metals considered is nearly exactly the same. But if actually the atomic magnetisms are different, and stand in the integral proportion of 2 : 4 : 5 : 6, it is obvious to assume that this behaviour is connected with the various free valencies of the metals. For it appears probable beforehand that not all the valencies of the atoms but only the free ones are in rotation, and that therefore *only the latter* are responsible for the generation of atomic magnetism. Hence the free valencies of Co, Ni, Fe, and Mn in the solutions in question should be as 2 : 4 : 5 : 6. If there is any truth in this, chemistry acquires in the magnetic examination of paramagnetic solutions an instrument which permits an attack at all events upon a range of investigations hitherto as good as entirely closed.

According to Mendelejeff, the following salt-forming oxides of our four metal occur :—

Ni_2O_2, Ni_2O_3

Co_2O_2, Co_2O_3, Co_2O_4

Fe_2O_2, Fe_2O_3, Fe_2O_4, Fe_2O_6

Mn_2O_2, Mn_2O_3, Mn_2O_4, Mn_2O_6, Mn_2O_7.

The oxides of the form R_2O_2 correspond to the salts of our magnetically-examined solutions. The rest give, by the possibility of their existence at least an indication of the number of their free valencies. Excluding multiple combination, we have for the proportion of the free valencies the numbers 2 : 4 : 8 : 10. It is quite possible that with multiple linking, especially of the more complicated combinations Fe_2O_6 and Mn_2O_7, the proportion becomes 2 : 4 : 5 : 6.

Clearly, the salt solutions of the magnetic metals represent a simpler case than the metals themselves, just as from a dielectric point of view gases are simpler than liquids. Here it is interesting to note how as regards magnetic susceptibility the free valencies appear to have the determining influence, while for the dielectric capacity the total sum of valencies of the simple or compound molecules appears to be the determining element.

We return once more to the values of T and δ found above, and consider the maximum values $T \backsim 10^{-19}$ sec. and $\delta \backsim 10^{-9}$ cm. T appears at first surprisingly small, while the orbital diameter δ differs less from the usual value. But these numbers lose much of their extraordinary appearance by the following consideration. Richarz lets the valency charges rotate with the material atoms themselves, in order to obtain the lower limit for T. Hence he has to deal with the inertia of matter. But here we shall adopt the view put forward by J. J. Thomson, P. Drude and others, based upon experiences in cathode and canal rays. The chemical atoms consist of greater and smaller electrons with definite electric charges. For the smaller ones, the cathode ray particles, the ratio of charge to mass, has been determined by Kaufmann* to be $1 \cdot 26 \times 10^7$ C.G.S. The greater electrons, probably positive, have the same charge, but greater mass. Thus Drude† finds for Ni the ratio of masses for negative and positive electrons from optical data to be 1 : 9·45.

In the case of molecular currents we may, therefore, regard the greater electrons as nuclei, about which the smaller ones as satellites revolve, their period of revolution being $T = 10^{-19}$ secs. From this conception we derive a calculated linear velocity of the small electrons of $\pi\delta/T \backsim 10^{10}$ cm. per second, which is of the order of the velocity of light. That is also the velocity with which the electrons, as cathode particles, fly across the Crookes' vacuum by the concurrent evaluation of J. J. Thomson ($1 \cdot 5 \times 10^9$), P. Lenard (0·67 to $0 \cdot 81 \times 10^{10}$), and W. Wien ($10^{10}$ cm. per second). Hence we can hardly doubt that the electrons can indeed acquire such extraordinary velocities provided they are impelled by a suitable force. This force is, in the case of cathode rays, furnished by the high potential gradient at the cathode. It is another question whether the electrons possess such velocities in their natural condition, without assignable cause. In answering this question, Becquerel's latest measurements in connection with the rays described by him are very important. By magnetic deflection he found, for the particles emitted by radium preparations, the value $(m/\epsilon) \times v = 1{,}500$. For cathode rays the same product is 1,030 to 1,273. Now, the radium particles are pretty certainly not larger than the cathode ray particles, and thus the natural velocity of the particles emitted by the radium preparation is at least of the order of 10^{10} cm. per second. Hence we conclude that the equal velocity of the electrons obtained in the case of the central motions supposed to produce magnetism is, at all events, not impossible.

As regards the orbital diameter δ, whose greatest value we have found to be about 10^{-9} cm., we must at once admit that δ^3 does not strictly agree with the atomic volume indicated by chemistry as the ratio of atomic we get, and specific gravity in the solid or liquid states, and which turns out to be a minimum in paramagnetic bodies. Generally speaking, the atomic volume will be greater than δ^3. On the other hand, we may assert that the larger δ, and hence the larger the more or less circular orbit described by the electrons the greater will be the sphere of molecular action, and, inversely, a diminution of the atomic volume will be accompanied by a diminution of δ. Although, therefore, a direct and similar alteration of the atomic volume and the diameter δ cannot be strictly proved, yet such a connection is probable, and in any case we have here for the first time theoretically a necessary metrical relation affecting magnetism, which is closely related to the empirical rule of the minimum atomic volume of magnetic substances.*

II.

We have seen in the last part that the new interpretation given to molecular magnetism does not contain any contradictions and is therefore possible. We shall further show that it casts new light on some phenomena hitherto unexplained.

1. Two conditions attend, as we have seen, the presence of paramagnetism—minimum atomic volume and force, *i.e.*, unsatisfied valencies. Both conditions are fulfilled by oxygen. As regards atomic volume, Meyer's table may be consulted,† and as regards the tetravalence of oxygen, which is usually di-valent, that of Heyes.‡ Hence it is not surprising that oxygen is paramagnetic, while most other gases are diamagnetic. If we imagine, then, two links of each atom bound in the oxygen molecule, and the others free, we get as before for the magnetic moment of an oxygen atom $4 \cdot 6 \times 10^{-1+x-2y}$ C.G.S. R. Hennig, on the other hand, found for the susceptibility of oxygen in comparison with a vacuum at 25°C. and the atmosphere, the value $0 \cdot 12 \times 10^{-6}$ C.G.S, the field being about 10^4 units. This gives for the magnetic moment of 1cc. oxygen under the conditions indicated the value $4\pi \times 0 \cdot 12 \times 10^{-6} \times 10^4 = 1 \cdot 5 \times 10^{-2}$ C.G.S., from which, by comparison of the indices, we obtain $x - 2y = 1$.

Hence we have for $y = 9$, $x = 17$,

$y = 10$, $x = 19$, &c.

Since a period $T = 10^{-17}$ lies too close to the ultra-violet rays we should give preference to the second pair of values.

We see that the values are of the same order of magnitude as in the case of iron, except that the diameter δ of the orbit appears somewhat smaller. But we may remark that the value of the magnetic moment employed by Richarz for a tetravalent Fe atom—viz., 2×10^{-22}, also gives a correct result when we utilise the free valency idea, although it is doubtful whether the iron atom may be directly replaced by the oxygen atom in a magnetic point of view.

2. From his ample material concerning magnetic susceptibilities S. Meyer deduces the following empirical rules: The molecular magnetism k of the paramagnetic combinations is smaller than the sum of the atomic magnetisms of the constituents. Oxidation seems generally to depress the k of the element, so much so that paramagnetic metals may yield diamagnetic oxides.

The first rule is a direct and general consequence of our conception of the part played by unsatisfied valencies in the genesis of magnetism. For in the chemical combination of two bodies we have always to do with the joining of valencies. Hence the magnetic susceptibility of a combination of paramagnetic bodies can at the utmost only be the sum of the atomic susceptibilities, but will mostly be smaller. Should the case occur that all the valencies are bound, or that the rotation of the unsatisfied valencies is hindered by the binding of the others, the combination may be diamagnetic. The second rule of Meyer furnishes an example of this. That the combination of two diamagnetic bodies, in the case that one of them at least has a small atomic volume, should appear feebly paramagnetic, may be explained by supposing that by the combination of some valencies between the atoms other links hitherto bound become free. This case will, of course, be a rare exception, although possible. Perhaps the copper compounds furnish such an example.

* *Wied. Ann.* 65, p. 439, 1898.
† *Physikal Zeitschr.* 1, p. 164, 1900.

* Königsberger, *Wied. Ann.*, 66, p. 731, 1898; and Meyer, *ibid.*, 69, p. 261, 1899.
† *Wied. Ann.*, 69, p. 236, 1899.
‡ *Phil. Mag.*, 25, p. 221, 1888.

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3. The third application refers to the kernel of the new hypothesis—viz., the order of magnitude of the values in question. We imagine, as already explained, that greater nuclei, probably positive ones, are surrounded by smaller nuclei, probably negative, which revolve as satellites round them. It is not necessary to consider the negative electrons as permanently attached to their nuclei. It is, indeed, probable that the various electrons have different velocities in their central motions, and that the value indicated represents a mean value. Now, if an electron attains a much larger velocity than corresponds with its period of revolution, it can proceed from the sphere of influence of one nucleus into that of another. This, of course, alters nothing in the conception made of the stationary condition of a magnetic body.

Imagine an iron rod longitudinally magnetised to saturation, and let the magnetic lines of force within it run parallel to the axis, so that they only enter the air at the terminal surfaces. Then the planes of the orbits of all the electrons are all parallel to each other, and perpendicular to the axis of the rod. A cross-section of the rod contains all the orbits whose centres are situated in it. In the interior of the rod we have the stationary condition mentioned. But at the surface, as at the surface of a liquid, a projection of specially swift electrons is possible, where otherwise no impediment exists. Such an impediment is air or a vacuum, and a dielectric generally which surrounds the magnet, since the protrusion of negative electrons at once produces an enormous difference of potential which prevents the projection of further electrons. At the polar surfaces themselves, as we see, no projection of electrons may be expected. A magnetic rod immersed in a dielectric loses, therefore, nothing of its energy.

This conclusion loses nothing in validity when the magnetic rod is magnetised in any manner, instead of being longitudinally magnetised.

The difference of potential appearing at the surface of a magnet at right angles to the magnetic lines of force represents an E.M.F. acting similarly to Volta's force, and capable of superposing itself upon the latter. That it exists has already been proved by the demonstration of the E.M.F. due to magnetisation. We refer specially to the more exact measurements of Hurmuzescu.* Two iron wires, 1mm. thick, and polished at the ends with emery paper, were inserted into the branches of a U-tube. One of the branches was placed between the poles of a strong electromagnet. The tube was filled with a solution of acetic or oxalic acid. The electrode normal to the magnetic field only touched the liquid at its lower end. As a result, it was found that the magnetised electrode was always negative as compared with the unmagnetised one. The direction of the field was immaterial. The curve of E.M.F. in terms of H resembles the curve of magnetic intensity in terms of H.

These results are a simple consequence of our hypothesis. One of the electrodes is magnetised transversely. Hence electrons are projected from its surface touching the liquid, and they change the liquid negatively. Owing to the conductivity of the acid and of the rest of the circuit the difference of potential is at once equalised, and a current is generated, the magnetised electrode forming the positive pole. That the direction of magnetisation is without influence is obvious, as also that the E.M.F. must increase with the magnetisation until saturation is attained.

The results of other experiments made by Hurmuzescu may be similarly predicted from the hypothesis. Thus, for instance, the electrode to be magnetised was entirely covered with an insulating layer, and only in the centre of its length a small round surface of the size of the cross-section of the wire was bared, so that the electrode when immersed in the acid was only touched by the liquid in that small surface. The electrode was again magnetised transversely, but placed so that at one time the normal of the bared surface was perpendicular to the magnetic field, and at another time parallel to it. The magnetised electrode was again the positive pole, but the E.M.F. differed with its orientation. In a field of 5,320 units the E.M.F.s were—

First position.....	114×10^{-4} volts.
Second position.....	19×10^{-4} volts.

Such a result may be expected from the theory. In the first case, the orbits of the electrons are normal to the bare surface, and can therefore emerge along its whole extent. In the second case, the orbits lie nearly all in the free surface. If this were plane, no electrons could emerge; but it is somewhat curved, and so some projections are possible. Under equal conditions, the E.M.F.s should be as the projections of the surfaces upon a plane containing the direction of the field and the axis of the electrode. In another experiment, the electrode last described was placed parallel to the lines of force. Hence the orbits were normal to the bare surface, and could emerge. As a matter of fact, the results were the same as in the first case of transverse magnetisation, where the liquid only touched the terminal surface of the electrode, though not so regular.

* *Journ. de Phys.*, 4, pp. 118—127, 1895.

ALTERNATING-CURRENT INDUCTION MOTORS.*

BY A. C. EBORALL.

(*Continued from page 644.*)

With regard to squirrel-cage rotors, and to the modification of them, the rotor wire-wound with closed coils, there is not much to say. The chief difficulty with the former lies in the fact that it is difficult to make a good mechanical job of the connections to the end rings. If the rotor bars are screwed to these rings the contact between bar and ring is not only uncertain, but however good it may be at first it is certain to deteriorate under the influence of the heavy rotor currents and the heating and cooling of the rotor. Consequently, most makers sweat the rings over the projecting and flattened ends of the bars. But with this the rings will sometimes melt right off under overload, splashing the solder all over the stator coils, and generally doing other damage. The author's firm braze the rings on, when a motor of this character is put to work of an exceptionally heavy nature, where overloads are the rule and not the exception, or when the starting conditions are severe. Messrs. Kolben get over the difficulty in the manner shown in Fig. 6; here the rotor bars are connected to the short-circuiting rings by means of thin copper strips, used as radial connectors. The rings themselves are of bronze, and are of small diameter, but very massive; they are keyed directly on the shaft without any insulation whatever. In a communication to the author, Mr. E. Kolben states that he has found this construction to prevent entirely the evil mentioned above, and that it greatly assists his single-phase motors to start well—doubtless on account of the extra resistance in the strips. Mr. Kolben also uses this construction for larger motors for crane and similar work (where large starting torques are required without, if possible, the employment of a starting resistance) as it allows of the insertion of the resistance strips of brass or other material, in place of the copper connectors. Several firms, notably the Oerlikon Company, avoid the squirrel-cage construction altogether, by winding the rotor with closed coils. In this case the rotor winding may either consist of a regular wave winding, taken all the way round either once or else several times and finally short-circuited, or better, of a number of coils, or groups of coils, separately short-circuited. Such wire-wound rotors are naturally more expensive than either of the forms described above, and are frequently difficult to wind, on account of the trouble experienced in handling the heavy conductors. The employment of wound rotors and non-inductive starting resistances is, as already indicated, always preferable for motors of any size. Here the rotors are invariably wound with a three-phase star-connected drum winding, which may be carried out either with overlapping (rectangular) coils, or with two or four bars per hole or slot, arranged as a cylinder wave-winding.

The common junction to the three phases of such a winding is frequently the iron-work of the rotor; this is very convenient with motors of considerable size, where the conductors are usually massive. Star-connected bar-windings of this character are always unsymmetrical, and "false connections" have to be made in each phase.

A point to be remembered when designing wound rotors for high-tension motors is the fact that the rotor volts per phase (that is, the voltage between any two slip-rings at normal stator pressure when the brushes are lifted off and the motor is at rest) must be kept down to a safe value: this is because at starting, with all resistances in, the voltage across each resistance (and the corresponding two rings) may be sufficiently large to be a source of danger to the attendant, if the turns in the winding have not been kept down; moreover, there is some risk of arcing taking place. On the other hand, in no case must the number of rotor conductors in series be too few, especially if the motor is of large size, else the cost of the starting box becomes excessive, and, if this latter is mounted on a switchboard, the three heavy cables coming to the latter may become inconvenient to arrange for; moreover, the contacts on the box may give trouble. It may sometimes happen that it is desirable to regulate the speed of a polyphase motor (by means of the rotor resistance) at a point situated a considerable distance away from the motor; in such a case, and if the motor is for a low voltage, it may pay to arrange the rotor windings to transform up, as it were, in order to effect a saving on the cost of the three cables, coming from the rings to the starting box, but this must not be pushed too far. Although it is the standard practice with one or two firms to build the starting resistance within the rotor itself, instead of employing a separate starting box and slip-rings, it would seem that the latter practice is the better. The advantage of doing away with the external arrangement consist, of course, in getting rid of the sliding contacts; on the other hand, it is easy for the short-circuiting device (whether operated by hand through the hollow shaft or automatically) to get out of order, inspection of

* Paper read before the Institution of Electrical Engineers.

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the contacts is difficult, and, above all, the motor is brought up to speed abruptly, because a subdivided resistance is practically out of the question. Consequently, the effect on the pressure regulation of starting a motor so fitted under heavy load is bound to be greater than if the motor had been fitted with an external graduated resistance, permitting of easy and gradual starting. However, several firms are now engaged in studying this detail, and considerable improvements may be expected shortly in the electrical and mechanical design of internal starting gear.

C. *Notes on Performance and Design.*—An analysis of the guaranteed performance of a given line of open or semi-enclosed induction motors between 2 B.H.P. and 100 B.H.P. built by any of the best Continental or American makers, and whose construction is on the lines indicated above, may be set forth as follows :—

1. No-load Current. Expressed as a percentage of the full-load current, the values for this will be as under :—

	Polyphasers.	Single-phasers.
For motors between 2 — 5 B.H.P. inclusive	30% ...	40%
Ditto 7½— 20 ditto	25% ...	30%
Ditto 25 —100 ditto	20% ...	25%

2. Overload Capacity. This is sensibly the same for all sizes with a given line of motors run at constant stator pressure, and will be as follows :—

	Polyphasers.	Single-phasers.
For one hour*	50%	Varies considerably,
Before falling out of step...	90%	but generally small.

3. Full-load Drop of Speed (Slip). At constant pressure on the stator terminals this will be :—

For induction motors between 2 — 5 B.H.P. inclusive	7%
Ditto 7½— 15 ditto	5%
Ditto 20 — 40 ditto	4%
Ditto 50 —100 ditto	3%

4. Heating. The final temperature-rise after a long continuous run at full load will not exceed 40°C. for semi-enclosed motors having outputs between 2 B.H.P. and 125 B.H.P., and 30°C. for larger sizes.

5. Full-load Efficiency. For semi-enclosed motors with hot windings the values for five representative sizes will be as follows :—

	2	5	10	25	50 B.H.P.
Polyphase motors ...	75% ...	79% ...	85% ..	87% ...	90%
Single-phase motors...	73% ...	77% ...	83% ...	86% ...	89%

6. Full-load Power-factor. The values for this quantity for five such representative motors will be :—

	2	5	10	25	50 B.H.P.
Polyphase motors ...	78% ...	80% ...	85% ...	87% ...	88%
Single-phase motors ...	72% ...	75% ...	80% ...	83% ...	85%

7. Weight per B.H.P. The net weight per B.H.P. (that is, not including the weight of the rails, pulley, and starting resistance, if any) of the five representative motors designed and constructed on the above lines will not come out much below the following values :—

	2	5	10	25	50 B.H.P.
Polyphase motors	80 ..	58 ...	56 ...	40 ...	40lbs.
Single-phase motors	115 ...	88 ...	66 ...	62 ...	62 „

NOTE.—The values given in Nos. 1 to 7 above are for 50-cycle motors at voltages of 110, 220, 440, or 500 volts, having the following number of stator poles per phase :—

All motors between	2—7½ B.H.P. inclusive,	four poles.	
Ditto	10—30	ditto	six „
Ditto	40—100	ditto	eight „

The various values, however, for 40 and 60 cycle motors having the same number of poles are practically the same as those given above. A standard line of induction motors constructed on the lines already indicated, and to which the above figures relating to performance apply, would have the following general technical data.

1. Peripheral Speeds :—4,000ft. to 7,000ft. per minute, according to the size of the motor.

2. Ampere-conductors per inch of stator (inner) periphery at full load.

B.H.P.	Ampere-conductors per inch.
2 to 7·5	250
10 to 30	330
40 to 100	430
100 to 150	570
Above 200	600

3. Flux densities per square inch. In the stator teeth :—

B.H.P.	Maximum value of B.
2 to 7·5	65,000
10 to 30	70,000
40 to 100	80,000
Above 100	85,000

In the rotor teeth :—

B.H.P.	Maximum value of B.
2 to 7·5	80,000
10 to 30	85,000
40 to 100	90,000
Above 100	100,000

In the air-gap the flux-density should never exceed 30,000 lines per square inch. The flux-density in the stator core is determined solely by the permissible loss, and does not otherwise affect the performance of the motor. The above figures give very good results for 50 ∿ motors having partly closed slots for both rotor and stator. With motors for higher frequency, and for hole-wound stators and rotors, smaller values must be taken.

4. Current Densities per square inch. With low and medium pressure semi-enclosed motors, the amperes per square inch in the stator windings at full load will be between 1,500 and 1,100, according to size, while in the rotor bars the current density will be about 15 per cent. higher. With high-pressure motors, somewhat smaller values must be taken in the stator on account of the relatively larger space taken up by insulation.

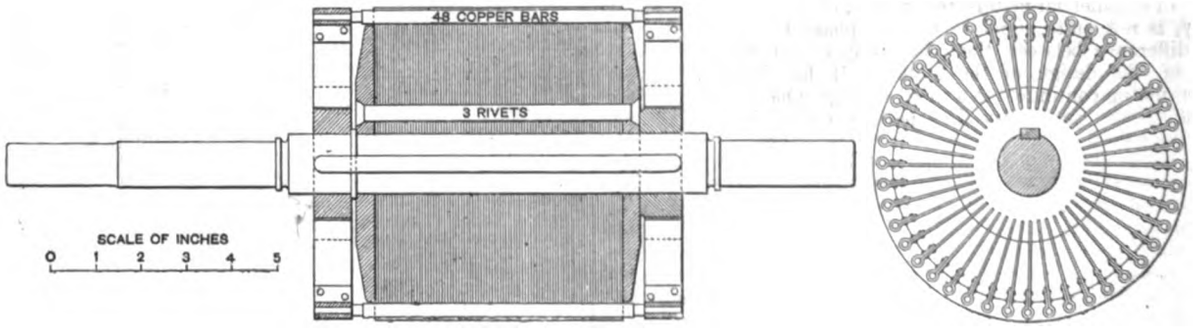

FIG. 6.

5. Length of Air-gap. This is always to be made as small as possible, and is determined wholly by mechanical considerations. Usual values for the length of air-gap, that is, the distance from iron to iron, are :—

Rotor diameter.	Air-gap length.
Up to 4 inches inclusive	1/100 inch.
Between 5 and 8 inches inclusive.....	1/75 „
„ 9 and 12 „	1/50 „
„ 15 and 20 „	1/32 „
„ 24 and 32 „	1/16 „
„ 40 and 60 „	1/8 „

Although the above figures relating to the design of induction motors have been taken wholly from practice, it is perhaps necessary to point out that it is not possible to apply hard and fast rules and constants when designing such motors—experience in designing and a large quantity of experimental data for the type in question are absolutely necessary if the best results are to be obtained.

PART II.—STARTING DEVICES FOR SINGLE-PHASE INDUCTION MOTORS AND SOME NOTES ON RECENT DEVELOPMENTS.

It is not too much to say that more attention has been given to the question of starting devices for single-phase induction motors than to any other problem connected with single-phase working. The first difficulty was to get such motors to start at all; then after this was overcome, there came the question of reducing the heavy starting current; finally, it was sought to so improve the starting device as to permit of the motor starting against load, still with a moderate current consumption. In the six years during which the subject has been before electrical engineers, successive improvements have taken place, and it is to the latest development in single-phase motors that the author wishes more particularly to refer in this part of his Paper, namely, the new motor

* The temperature rise not exceeding 70°C. for semi-enclosed motors, and less for open-type motors.

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of Mr. Alex. Heyland. Before doing so, however, it may perhaps not be out of place to consider very briefly the underlying principles of all single-phase induction motors, although, of course, there is nothing new to be said on the subject in these days. It has already been stated that a single-phase induction motor is nothing more than a polyphase motor running on one phase. Let, for instance, a two-pole two-phase motor be running from two-phase mains without load. Neglecting (as may quite well be done) the trifling power current required to make up the motor losses (under these circumstances practically only iron, ventilation and friction), the current read on a amperemeter in each phase is the "magnetising current" of that phase of the motor—that is, it is the wattless current required for driving the magnetic flux through the magnetic circuits of the motor; further the speed is synchronous. Now let one phase be switched out. The motor will go on running as a single-phaser at practically the same speed, but the amperemeter in the remaining phase will read approximately twice the current that it did before—that is, the magnetising current in this phase has doubled. What has happened is briefly as follows: The magnetic flux originally provided by the switched-out phase is now replaced by a flux of approximately the same value and relative position furnished by a magnetising current in the rotor. Magnetising currents are called into being in the rotor, induced by the magnetic flux of the phase still connected to the mains, and in quadrature with this flux with regard to time, and these currents are carried round nearly 90deg. in space by the practically synchronous rotation before reaching their maximum. Thus the cross-flux produced by them has very nearly the same effect as that formerly produced by the switched-out phase. The magnetising current in the rotor has, of course, to be balanced by a corresponding stator current, so that the amperemeter reads the magnetising amperes of phase 1, plus the magnetising amperes of the rotor transferred to the winding of phase 1. Hence the magnetising current in the latter approximately doubles. With this perfect motor running at synchronous speed, it would be found that a voltmeter connected to the terminals of the switched-out phase would give a reading equal to the pressure on the mains on which phase 1 is running. This E.M.F. is that induced by the cross-magnetisation of the rotor magnetising currents, and is in quadrature with the impressed E.M.F. of phase 1, as already stated. In commercial motors the E.M.F. of phase 2, measured in this way, is not quite equal to that of phase 1. The magnitude of the difference between the two voltages is a measure of the quality of the design of the motor. It has been said above that the motor continued to run as a single-phaser at practically the same speed. In reality the speed is a trifle less (the difference being too small to detect on a counter), owing to the fact that the rotor currents cause a slight slip, so that even a single-phase motor without friction and ventilation losses (unlike the polyphase motor) cannot run at a synchronous speed at no load. Of course, as the rotor is loaded, the rotor power currents called into being by the load are magnetically balanced by corresponding stator currents (when the rotor and stator coils are co-axial, or approximately so) and the slip increases, that is, the speed departs more and more from synchronism. Owing to this latter circumstance the induced rotor magnetising currents are carried round in space less than 90deg.; the cross-magnetisation produced by them is accordingly shifted from the most effective position, until with continually increasing load there comes a point at which the torque due to the cross field and the rotor load currents attains a maximum value—if this value is exceeded the motor pulls up. When the rotor is stationary, the cross magnetisation is reduced to zero; there remains now only the one flux of the phase connected to the mains (phase 1), and this flux cannot possibly produce a torque—that is, the motor cannot start—because its axis (that is, the axis of the exciting coils of phase 1) coincides with the axis of the current-carrying coils of the rotor. In order, therefore, to enable a single-phase induction motor to start at all, an auxiliary starting field must be created that will do exactly the same thing as the rotor magnetising currents do at synchronous speed. That is, with regard to space, a magnetic flux must be established in quadrature with the principal flux inducing the rotor currents; and with regard to time, this auxiliary flux must coincide with the rotor load current—that is to say, it must be approximately 180deg. behind the corresponding stator current. Every single-phase induction motor must therefore be provided with a device to produce a suitable cross-flux in the air-gap, and the amount of starting torque available will depend purely upon the value of this cross-flux, and upon the effectiveness of its time relations as stated above.

All single-phase induction motors are provided with starting coils wound in the useless winding space of the stator. They rarely occupy more than one-third of the total stator winding space, and frequently less; moreover, these coils are invariably so arranged that the magnetic axis of each coil is in quadrature* to the magnetic axis of the corresponding running coil—a disposition exactly fulfilling the "space" requirement stated above. The difference existing between the various starting devices lies mainly in the various methods of producing the requisite phase relation of the cross-magnetisation.

With the exception of the Heyland motor, all the devices employed for producing this requisite phase difference are external to the motor, and they have all been devised at one time or another by Mr. C. E. L. Brown, and have gradually been adopted by all other single-phase motor builders. These external starting devices take the special form of arranging that the self-induction of the circuit, including the starting coils, has a much higher value than that of the circuit containing the running coils, this being attained by suitable winding proportions in conjunction with choking coils or non-inductive resistances, or condensers; or any two of these in one or other of the stator circuits. The choice of such apparatus is governed by the relative value of the turns in the starting and running coils, and by the particular connections used at starting. The starting torque given by motors arranged in this way is inconsiderable, barely sufficient in fact to run the motor up to speed against the load of belt and loose pulley. Moreover, unless the motor is very carefully designed—particularly from the magnetic leakage point of view—the starting current at this small torque will be excessive. With the above-named exception, the very best single-phase induction motors of the present day working under the most favourable conditions require a current at starting at least equal to the full-load current in order to run them up to speed without the load, while against the full load they will not start at all, whatever the value of the starting current. The principal reasons for these comparatively indifferent results are, that the phase difference at starting produced by the above-mentioned means is small, and

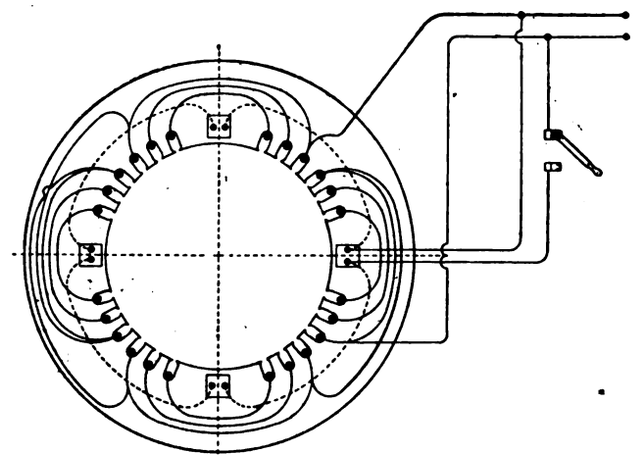

Fig. 7.

that the cross-flux produced by the starting coils does not attain a high value. As with independent alternating-current circuits a large phase difference will be produced by increasing the self-induction of the circuit, it might be thought that this could also be obtained in a motor by arranging the starting device and starting coils on these lines. But it must be remembered that the stator circuits of an induction motor are not really independent, on account of the action of the rotor currents. These behave with regard to the stator currents just as the loaded secondary of a transformer behaves with regard to the primary—that is to say, the self-induction of the stator windings is more or less completely wiped out by the mutual induction of rotor and stator. It follows from this that better results will be obtained if the number of turns of the starting coils is kept low, and the increase of self-induction produced by an external choking coil, or equivalent device involving magnetic leakage. This point was recognised at an early stage by motor builders, and an external choking coil (to produce as much phase difference as possible) is a leading feature of several modern starting devices. But this increase of self-induction, whether produced externally in this way, or by winding the starting coils with a large number of turns, effectually prevents the starting field of the motor (that is, the field in quadrature position to that of the stator running coils) from attaining that high value already shown to be absolutely necessary if a large starting torque is required. Where the self-induction is increased by increasing the turns of the starting coils, the strength of the cross-flux falls off inversely as the square root of the self-induction; if the choking coil is used, the strength of the cross-flux is diminished by an amount equivalent to the leakage flux of the coil. Consequently, it is evidently a clear fundamental point, that to obtain a large starting torque the self-induction of the starting coils should be kept down as much as possible.

*A notable exception to this disposition is the arrangement that has been used for many years by the Swedish firm of Wenström for their small single-phase motors, which have the starting coils "staggered" from the position indicated here.

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It has been hitherto generally held that the design of starting devices for single-phase induction motors should be such that the starting conditions should approximate as nearly as possible to the starting conditions of polyphase motors—that is, designers have aimed at the production of a rotary field at starting. Not only this, but every effort has been made to make this field as uniform as possible, by so proportioning the windings of starting and running coils as to produce two equal magnetic fluxes, and the production of a larger field by one or the other winding has been particularly avoided. Mr. Heyland's motor, which is shown here to-night, and described below, is designed with regard to the starting device on exactly opposite lines to these. Briefly, there is no external phase-shifting device, the starting winding being put straight on the mains, and this winding has comparatively few turns, and is so arranged that under all circumstances its self-induction is less than that of the running coils—that is, the winding carrying the current of greater phase-difference is made to have the smaller self-induction. As a result of the small self-induction of the starting coils, a cross-magnetic flux of great strength is available, and this cross-flux is made to have the proper time relation by a special arrangement of the magnetic circuit of the stator. The production of a rotary field at starting is not aimed at, the whole idea of the starting device being to produce a powerful alternating magnetisation having the proper phase relation in a direction (considering the two-pole case) at right angles to the axis of the running coils. The result is that the Heyland single-phase motors will all start against full load quite easily without an excessive current consumption, and it will be, therefore, readily admitted that an important advance has been made in single-phase motor work.

Apart from the design and arrangement of the starting device, the Heyland motors differ but little from other well-designed motors of the induction type. The stator-running winding consists of a number of rectangular coils wound in half-closed slots in such a manner that magnetic leakage is as small as possible, while the rotor is wound with a regular three-phase star-connected winding, with its three free ends connected to slip-rings on the shaft, for the insertion of a starting resistance. A squirrel-cage rotor, or one of its modifications, could be easily used, but it has been found that the reduction of the starting current (for a given torque) brought about by the use of the resistance well repays its use, even for motors as small as 1 H.P. Fig. 7 illustrates diagrammatically the stator windings of the Heyland single-phase motors, the figure illustrating a four-pole motor. The running coils are shown by the full lines, and the starting coils by the dotted lines. These latter coils are wound in rectangular holes in order to obtain the necessary large phase difference of the current in them; the flux produced by these coils links very unfavourably with the rotor windings, which has the effect of reducing the mutual induction of the circuits in question, with the result that the current in the starting winding lags considerably, sometimes as much as 50deg. The relation of the stator starting coils to the

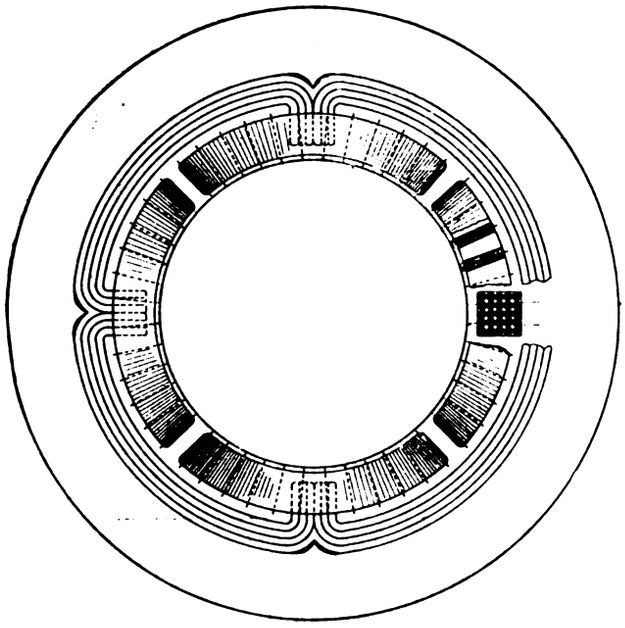

FIG. 8.

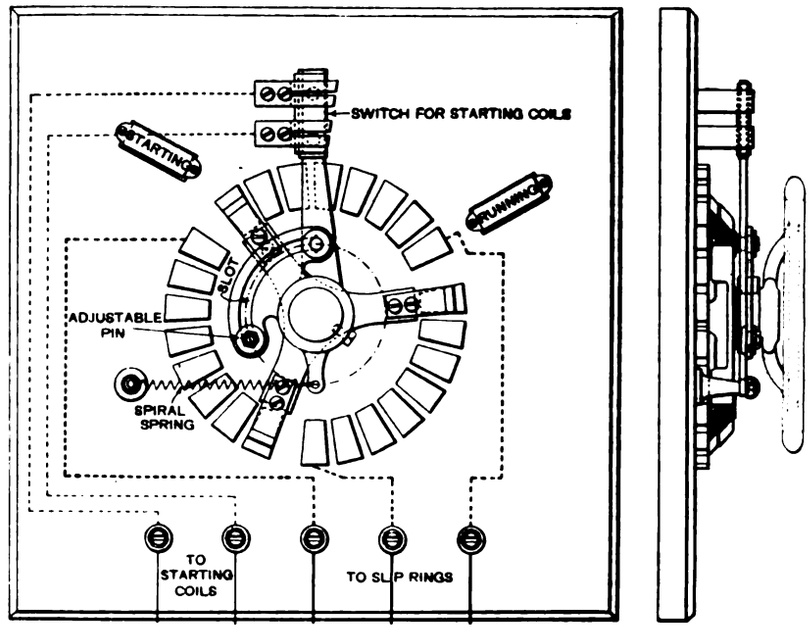

FIG. 10.

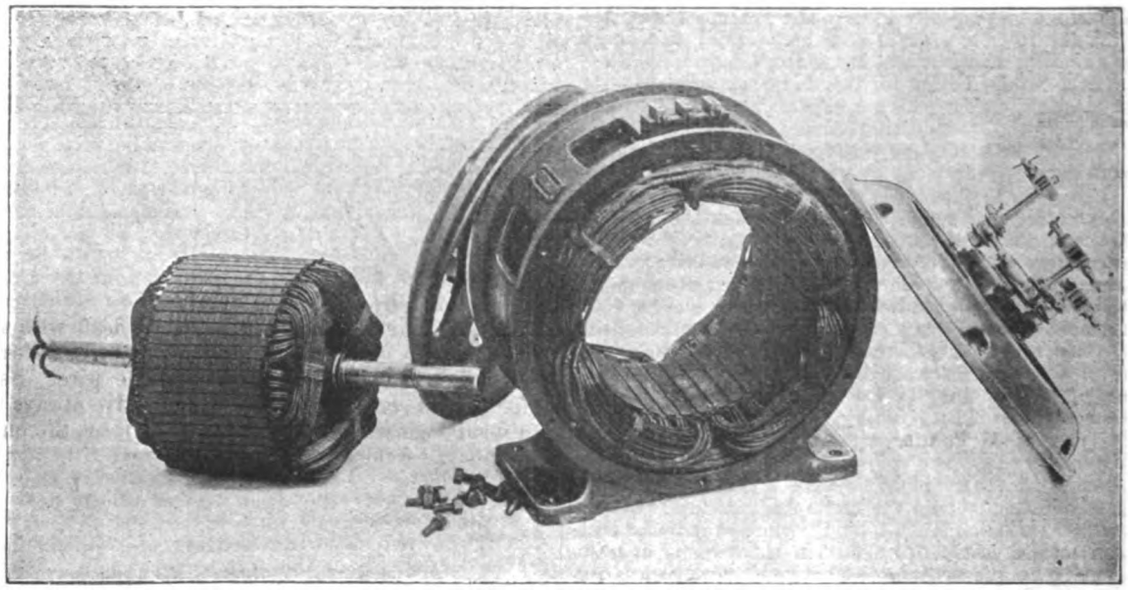

FIG. 9.

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coils of the rotor is in fact entirely analogous to the relations existing between the primary and secondary coils of a transformer having great magnetic leakage. As stated above, the turns of the starting coils are comparatively few in number, and have a low resistance; the amount of phase difference of the flux produced by the current in them is determined by the shape given to the holes, the dimensions of these, and by the winding depth. Fig. 8 and Fig. 9 show clearly the arrangement of the stator running and starting coils as actually carried out for a four-pole motor, while the form of the rotor winding can be seen from the latter figure also.

The motor is started as follows:—All the rotor resistance being in circuit, the stator windings (both running and starting) are switched directly on the mains; the motor will immediately start up with great torque, and the rotor resistance and starting coils are to be cut out as it does so. The exact moment at which the latter are cut out affects only the starting current: if the motor is starting light, the single-pole switch can be opened when the arms of the rotor resistance are on the second contact; if it is starting against full-load, the starting coils require to be left somewhat longer in circuit—that is, they are to be cut out, for instance, on the fourth or fifth contact of the starting resistance.

The earlier Heyland motors were all furnished for use with a single-pole switch in the starting circuit. This has now been done away with, however, by combining it with the starting resistance box (see Fig. 10), so that the operation of starting up is as simple as that with a shunt-wound direct-current motor.

(To be concluded.)

PARIS EXHIBITION AWARDS.

Below is a list of the principal medals and awards made to British exhibitors of electrical and scientific specialities at the Paris Exhibition:—

GROUP III.—Class 11 (Typography, &c.).

Bronze Medal.—A. W. Penrose & Co., London, W. (photo-engravers' finishing machinery, photographic arc lamps, &c).

Class 12 (Photography).

Grand Prize.—Royal Observatory. (See Class 14.)

Gold Medals.—A. W. Penrose & Co. (see Class 11) and Newman and Guardia (kinematographs, &c.).

Silver Medals.—Dr. J. M. Davidson (X-ray photographs), and F. H. Glew (X-ray and lightning photographs).

Bronze Medal.—G. Corden (photographs of lightning), B. Molesworth (telephotographs), S. Webb (photographs of lightning), and R. N. Wolfenden (X-rays applied to zoology).

Class 14 (Maps, &c.).

Grand Prize.—Royal Observatory (magnetic records, &c.).

Gold Medal.—Prof. A. W. Rücker (magnetic survey maps).

Class 15 (Mathematical and Scientific Instruments).

"Hors Concours."—Sir W. Abney (colour photometer), Mr. C. Vernon Boys (constant of gravitation apparatus, radio-micrometer and quartz fibre), Sir W. C. Roberts-Austen, K.C.B. (recording pyrometer), and Prof. J. J. Thomson (apparatus for measuring the velocity of the cathode rays).

Grand Prizes.—Board of Trade Gas Referees (pentane table, photometer), and the Cambridge Scientific Instrument Co. (electrical and other instruments).

Gold Medals.—James J. Hicks (electrical and scientific instruments), Negretti and Zambra (electrical and scientific instruments), W. Watson & Son (scientific instruments).

GROUP IV.—Class 19 (Mechanical Engineering).

"Hors Concours."—Thwaites Bros. (blowers, steam hammers, and centrifugal pumping engine).

Grand Prizes.—C. A. Parsons & Co. (steam turbines), Willans and Robinson (2,400 H.P. central-valve triple expansion steam engine coupled direct to a Siemens continuous-current dynamo), and Galloways (Ltd.) (boilers and vertical compound engine).

Gold Medals.—Marshall, Sons & Co. (compound steam engine), Ruston, Proctor, & Co. (steam engines), Ransomes, Sims and Jefferies (steam engines), and R. Garrett & Sons (boiler and steam engines).

Silver Medals.—Robey & Co. (compound horizontal engine coupled direct to 350kw. electric generator), E. Green & Son (fuel economisers), G. and J. Weir (feed pumps, &c), and Patent Exhaust Steam Injector Co. (injectors, &c.).

Bronze Medals.—James Proctor (stokers), Tangyes Limited (steam engines, &c.), and Deighton's Patent Flue Tube Co. (flues).

Class 20 (Various Types of Engines).

Grand Prize.—Crossley Bros. (gas engines).

Gold Medals.—R. Hornsby & Sons (Hornsby-Akroyd oil engines), Priestman Bros. (oil engines), Campbell Gas Engine Co. (gas engines), National Gas Engine Co. (gas engines), and Tangyes Limited (gas and oil engines).

Silver Medals.—Ruston, Proctor & Co. (oil engine), Dudbridge Iron Works (gas engines and oil engines), Robey & Co. (winding engines, &c.,) Blackstone & Co. (gas engine and oil engines), and J. and F. Howard (oil engines, &c.).

Bronze Medals.—R. Cundall & Sons (oil engine), A. Dougill & Co (gas and oil engines), and Duke and Ockenden (wind motor).

Class 21 (General Machinery).

"Hors Concours."—Thwaites Bros. (See Class 19).

Grand Prize.—Merryweather & Sons (fire engines, &c.).

Silver Medals.—Mather and Platt ("Grinnell" automatic fire extinguisher and alarm, &c.), G. Salter & Co. (spring balances, dynamometers, tension ratchets for telegraph wire, &c.), Mossberg Roller Bearings, Ltd., (roller bearings), J. J. Stockall & Sons (automatic alarm clocks, &c.).

Bronze Medals.—Samuelson & Co. (blowers), and Roller Bearings Co. (roller bearings, &c.).

Class 22 (Machine Tools).

"Hors Concours."—Thwaites Bros. (See Class 19.)

Grand Prizes.—Smith and Coventry (planers, lathes, chucks, gauges, &c.) and Mather and Platt.

Silver Medal.—Robey & Co.

Bronze Medal.—Belshaw & Co.

Class 23 (Mechanical Production and Utilisation of Electricity).

Grand Prize.—Siemens Bros. & Co.

Gold Medals.—C. A. Parsons & Co., and Mr. Duddell (Cambridge Scientific Instrument Co.).

Silver Medal.—Mr. Wm. Burton (James J. Hicks).

Class 24 (Electro-Chemistry).

Gold Medals.—Electrical Power Storage Co. (storage batteries), Chloride Electrical Storage Syndicate (storage batteries), and S. Cowper-Coles (specimens of electro-deposited metals, &c.).

Class 25 (Electric Lighting).

Gold Medals.—W. A. S. Benson & Co. (electroliers and accessories), and Simplex Steel Conduit Co. (Simplex steel conduit system-tubes, bends, &c.).

Silver Medal.—Belshaw & Co. (switches, fittings, &c.).

Class 26 (Telegraphy and Telephony).

Grand Prize.—G. P. O. (telegraph instruments and apparatus).

Silver Medal.—Patent Nut and Bolt Co. (bolts, nuts, screws, &c.).

Class 27 (Various Applications of Electricity).

Grand Prize.—James White (collection of Lord Kelvin's electrical instruments).

Gold Medal.—Crompton & Co. (potentiometers, standard resistance, Hibbert's 1-volt standards, electric thermometers, &c.).

Silver Medals.—James J. Hicks (electric anemometers, battery hydrometers, electric thermometers, &c.), and J. J. Stockall & Sons (electric clocks, alarms, &c.).

Class 28 (Civil Engineering. Transportation).

Gold Medals.—Jessop and Appleby Bros. (crane), Grafton & Co. (crane), Temperley Transporter Co. (model of traveller), and Ruston, Proctor & Co.

Silver Medals.—A. C. Wells & Co. (the "Wells" light, waste oil filters, &c.), and Hardy Patent Pick Co. (mining tools, &c.).

CORRESPONDENCE.

ELECTRICAL CONDUCTORS AND DIRT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Prof. F. G. Baily's interesting article in your issue of the 10th inst. Though he appears to think so, there is not any difference between us. In my Paper published in your issue for April 27th., I dealt with a specific case where the supply was afforded by the Westminster Company who do not earth their middle wire. As I have pointed out, in such an instance the negative always tends to earth itself; consequently, the positive wire is the one that is at the greatest difference of potential from earth. In the case alluded to by Prof. Baily the middle wire was earthed at the station, so that it would always be the other two wires that would be at the greatest difference of potential from earth. The potential would of course be negative in the case of one wire and positive in the case of the other.

I have never suggested that dirt accumulates more rapidly upon a positive wire than on a negative one merely because of its sign. It is, however, the case that it does so in instances where the middle wire is not earthed, as is at present, I believe, usually the case, at any rate, in London. As pointed out in my Paper, the necessary requirement in order to keep conductors and fittings clean is to maintain them as nearly as possible at earth potential.—Yours, &c.,

London, S.W., Aug. 17, 1900. A. A. C. SWINTON.

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LEGAL INTELLIGENCE.

National Telephone Co. v. Clontarf and Hill of Howth Tramway Co.

In the Vacation Court, Dublin, on Wednesday, before Mr. Justice Barton, application was made by the plaintiff company for an order restraining defendants, their servants, agents and workmen, pending the hearing of an action, from interfering with the wires of the plaintiffs' system of telephonic communication between Dublin and Howth by placing their tramway trolley wires in such close proximity to plaintiffs' wires that they were precluded from working their telephone system with efficiency. The act under which the tramway from Dollymount to Howth was constructed contained provisions that they should carry out the work so as not to interfere with the working of the telephone system. What the National Company complained of was that the Tramway Company had placed their trolley wires in such close proximity to the telephone wires that the telephone system had been subject to frequent interruptions. It was alleged that in three places (and this was not denied) the Tramway Company had actually placed their wires in mechanical contact with the wires of the National Company, the result being that the electric current of the tramway system was transferred to the telephone wires, which were in danger of being fused along the whole system and rendered useless. Plaintiffs invited defendants to have the matter referred to an arbitrator appointed by the Board of Trade, but this offer was declined by defendants, who had practically said that plaintiffs, if they had any legal remedy, must enforce it. An affidavit by Mr. F. Gill, superintendent for Ireland of the plaintiff company, was read by Mr. O'Connor, Q.C. (for the plaintiffs), who said that what plaintiffs complained of could be remedied quite easily, and he asked that the injunction should be granted.

Mr. CAMPBELL, Q.C., M.P., replied for the defendant company, and said they had got the Board of Trade certificate that the line had been constructed in compliance with requirements. By sec. 55 sub-sec. 2 of the Tramway Act, if defendants' lines improperly interfered with the telephone wires they could remove their wires to another place and make the defendants pay the cost, which, according to a letter written by Mr. Dillon (plaintiffs' solicitor) would only amount to £42. Instead of that simple remedy they came into Court with a ridiculous suit in Chancery.

Mr. JUSTICE BARTON said at first sight the application seemed a very urgent matter, but it was admitted on both sides that plaintiffs themselves could to-morrow, at the cost of between £40 and £50, set this matter right. It was their own poles, not those of the defendant company, that seemed to be the poles which ought to be removed, and of course plaintiffs could recover the cost of that removal from defendants if it turned out in the end that they were in the right and defendant company in the wrong. That being so, the question of urgency disappeared, and his lordship refused the application, but reserved the question of costs.

Moon, Loughlin & Co. v. Pye.

At the Blackburn County Court on Monday, Messrs. Moon, Loughlin & Co. sought to recover from Mr. Pye, engineer, Blackburn, £18. the price of a dynamo. Plaintiffs received an order from Messrs. Clark & Co., Hanley, for a dynamo, and communicated with Messrs. Humphreys & Son, Salford, who referred them to defendant. A dynamo was bought from Pye, and plaintiffs said they paid for it subject to the machine passing the necessary tests. It was alleged that this it had failed to do. Mr. Clark gave evidence and said it was an old machine. One witness said the machine could be made all right for 20s, while another said an expenditure of £5 would make the dynamo as good as new.

The defence was that the machine was not sold as absolutely new, and that when placed on the railway it was perfect.

Judge Coventry gave judgment for the plaintiffs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—The Castle-street–Bathing Station tramway route is to be electrically equipped on the overhead trolley system. The existing tramway in Union-street between St. Nicholas and Castle-streets is also to be similarly equipped with side poles and span wires. The burgh surveyor (Mr. W. Dyack) has been authorised to invite tenders for 800 tons of steel rails and 10,000 tons of causeway setts, and the electrical engineer (Mr. J. Alex. Bell) to invite tenders for the tramway poles. The electrical engineer and the superintendent of the tramways are to report as to the type of car to be adopted, and the number to be ordered. Mr. Bell has also been authorised to communicate with the Westinghouse Company in order to ascertain whether they would give a quotation of the cost of electrically equipping the tramway in Union-street on the underground conduit system.

Abertillery.—A resolution to apply for a provisional order has been unanimously passed by the Council.

Antananarivo (Madagascar).—A concession has been granted by the French Government to M. Orville Florens, sen., of Paris, for the supply during 50 years of electric current for lighting and power for Antananarivo and surrounding district. This work is coupled with the supply of water for the same district, and both are to be completed within two and a-half years.

Blackburn.—An inquiry was held here on Friday into the application of the Corporation to borrow £190,000 for extensions of the electricity supply works. The town clerk said it had been originally proposed to ask for over £220,000, but this had been reduced. The electricity works adjoined the No. 1 Gasworks, which were very old and had become too small to meet the needs of the town. The Corporation had purchased land in another part of the town for new gasworks, and when these were completed the whole of the No. 1 Gasworks would be devoted to the generation of electricity. That site had been valued at £30,000. The consulting engineer (Mr. E. M. Lacey) stated that part of the proposed scheme would meet the requirements for the next four or five years. When this was carried out there would be land available for further extensions for the next 15 or 20 years.

Buenos Ayres.—According to the *Review of the River Plate* the electric lighting companies in this city have entered a joint protest against the new tax imposed upon them by the municipality, and which they consider to be a duplicate of another tax. The companies have to pay 5 per cent. of their gross receipts for the use of the subsoil, and this year a tax has been placed on all transformer pits and corner boxes, and this the companies consider to be already covered by the 5 per cent. subsoil tax. The companies intend to test the legality of several other taxes, including this 5 per cent., on the ground that when some of them obtained their concessions the tax was only 2½ per cent, of the gross revenue, and it is argued if the authorities have the right to increase it to 5 per cent., they have an equal right to make it 10, 20 or any other rate.

The directors of the Sociedad Cooperativa Telefonica have issued their report for the year ended June 30 last. The profit on the year's working shows a credit balance of $113,240.69. The company possesses 3,244 metres of underground mains and 42 subterranean chambers and 7,098 kilometres of line. Messrs. L. M. Ericsson & Co, Stockholm, are building multiple boards for the new central office at a cost of $25,000 gold.

Bury St. Edmunds.—The £800 recently borrowed for lighting the roads on the Brown estate is instead to be applied in the lighting of Risbygate-street and St. Andrew street, and in erecting eight arc lamps in the central portion of the town.

Burnley.—An inquiry has been held here into the application of the Council to borrow £1,200 for electric lighting. There was no opposition. The amount of existing loans is £51,250.

Central London Railway.—It has been discovered that the present system of cancelling tickets lends itself to fraud, and the directors are considering how best to obviate this. Electrical communication is being established at some of the stations between the platforms and the booking halls, so that a signal may be made to the lift attendant, indicating the approach of a train, this arrangement being required to regulate the number of passengers to be allowed to descend to the platforms for the incoming train. With the present five-minute service, it has been impossible to avoid overcrowding at the Bank Station at certain periods of the day. On such occasions the 30 seconds allowed for stoppages at the platform has been considerably exceeded, with the result that the journey has been prolonged beyond the scheduled time, and intervals of 10 minutes between the running of trains have occurred. With the introduction of a more frequent service, it is believed that this difficulty will disappear. The daily average number of passengers has already reached a total of nearly 100,000.

Chester.—An inquiry was held here on Wednesday into the application of the Council to borrow £35,000 for electric lighting extensions. The town clerk (Mr. S. Smith) explained that powers had already been obtained to borrow £65,000, and that had been over-expended by about £740. The present loan would be applied in making additions to the generating plant and in extending the mains, &c. The electricity undertaking had been an unqualified success, and they had been able to place £2,465. 1s. 1d. to reserve. They started by supplying current at 6d. per unit, and had reduced the price to 4½d., in addition to allowing large customers considerable discounts. During the year ended March, 1900, the Corporation sold 617,792 units, against 473,656 last year. The Corporation had decided to take over the tramways and though it was not absolutely settled, electric traction would probably be adopted. The Corporation would be able to generate the necessary current at the present station, as provision had been made for doubling the buildings. There was no opposition.

City and Guilds of London Institute.—The programme of technological examinations for the session 1900-1, price 1s. net, is issued by Messrs. Whitaker & Co.

Clydebank.—The Commissioners have decided to apply for electric lighting powers.

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Colliery Lighting.—At an inquest at Haydock into the circumstances attending the death of eight men who succumbed to injuries received in an explosion of gas in the old Boston colliery, Haydock, the Inspector of Mines (Mr. H. Hall) expressed the opinion that in all sinking operations electric lights should be used. The jury returned a verdict of "Accidental death," and recommended that in future sinking operations should be carried on by electric light.

Crieff (N.B.).—A committee is to report upon the question of obtaining electric lighting powers, or as to allowing the North British Electricity Supply Co. to obtain an order.

Crystal Palace Accident.—The deputy-coroner for West Kent (Mr. E N. Wood) resumed on Friday last the inquest on the bodies of Frederick Elliston (33) and William Philbrook (19), who met their death in a boiler explosion on the premises of the Crystal Palace District Electric Supply Co. on 25th ult. Mr. Walter Phillips, electrical engineer to the company, said that every year until this year the boiler had been thoroughly examined. The reason why it was not done this year was because the company were busy, and could not let the boiler be idle, as the examining process took over a week. Since the explosion he had examined the fragments of the boiler, and found flaws. In his opinion those flaws were the cause of the explosion. The jury returned a verdict that the deceased died from injuries caused by an explosion of a boiler, due to its defective condition, which might have been discovered had the boiler been thoroughly examined.

Customs Decisions.—A recent decision of the United States Customs Board is to the effect that telephone switchboard cables composed of 64 copper strands, each tin coated and cotton covered, wrapped successively with paper, metal foil, paper, cotton thread and insulating material, the wire being the component of chief value, are dutiable as articles manufactured from copper and not under the head of "covered wire."

Derby.—An inquiry was held here on Thursday last into the application of the Council to borrow, among other sums, £730 for purchasing a condenser for the electricity works.

Dewsbury.—The question of extending the electric lighting mains to West-town is under consideration.

Dublin.—At a special meeting of the Council on Monday, the report of the Electric Lighting committee, recommending the acceptance of the tenders for generating plant for the new works at the Pigeon House was discussed. (The tenders are set out in another column.) Exception was taken that the committee's report was being rushed through, but the Lord Mayor pointed out that the report had been in the hands of members for a month, and that a special meeting of the Council had been called to consider it. After some discussion it was agreed that another special meeting should be called for Monday next to finally decide the matter. In the meantime, the secretary of the Dublin United Tramways Co. (Mr. C. W. Gordon), has addressed a letter to the Lord Mayor in which the company's offer to supply electricity "in bulk" is renewed.

The deputation recently appointed to visit Continental cities where three-phase systems of distribution were in operation reported their visits to the Paris Exhibition, Strasburg, Mannheim, Mayence, Frankfort-on-Main, Nuremberg, Prague, and Oerlikon. The general conclusion, the committee reported, to be drawn from their visit, was "that for a combined lighting and motor supply the three-phase system was superior to either the continuous-current or single-phase systems, while if it was desired to supply power for street tramways it was only necessary to combine a three-phase motor with a continuous-current generator of the required voltage. The great advances which had been made in the manufacture of three-phase generators largely contributed to the steadiness of supply under varying conditions, and also simplified the problem of the distributing network. The committee were satisfied the scheme laid down by Mr. Robert Hammond for the supply of electricity to Dublin from the Pigeon House station was one which could be adopted with confidence by the Electrical committee of the Corporation."

Dundee.—The salary of the city electrical engineer (Mr. Walter H. Tittensor) has been increased from £250 to £350 per annum, to be further increased to £400 at the end of twelve months, on account of the extra work entailed by the electric tramways.

Electrical Enterprise in Italy.—The Mediterranean Railway Co., of Milan, have secured a concession from the Italian Government to substitute electric working on the line from Sampierdarena to Rome. The power station will be erected at the former town. The company are about to purchase 23 electric locomotives.

Electric Traction in the Liverpool District.—A syndicate is being formed to promote and construct a series of railways in Cheshire and the Liverpool district, including an electric railway across the estuary of the Dee from a point near Caldy to Point of Air (Flintshire) and on to Rhyl, and an underground electric railway from the Central (low level) Station, Liverpool, to Huskisson Goods Station, and from Central Station to St. James's station. The first line will be about 14 miles long, 5 miles being carried on an embankment and bridge, or on a bridge alone, over the Dee estuary, connection being made with the Wirral Railway and L. and N. W. and G. W. joint railways, near West Kirby, and with the L. and N. W. and the Denbigh and Corwen Railways at Rhyl. The second line will require two tunnels connecting the Cheshire Lines Railway at Huskisson station with the Mersey Railway at Central (low level), running thence to St. James's. The consulting engineer is Mr. R. H. Scotter, of Southport and London, and it it claimed that by the combined schemes much quicker and cheaper access would be afforded between Liverpool and West Lancashire, the North Welsh coast and Ireland, via Holyhead. The electric system would be continued from Huskisson to Aintree, and from Aintree to Southport on the Cheshire Lines and the Southport and Cheshire Lines Extension.

Electricity in Mining.—The electrical transmission plant of the Deep Leads Electric Transmission Co. (Ltd.) (Victoria) has been erected, and two units of 2,500 H P. each are ready. Electric current will be supplied to the entire group of mines in the district.

Exhibition.—In 1901 an extensive exhibition of Russian industries is to be held at Riga.

Glasgow.—At the Corporation meeting last week Bailie Maclay submitted the report of the electricity department, in which the scale of charges for 1900 1 was set out. Bailie Anderson, in criticising the report, said there ought to be, as in Edinburgh, one rate for current for light and one for power, and the large consumer should be allowed a reduction, which should be taken off his account, and not regulated, as at present, by the demand indicator. Bailie Maclay admitted the arrangement was not perfect, and promised that it should be looked into. He afterwards moved the approval of the annual report and balance-sheet of the committee, an abstract of which was given in our last issue. The motion was adopted.

Grimsby.—The Grimsby Street Tramways Co. have let the contract for the erection of electric power station in Cleethorpes, in addition to having purchased new electric cars, at a cost of about £700 each. It is anticipated that by next year the Grimsby and Cleethorpes lines will be working by electricity. The work of laying a double set of rails along Grimsby-road suitable for electric traction will be started in October. The station, which is to be acquired by the District Council as soon as that body has the necessary powers, will be constructed so as permit of considerable extension, the Council intending to provide accommodation for the plant necessary for street lighting by arc lamps. Negotiations for the lighting of the Cliff Gardens, pier, and promenade by electricity are progressing satisfactorily.

Guernsey.—At a special meeting of the States convened for Sept. 3 a proposal will be made to place at the disposal of the Electric Lighting committee £350 to defray the expenses of the consulting electrical engineer (Mr. A. L. Davis) in connection with the electricity supply scheme.

Halifax.—The accounts of the electricity department for the past year have been submitted. The capital outlay is £93,218, an increase of £20,748 on the previous year; the units of current sold, 1,371,333, an advance of 742,574; the gross profit, £9,001, an increase of £4,436, and the average price obtained per unit, after deducting discounts, 2·77d. The cost of production per unit was 1·23d., a reduction of nearly ½d. compared with the previous year's results. The output of the Halifax works (1,371,333 units) was exceeded by only seven stations in Great Britain (excluding London): Liverpool (5,729,477), Manchester (4,773,247), Edinburgh (4.174 541), Brighton (3,206,623), Glasgow (2,824,350), Bradford (2,416,130), and Leeds (1,697,258).

Hotel Lighting.—In consequence of the building of the north block of the Hotel Cecil, Strand, London, the electric lighting installation is being considerably extended, under the superintendence of the chief engineer (Mr. W. A. Poynton), and a fifth 75kw. turbo-dynamo has been ordered from Messrs. C. A. Parsons & Co.

Hyderabad (India).—*Indian Engineering* announces that proposals have been made for constructing an electric tramway between Hyderabad and Secunderabad, and for the supply of current for electric lighting and power.

Ilford.—The foundation stone of the electricity supply station building will be laid to-morrow (Saturday) by the chairman of the council (Mr. H. Weeden, J.P.).

Kingstown (Dublin).—The Council have decided to carry out the terms of their provisional order (obtained in 1896), and the proposed application of Messrs. Porte, Sykes & Co. will consequently be opposed.

Launceston.—Owing to the increase in the price of gas, the leading tradesmen and other citizens recommend the Council to adopt an electric lighting scheme.

Leeds.—The Tramways committee recommend the City Council to promote a bill authorising the extension of the tramway system. Six new tramway routes are proposed.

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Leeds.—The Corporation are recommended by the Lighting committee to abolish electricity meter rent as from Oct. 1.

Light Railways.—The Board of Trade have, after modification, confirmed the Barnsley and District Railway and the South Staffordshire Light Railway Orders, 1900.

Liverpool.—Electricity is being generated at the new Lister power station both for public and private use.

Llanelly.—The British Insulated Wire Co., which recently acquired the provisional electric lighting order of the Council, has come to terms with the directors of the local tramways company for the acquisition of the undertaking. The lines are to be reconstructed and equipped electrically. Considerable extensions are to be carried out.

Los Angeles (California).—Two companies are engaged in this city in transmitting electric power, one company's source of power being situate 80 miles distant from the point of distribution. The city tramways are worked electrically, the companies owning the lines having altogether 120 miles of track. To increase the water-power facilities a local company is being formed to construct a lake 10 miles long by 2 miles wide and 100ft. deep by means of a dam across the Mojave river at Victor.

Maidstone.—The Council have been informed by the Local Government Board that, while prepared to approve the electric lighting scheme for Maidstone, the Board would like to have the opinion of an independent expert, and it is proposed to ask Sir William Preece to report.

Moss Side.—The following agreement has been entered into between the District Council and the Manchester Corporation in regard to the tramways in the district :—

(1) The Moss Side Council to grant to the Manchester Corporation a 21 years' lease from the expiration of the lease to the Manchester Carriage Co. ; (2) the Corporation to reconstruct at their own cost the tramways owned by the Council, to erect the overhead equipment thereof, to repair and maintain the permanent way and overhead equipment during the lease, to renew the rails during the last six years of the term, and to hand over the permanent way in good condition to the Council at the end of the lease, but the overhead equipment shall remain the property of the Corporation unless the Council determine to purchase it ; (3) the rental for the lines to be at the rate of £400 per mile of single track per annum ; (4) the line in Upper Chorlton-road to be acquired by the Moss Side Council, and to be leased on the same terms as the other lines ; the cost incurred by Moss Side in acquiring and relaying the line to the Manchester specification to be refunded by a series of annual payments during the period of the lease ; (5) the lease of all the lines to terminate at the same time.

Penzance.—On the recommendation of the Electric Lighting committee it has been decided to engage an electrical engineer to report as to the establishment of electricity works.

Russia.—Electric tramways are being constructed at Riga, and the tramways at Libau are already running over a portion of the lines for which a concession has been granted.

Shoreditch (London).—The Vestry have experienced difficulty in regard to outstanding accounts for electric current, wiring and fitting work, &c., and have issued the following rules : –

Weekly Accounts.—Meters to be read, as at present, each Thursday, and demand notes sent to accountant's office same day. Payment to be made by the Friday week following, failing which the collector is to attend at the lighting station, and proceed to the defaulter's premises, together with a representative of the electrical engineer, who will disconnect the supply unless payment is made on demand.

Monthly Accounts.—Meters to be read on last day of each month, and demand notes to be sent to accountant's office same day. On demand notes payment is requested within 15 days, but consumers should be allowed credit to 21st of each month. If payment is not made by that date final notice allowing three days' grace to be served, and in default of payment supply is to be cut off (as above described).

Quarterly Accounts.—Meters to be read as near quarter-day as possible. Demand notes to be sent to accountant's office by 15th of next month. Payment is requested within 15 days on demand notes. In the first week of the last month of the quarter a list of outstanding accounts to be prepared, and defaulters who have not paid by the Friday 14 days before quarter-day are to be served with final notice giving three days' grace, after which supply will be disconnected.

When the supply has been disconnected under these rules all expenses of re-connection to be charged to consumer.

Soul (Corea).—The street railways in this city have now been extended southwards to the river port Riong-Sau, the miles of track opened being 8·77. There are six cars in use, and the number of miles run daily is about 380. The cost of construction of the line, including the telephone service throughout has been 40,000 yen (£4,000) per mile.

South Dublin.—The Council have applied to the Dublin United Tramways Co. for terms for supplying electric current for lighting the districts of Templeogue and Rathfarnham electrically.

Sunderland.—The Tramways committee have decided to invite tenders for the construction of 24 new electric tramcars, bringing the number up to 50.

Taunton.—On Wednesday last week the mayoress (Mrs. W. A. Wrenn) formally started the new machinery erected at the electricity works at a cost of about £5,000. Afterwards the chairman of the Electric Light committee (Ald. W. Potter), who has been from the first connected with the muncipal electricity undertaking in that capacity, and Mrs. Potter, were recipients of a presentation to celebrate the event.

Transmission of Cablegrams by Telephone.—Since 1895 the Liverpool Chamber of Commerce have agitated for an arrangement between the Postmaster-General, the Atlantic cable companies, and the National Telephone Co., whereby cable messages arriving after ordinary business hours (6 p.m.) might be transmitted direct by telephone to addresses, or replies received by the telephone company for transmission abroad by the cable companies. The matter has now been brought to what is described as "a satisfactory issue." The following correspondence has passed between the negotiators :—

From Mr. J. C. Lamb to Mr. C. M'Arthur, M.P. :—

General Post Office, London, August 18, 1900.

SIR: In regard to the proposed use of the National Telephone Co.'s exchange in Liverpool for transmission after business hours of cable messages of that company's subscribers, I am directed by the Postmaster-General to acquaint you that, in compliance with the representations of the mercantile community of Liverpool, he proposes to authorise such an arrangement subject to the acceptance of a suitable licence by the National Telephone Co., and the cable companies concerned. The Postmaster-General did not feel himself in a position, at the present stage, to make any public announcement on the subject. He understands, however, that the letter in which the arrangement was proposed to the National Telephone Co. has been published by that company, and in the circumstances he desires me to enclose for your information a copy of the letter in question. I am to add that the National Telephone Co. and the Transatlantic cable companies have now agreed to the arrangement, and a formal deed embodying the Postmaster-General's licence and the necessary details is in preparation.

(ENCLOSURE.)

General Post Office, London, July 20, 1900.

To the Managing Director, National Telephone Co.

SIR : I am directed by the Postmaster-General to say that, after giving careful consideration to the question of transmission by telephone after business hours of cable messages to subscribers of the National Telephone Co. in Liverpool, he is of opinion that the best way of meeting the urgent public demand which still exists for their direct delivery by telephone from the offices of the cable companies will be to make an agreement on the subject between the National Telephone Co., the cable companies and himself. Under this agreement authority would be given for the use of the Telephone Company's system in the manner proposed, which otherwise would be an infringement of the conditions of their licence, and the cable companies would undertake to account to the Postmaster-General at the ordinary inland rate for all cable messages delivered or received by them by telephone. The Postmaster General will be glad to know at as early a date as possible whether the National Telephone Co. are willing to enter into an agreement of the kind proposed. If so, he will at once have a draft prepared for the company's consideration. JOHN ARDRON.

West Cumberland.—A scheme for the construction of an electric tramway from Whitehaven to Maryport, through Workington, is being promoted by Messrs. Dick, Kerr & Co.

Will.—The will of the late Mr. B. H. Van Tromp, director of the Brush, County of London and Brush Provincial, Dover Electricity Supply, and Electric and General Investment Co.'s, has been proved, and the gross value of the estate returned at £54,081, personalty being valued at £42,042.

Water Power Utilisation in Bohemia.—The municipal authorities of *Elbogen* (Bohemia) are establishing electricity generating works, and are utilising the water power of the district.

Water Power Utilisation in Spain.—Application has been made by a Bilbao syndicate for a concession to put down plant to utilise the water power of the river Nalon, in Asturias, for the generation of electrical energy.

Willenhall.—The Midland Electric Corporation for Power Distribution start laying their mains here next month, and electric current will be available about February next.

Working Canal Traffic by Electricity.—The success of an arrangement by which canal traffic is worked electrically on the Finow Canal, near Ederswalde, Germany, has led to the consideration of a project for the adoption of a similar system on a portion of the Kaiser Wilhelm Canal at Lübeck. Vessels will be hauled through the canal by electric locomotives running alongside, and when the work of construction is completed this portion of the canal is to be lighted electrically. Messrs. Siemens and Halske carried out the arrangements on the Finow Canal, the experiment being assisted by a grant from the present Government of £1,000.

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NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date) a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made quite complete. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is the most complete and correct book of its kind ever published in any language.

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Armature Winding of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"Temperature Coefficients of 'Conductivity' Copper." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 84·9°F. Printed on strong cardboard, 6d. net.

IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade.

"Primary Batteries: Their Construction and Use."—By W. R. Cooper.

"Practical Telephony."—By Dane Sinclair and F. C. Raphael.

"'The Electrician' Wireman's Pocket-book."—Edited by F. C. Raphael. *Nearly ready.*

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

TENDERS INVITED.

Whitby District Council invite tenders for the supply and erection of electricity generating plant, some particulars of which are set out in an advertisement. Specification may be obtained at the offices of the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster. Tenders, addressed to the clerk (Mr. Wm. Seaton Gray), Council's offices, Whitby, must be in before noon of Sept. 3.

Hackney (London) Electric Lighting committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, arc lamps, meters, travelling crane, and workshop equipment. Specification, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, S.W., after 22nd inst., and tenders, addressed to the vestry clerk (Mr. George Grocott), Town Hall, Hackney, must be in by 4 p.m. of Sept. 12. Further particulars are given in an advertisement.

Newcastle-upon-Tyne New Tramways committee invite tenders for conduits and holes for poles. An advertisement contains further particulars, and specifications may be obtained after 17th inst. from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., and 29, Princes-street, Manchester. Tenders (addressed to committee) must be delivered at the office of the town clerk (Mr. Hill Motum) by noon of 31st inst.

The Vestry of St. John, *Hampstead* (London) invite tenders for the supply and erection of (1) eight dry-back marine boilers, (2) steam and water pipes, feed pumps, &c., (3) feed-water heater, or (4) feed-water detartariser, (5) fuel economiser, (6) cast-iron water tank, and (7) two blow-off tanks. Conditions and specifications may be obtained at the offices of the vestry clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, N.W., to whom tenders must be delivered by 4 p.m. of Sept. 27. An advertisement contains further particulars.

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Oldham Electric Light committee invite tenders for the supply and erection of dry-back marine boilers, with mountings, gangways, feed and drain pipes, &c., complete, and also for mechanical stokers with shaftingand gearing for driving; or water-tube boilers as an alternative to the dry-back marine boilers, including mountings, &c. Further particulars are given in an advertisement, and copies of specifications may be obtained from Mr. A. Andrew, Gas and Water offices, Oldham. Specification and drawings can also be seen at, but not obtained from, the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W., and tenders must be sent to the superintendent (Mr. A. Andrew) on or before Sept. 11.

Hammersmith (London) Vestry require tenders for the supply, delivery and erection of two single-phase alternate-current motors, coupled to two centrifugal pumps, with accessories. Specification may be obtained from the clerk's office, Town Hall, Hammersmith, and tenders must be delivered before 5 p.m., Sept. 12. An advertisement contains further particulars. Mr. F. W. J. Webb is acting clerk.

The managers of the *Poplar* and *Stepney* Sick Asylum District invite tenders for sundry work in connection with a telephonic installation at their sick asylum. An advertisement gives further particulars, and tenders must be delivered to the clerk to the managers (Mr. Robert Foskett), Bromley, Middlesex, E., by 5 p.m., Sept. 17.

Hull Electric Lighting committee invite tenders for steam and water pipes, feed-pumps, water-softener, &c., for their Sculcoates-lane generating station. Specifications may be obtained from the city treasurer, and tenders (addressed to chairman of committee) must be delivered at the town clerk's office, Town Hall, Hull, by noon of Sept. 27. An advertisement contains further particulars.

The Board of Management invite tenders for the electric lighting of the *Preston and County of Lancaster Royal Infirmary*. An advertisement contains further particulars, and specifications, &c., may be obtained at the office of the architect (Mr. F. E. Dixon, C.E.), 19, Lune-street, Preston. Tenders must be delivered to the secretary (Mr. Walter Davies), 5, Winckley-street, Preston, by Sept. 1.

Aberdeen Electric Lighting committee invite tenders for two 200kw. direct-coupled continuous-current generators and one 120kw. balancing set; also for one 420kw. direct-coupled continuous generator. Willans engines are specified in both cases. Further particulars are given in an advertisement, and tenders must be lodged with the city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, by noon on Sept 29.

Tunbridge Wells Corporation invite tenders for the supply and delivery of high and low-tension cables. Specifications from the borough electrical engineer (Mr. Horace Boot), and tenders must be sent to the town clerk (Mr. W. C. Cripps) by 20th Sept. See also advertisement.

Greenock Police Board invite tenders for water-tube boilers, two steam dynamos, boosters, switchboard, steam and exhaust pipes, &c. Further particulars are given in an advertisement, and tenders must be lodged with the town clerk (Mr. C. MacCulloch), Municipal Offices, Greenock, by Sept. 10.

Nelson Corporation invite tenders for a 200kw. steam dynamo. Specifications, &c., may be obtained from the engineer (Mr. A. Allen), Gas Works, Nelson, and tenders must be sent to the town clerk (Mr. R. M. Prescott), Town Hall, Nelson, by Sept. 8. Further particulars are set out in an advertisement.

Southampton Guardians invite tenders for the erection and completion of electrical plant, and an installation for the lighting of the new workhouse infirmary at Shirley Warren. Tenders to clerk (Mr. David P. Gwillim), St. Mary-street, Southampton, by noon, Sept. 11.

Southampton Harbour Board invite tenders for a 30-cwt. portable electric wharf crane. Tenders by Sept 17.

Shipley (Yorks.) District Council invite tenders for steam and exhaust pipes, storage battery, switchboard and connections, and cables. Tenders to clerk by 27th inst.

Cardiff Corporation invite tenders for sundry pipes, feed water heater, &c. Tenders to town clerk, Town Hall, Cardiff, before 31st inst.

Ilford District Council invite offers for "free" wiring in their district. Applications to clerk before noon, 29th inst.

Salford Corporation invite tenders for lighting and traction switchboards, and balancing transformer. Tenders to town clerk by Sept. 3.

London County Council Asylums committee invite tenders for boilers, engines, dynamos, &c, at Horton Estate, Epsom, Surrey. Tenders to committee, 6, Waterloo-place, S.W., by 10 a.m. of Sept. 22.

Stockport Tramways committee invite tenders for 20 double-deck tramcars with electrical equipment. Tenders to clerk by 31st inst.

Portsmouth Corporation invite tenders for plant and apparatus for equipment of tramway power station. Tenders to town clerk by 10 a.m., Sept. 4.

Worthing Corporation invite tenders for electricity generating plant. Tenders to town clerk by noon, Sept. 3.

Luton Town Council require tenders for watt and demand meters. Tenders to town clerk by Sept. 14.

Dorking District Council invite offers for leasing their provisional order. Tenders to clerk by 30th inst.

Middlesbrough Electric Lighting committee invite tenders for wiring the municipal electricity works. Tenders by 31st inst.

Hockheim-am-Main (Germany) Municipal Council invite tenders until Sept. 15 for the erection of electricity supply works. Tenders to der Magistrat.

TENDERS RECEIVED AND ACCEPTED.

The following tenders for generating plant for the proposed new electricity works at the Pigeon House for the Dublin Corporation are recommended for acceptance by the Electric Lighting committee:—

General Electric Co. (compound engines, generators, &c.)	£33,061
Holdsworth & Sons (Lancashire boilers)	6,653
Babcock and Wilcox (water-tube boilers)	5,278
Ditto (fuel economisers)	1,060

Shoreditch (London) Vestry have received the following tenders for electric cables:—

British Insulated Wire Co. (*accepted*)	£1 930 8 2	W. T. Henley's Telegraph Works Co.	£2,147 15 1
Siemens Bros. & Co.	2,262 8 4	W. T. Glover & Co.	2,129 12 6

Cardiff Corporation have accepted the tender of the British Electric Transformer Manufacturing Co. for the supply of ten 30kw. transformers at £690.

Nottingham County Council have accepted the tender of Mr. T. Scott Anderson for the electric lighting of the Radcliffe Asylum. There will be about 1,500 lights.

The tender of the Gateshead Electric and Mechanical Co. has been accepted for the electric lighting of the Ashington Industrial Co-operative Society's premises at New Hirst at £395. Six tenders, varying in amount from £310 to £430, were submitted.

APPOINTMENTS VACANT AND FILLED.

Eccles Corporation invite applications for the position of borough electrical engineer. Further particulars are set out in an advertisement, and applications must be addressed to the Public Lighting and Electricity Supply committee, and delivered at the offices of the town clerk (Mr. Wm. H. Hickson), Town Hall, Eccles, by noon, of Sept. 3.

Two shift engineers are required for the South Shields Corporation electricity works. Applications to borough electrical engineer (Mr. Jos. A. Jeckell) before Sept. 5. See advertisement.

There is a vacancy for an improver at the Dundee electric light and traction station. Applications to city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent-road, Dundee, by 29th inst. See advertisement.

Mr. W. H. Eccles, B.Sc., and Mr. C. F. Smith, Wh.Sc., have been appointed senior demonstrator of physics and senior demonstrator of electrical engineering respectively, at the South Western Polytechnic, Chelsea, S.W. Mr. Eccles was educated at the Royal College of Science, where he held a National Scholarship from 1891 to 1897. In 1898 he was appointed senior demonstrator in the physical laboratory of the Royal College of Science. Mr. Smith was educated at the University College, Bristol, and was apprenticed with Messrs. Sharp, Stewart & Co. for four years. In 1894 he obtained a Whitworth scholarship with first-class honours in theoretical and practical electricity. After spending a year in the drawing office and shops of engineering works in Hanover, he was afterwards engaged for six months in Munich in the public experimenting laboratory of the Polytechnic Society. On his return to England he was appointed chief electrical assistant to Dr. Obach at Messrs. Siemens Bros. & Co., and at present is assistant to the managing director of Messrs. Ransomes and Rapier.

Mr. E. Marples, chief assistant to the Liverpool District Lighting Co. (Ltd.), has been appointed electrical engineer to the Hoylake and West Kirby Council, at a salary of £150 per annum.

BUSINESS NOTICES.

Mr. J. H. Blake, Inchbrook, Stroud, and Mr. H. E. Steel, Cheltenham, trading as Blake and Steel, electrical engineers, at Cheltenham and Stroud, have dissolved partnership. Debts by Mr. Steel.

Mr. J. W. Barnard, sole agent for the E.P.S. small storage batteries (Q and V type), 4, Great Winchester-street, E.C., is now "on the telephone," No. 1632 London Wall.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the creditors of Henry Howe, electrician, 16, Boldlane, Derby, was held last week at the Official Receiver's Office, Derby. The liabilities were stated to be £132 13s. 9d., and the assets 10s. Failure was attributed to illness and losses incurred by a visit to British Columbia. The Official Receiver continues as trustee.

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Mr. F. J. Saffery, 14, Old Jewry Chambers, London, E.C., has been appointed trustee in the bankruptcy of Claude Vautin (electro-metallurgist), in place of the late trustee, Mr. J. J. Saffery, deceased.

In the bankruptcy of W. V. Scott, electrical engineer, lately residing at Shaftesbury-road, East Hammersmith, the first meeting of creditors will be held on Aug. 30, and the public examination on Oct. 16, both at Bankruptcy Buildings, London, W.C.

Claims against Herbert Sewell, electrician, &c., Clifton-place, and 63, Birklands-road, Shipley, must be in by Sept. 5. Mr. J. A. Binns, official receiver, 31, Manor-row, Bradford, is trustee.

The discharge in bankruptcy of F. G. W. J. Adams, lately trading with C. M. Downie as Downie and Adams, electrical engineers, at 24, Newman-street, London, W., has been suspended for two years.

A receiving order was made at the Burnley County Court on Tuesday against Robert Foster & Co., electrical engineers, Adlinton-street, Burnley, also trading as the Nelson Electrical Engineering Co, Stott-street, Nelson (Lancs.).

On Wednesday the creditors and shareholders of the Willoughby Destructor Syndicate (Ltd.), met at the Board of Trade offices, London, under a winding-up order. The company was formed in August, 1898, with a nominal capital of £3,200, in 1s. shares, to exploit patents and inventions relating to destructor furnaces for town refuse, and acquired several patents for a consideration of 63,993 fully-paid shares in the syndicate. A destructor was erected for the Devonport Corporation, but was refused, and this event and the differences among the directors led to the winding-up order. The liquidation is in the hands of the Official Receiver.

It has been resolved to wind up the British Blahnik Arc Light Co. (Ltd.) voluntarily. Mr. W. H. Chantrey, 57, Moorgate-street, E.C., is liquidator.

Sale by Auction.—Catalogues are now ready giving particulars of over 500 lots of high-class new engineering plant and machinery, electro-plating plant, loose tools and utensils, stores, &c., which will be sold by auction by Messrs. Wheatley Kirk, Price & Co. on Tuesday and Wednesday next, Aug. 28 and 29, at 10 for 11 o'clock prompt each day, at the Ormonde Works, Hornchurch-road, Romford, Essex. Illustrations are given of some of the more important machine tools included in this sale, and special attention is called to the quantity of practically new machine tools of a light character which are included in the auction. The extensive works premises are also to be disposed of. An advertisement gives further particulars.

Tramway Undertaking for Sale.—The liquidator of the Isle of Man Tramways and Electric Power Co. (Ltd.) (Mr. W. H. Walker, C.A.), 42, Castle-street, Liverpool, and 50, Athol-street, Douglas, announces in an advertisement that it is intended shortly to offer for sale by tender the electric, cable, and horse tramway undertaking of the company, together with the plant, cars, &c. Full particulars can be obtained from the liquidator.

English-Made Electric Bells, &c.—We have received from Messrs. Julius Sax & Co. (Ltd.). of Eagle Works, Coldharbour-lane, Camberwell, London, a copy of a new catalogue dealing with electric bell material, guaranteed (where described as of "best English make") to be of English manufacture, and known in the trade by the "Eagle" trade mark. Messrs. Julius Sax & Co. point out that the firm has been in existence since 1855, and claim that this catalogue is the most complete list relating to electric bells and electric bell material ever issued. Certainly great care has been taken in the compilation of the list, and a word of praise is due to the general excellence of the illustrations. The list occupies nearly 120 large quarto pages, and covers a wide range of this branch of electrical work. The trade only is catered for, and the discounts are on a very liberal scale.

B.T.H. Plant.—Pamphlet No. 73, issued by the British Thomson-Houston Co., illustrates and describes direct-current enclosed arc lamps.

English-Made Specialist Watches.—Messrs. S. Smith & Son, of 9, Strand, London, W.C., have on view at the Paris Exhibition a fine display of London-made watches, chronometers, &c., and in connection with this exhibit issue a pamphlet in French and English containing some interesting particulars and illustrations of a large number of watches with special movements. Some idea of the requirements of the scientific watch trade is given in the descriptions accompanying the illustrations, the watches specially described ranging in price from £450 to £50. The firm of S. Smith & Son was established 70 years ago and has continued in the fronk rank, as is evidenced by its extensive trade in watches and watch movements of the most intricate character, which are regulated up to a variation of 1sec. per month. In 1884 the British Government established a system of official certification in English watch-making for merit alone, and in that year Messrs. S. Smith & Son gained the first position and still hold it in 1900 with a watch which has secured the record with a total of 88·7 points out of a possible 100 at the Government Observatory at Kew. One watch exhibited at Paris (price £500) is 2in. in diameter, ½in. in thickness, and has combined movements of a perpetual calendar, showing the day of the week, day of the month, month of the year, and the year itself, including leap year; the changing phases of the moon, the fifths of seconds and the minutes of a split-seconds chronograph, a repeat action striking the minutes, quarters, and hours, besides the usual time dial of the ordinary watch. The revolving escapement, the latest important improvement in watchmaking, is brought into use for the first time in these fine examples of the watchmakers' craft. Hundreds of Messrs. S. Smith and Son's non-magnetisable watches are in use in the electrical profession throughout the world, and we can testify that in all cases which have come under our notice great value is set upon these time recorders by their owners. The Paris exhibit includes an infinite variety of watches and clocks, some of the latter being shown in exquisite examples of English-made clock cases of choice design. Messrs. S. Smith & Son have been awarded a bronze medal for their exhibit at Paris.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 15 to Aug. 21, with the ports of destination:—

Africa—Alexandria, £428 (including £207 telegraph wire); Cape Town, £798 (including £150 telegraph apparatus); Durban, £1,019; East London, £232. *Argentina*—Buenos Ayres, £607 (telegraph material). *Australasia*—Brisbane, £125; Rockhampton, £54; Sydney, £1,989 (including £210 telegraph material); Wellington, £30. *Belgium*—Ostend, £300. *Ceylon*—Colombo, £140. *China*—Foochow, £18. *France*—Boulogne, £24. *Germany*—Hamburg, £180 (telegraph material). *Holland*—Rotterdam, £115 (telegraph wire). *Hong Kong*—£29. *India*—Bombay, £86; Calcutta, £650. *Sweden*—Stockholm, £38 (telegraph wire). Total £6,862, against £11,651 for six days last year (Aug. 16 to Aug. 21).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

June 12, 1900.

10,679. A. Reame and C. Wokes. London. Improvements in or connected with fuse boards for the distribution of electricity.

10,688. L. de L. Wells and A. C. Brown. London. Improvements in electric telephones and apparatus relating thereto.*

10,703. V. Thomas. London. Improvements in the manufacture of filaments for electric incandescence lamps.

10,711. A. De Filippi. London. Improvements in and relating to electric signalling apparatus for railways and the like*

10,713. P. Imhoff and The United Alkali Co. (Ltd.). London. Improvements in means to be employed in the electrolytic manufacture of bleaching liquors and chlorates.

10,724. W. P. Thompson. Liverpool. Improvements in electric current interrupters. (The Voltohm Elektrizitäts-Gesellschaft, A. G., Germany.)

June 13, 1900.

10,743. C. W. Hill. London. Improvements in dynamos and motors.

10,751. W. H. Willatt. Hull. Improvements in electrical generators and electrical motors.

10,755. W. H. Willatt. Hull. Improvement in the governing by electricity of steam engines and other prime movers.

10,772. A. Reame and C. Wokes. London. An improvement in or connected with laminated electric switches.

June 14, 1900.

10,808. H. A. Couchman. London. Improvements relating to electric arc lamps.

10,811. C. A. Henderson. Edinburgh. An improved self-acting time switch or cutout for electric arc lamps.

10,833. R. Fabry. London. Improvements in and relating to electric accumulators.

June 15, 1900.

10,890. A. Hudson. Bolton. A life-saving guard or fender for electric tram cars or other motor vehicle which works automatically, or can be worked by the driver with a foot press or hand lever.

10,892. S. Jevons. Birmingham. Improvements in metal conduits or covers for enclosing the wires or cables used for the transmission of an electrical current.

10,913. H. H. Lake. London. Improvements in and relating to stop-mechanism for phonographs and the like. (T. S. Parvin, United States.)*

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June 16, 1900.

10,940. J. SWINBURNE. London. Improvements connected with electrolytic incandescent electric lamps.
10,970. P. M. JUSTICE. London. Improvements in electric telegraphs. (The Rowland Telegraphic Co., United States.)
10,974. A. RICKS. Liverpool. Improvements in electric accumulators, electrodes, or plates.*
10,985. J. WILKINSON and J. H. NOAD. London. Improvements in the production of soda and hydrochloric acid by electrolysis.
11,003. H. H. LAKE. London. Improvements in electric railways. (McElroy-Gruno Electric Railway System, United States.)*
11,006. H. H. LAKE. London. Improvements in secondary electric batteries. (Aroid Renterdahl, United States.)*

June 18, 1900.

11,011. H. W. CLOTHIER. Sheffield. Improvement in electrical switches for heavy currents and high potentials.
11,020. W. M. WALTERS. Liverpool. Improvements in or connected with electric lamps.
11,022. J. E. MACAULAY. Dublin. An electrical apparatus for adjusting tram-rail points.*
11,025. H. BINKS. London. Improvements in electric apparatus for life-buoys, and light to facilitate the rescue of persons from drowning and for other purposes.
11,026. A. P. LUNDBERG and G. C. LUNDBERG. London. Improvements in cord grips for electric light fittings.*
11,054. N. GARLAND. London. Electrically-operated cloth cutting machines.

June 19, 1900.

11,097. H. WOODWARD. Birmingham, Improvements in electrical accumulators or secondary batteries, and in the manufacture of the same.
11,099. J. PATERSON. London. Improvements in electric targets.*
11,107. E. EDWARDS. London. Improvements in electric patterns for punching machines, for embroidering machines, and for jacquard looms. (Curt Handwerck, Germany.)*
11,120. J. B. GOTTSBERGER. London. Improvement in plows for conduit electric railway cars. (Date applied for under Patents, &c., Act, 1883, sec. 103, Jan. 4, 1900, being date of application in United States.)*

June 20, 1900.

11,149. A. WHALLEY. Warrington. Improvements in telephone switch-boards.
11,190. SIEMEN BROS. & CO. (LTD.). London. An improvement in switches for high-tension electrical currents. (Siemens and Halske, Aktien Gesellschaft, Germany.)*
11,206. G. W. PARTRIDGE and G. K. B. ELPHINSTONE. London. Improvements in electric switches and like apparatus for making and breaking electric circuits.
11,207. L. ANDREWS. London. Improvements in or relating to the distribution of electricity.
11,208. F. J. WARDEN-STEVENS. London. Improvements in electric signalling apparatus.
11,217. G. E. HEYL-DIA. Liverpool. Improvements in the method of and material for covering electric cables, conductors, or wires with insulating material.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

7,370. LEIGH (Sprague). Control of electrically propelled vehicles and trains.
8,188. MARR, LAIDLER, and SUNDERLAND FORGE AND ENGINEERING CO. (LTD.). Rheostats or electric resistance switches.
12,279. EVERSHED AND VIGNOLES (Ltd.) and EVERSHED. Electric telegraphs for ships and other purposes.
12,565. ABEL (Karmin). Windings of dynamo machines and induction motors.
12,730. OFFENBROICH and ROCKEL. Galvanic cell.
12,767. BEAUMONT. Coin-freed electricity meters.
12,883. DUMONT. Apparatus for repairing incandescence electric lamps. (Date applied for under International Convention, April 12, 1899.)
12,962. NORTHEY and ELECTRIC MOTIVE POWER CO. (LTD.). Electrically-propelled road vehicles.
13,018. BARTON and GORHAM. Electric arc lamps.
13,053. SANDERS. Anti-vibrating springs for incandescent and other lamps.
13,054. SANDERS. Holders for globes and shades of gas, electric and other lamps.
13,111. WADE and ELECTRIC MOTIVE POWER CO. (LTD.). Electrical switches.
13,174. HERZOG. Electric signalling apparatus.
13,271. SINCLAIR and AITKEN. Telephone exchange systems.
13,509. ALDRIDGE. Electric cranes.
13,616. EVERSHED and VIGNOLES (LTD.) and EVERSHED. Motor electric meters, parts of which are applicable to motors and dynamos generally.
13,617. RIMINGTON. Electrical Measuring instruments.
13,646. HOLLICK. Electrical motive power apparatus.
13,846. CORDNER. Manufacture of a composition from rhea fibre applicable for electric insulation and other purposes.
13,994. VERITYS LIMITED and RIDINGS. Key switch for electrical circuits, particularly adapted for incandescent lamp sockets.
13,995. VERITYS LIMITED and RIDINGS. Carbon-feeding mechanism of electric arc lamps.

1900.

507. CLARKE. Construction and manufacture of electric bells.
839. LAKE (Shearman). Incandescence electric lamps.
1,445. LORING and CLARK. Electric transformers. (Date applied for under International Convention, June 24, 1899).
2,119. WATERHOUSE and SIMPLEX STEEL CONDUIT CO. (LTD.). Junction boxes for electric conductors.
2,964. HOWARD. Manufacture of pipes or conduits for electrical conductors, or for conveying liquids or gases or for analogous purposes.
3,527. HANSEN. Adjustable contact for electric alarm clocks.
4,109. GOLBY (Hansen). Electric clock.
4,785. DÉRI. Alternating-current motor.
5,178. DAY (White). Means for connecting electric cables.
5,486. QUINTAINE. Process for depositing pure tin by electrolysis.
6,185. HEYS (Scott, Varley and Anderson). Apparatus for winding wire and other material into coils and the like for electrical and other purposes.
6,188. BOUTILLIER and HUNTER. Armoured conduits for electric wires.
6,296. BORCHERS. Electric furnaces.
6,308. FESSENDEN. Electric incandescent lamps.
6,355. COOLEY. Methods of and apparatus for electrically separating the relatively volatile liquid component from the component of relatively fixed substances of composite fluids.
6,478. JONES. Electromagnetic mechanisms for producing reciprocating motion.
6,483. SIEMENS BROS. & CO. (LTD.). Siemens and Halske Aktien Gesellschaft. Apparatus for simultaneously actuating from one point the controlling switches of the several electrical motor cars of a train.
6,526. MÜNKER. Electric fire alarms.
6,684. DERVIN. Electric coherers.
6,878. JAMES. Electric arc lamps.
6,951. STEELE. Instrument for measuring electric currents.
7,084. BOULT (Pieper and Pieper). Electric motors.
7,098. SHORT. Multipolar electric machines.
7,100. HOLLUB and MIGNAL. Device for fixing incandescence electric lamps.
7,108. SIMMS and BOSCH. Magneto-electric machines.
7,109. VARLEY. Electro-magnetic coils.
7,198. THOMPSON (Sinding-Larsen). Method of producing complex chemical compounds by electrolysis with alternating currents.
7,410. KÄSBAUER, HABERFELLNER and LENCK. Regulators for electric arc lamps.
7,482. TIMAR. Electric sweating mattress.
7,562. BRITISH THOMSON-HOUSTON CO. (LTD.) (Rice). Third rail insulators for electric railways.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH MOTOR TRACTION CO. (LTD.)—This company was recently registered, with a capital of £1,000,000 in £1 shares, to adopt various agreements and to carry on the businesses of manufacturers of and dealers in motors, cycles, vehicles, &c., electricians, mechanical engineers, &c.

DONOVAN AND CO. (LTD.)—This company was registered on Aug. 15, with a capital of £10,000 in £1 shares, to acquire from Mr. E. W. Donovan the business carried on by the Electroid Gas Light Syndicate (Ltd.), and by J. S. Leach & Co. (Ltd.), and to carry on the business of mechanical, electrical, and hydraulic engineers, boiler makers, &c. The first directors are C. Pilkington (chairman), and E. W. Donovan.

MORDEY-FRICKER ELECTRICITY CO. (LTD.)—This company was registered on Aug. 13, with a capital of £20,000 in £1 shares, to acquire the benefit of certain inventions of Mr. W. M. Mordey and Mr. Guy C. Fricker, and to carry on the business of electricians, manufacturers of electricity meters, &c. The subscribers (with one share each) are J. Atherton, J. B. Atherton, W. M. M. Forwood, H. J. Russell, W. M. Mordey (electrical engineer), Guy C. Fricker (electrical engineer), and A. W. Haptie. The first directors are Jacob Atherton, George H. Nisbett, and Guy C. Fricker.

ROGERS & GOWLETT (LTD.)—This company was registered on Aug. 16, with a capital of £10,000 in £1 shares, to acquire the business carried on by Rogers Bros., at Watford, and to carry on the business of electricians, ironmongers, &c. The first directors are J. Rogers and P. Gowlett.

TURNER, ATHERTON & CO. (LTD.)—This company was registered on Aug. 8, with a capital of £175,000 in £1 shares, to acquire the businesses carried on by John Turner & Sons, John Turner, the Turner Machine Co., Turner Bros., and Giles Atherton, and to carry on the business of electrical and general engineers, cycle and motor car manufacturers, &c. Messrs. H. H., Albert, and Arnold Turner and G. Atherton are permanent governing directors, and Messrs. W. H. Atherton and W. E. Turner are managing directors.

BRITISH ALUMINIUM CO. (LTD.)—The annual return to June 7 has been filed. The capital is £400,000, in 20,000 7 per cent. preference, 10,000 ordinary, and 10,000 "A" 6 per cent. preference shares of £10 cash, of which 20,000 7 per cent. preference and 10,000 ordinary have been taken up. £10 per share has been called up on 16,770 7 per cent. preference and eight ordinary shares, and £167,780 has been received. £132,220 is considered as paid on 13,222 7 per cent. preference and ordinary shares.

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CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The annual return to June 7 gives the capital as £400,000, in 40,000 ordinary and 40,000 preference shares of £5 each, of which 30,000 ordinary and 33,420 preference have been taken up. £5 per share has been called up on 10,000 ordinary and 33,420 preference shares.

ELECTRICAL POWER STORAGE CO. (LTD.)—The annual return to July 26 has been filed. The capital is £100,500, in 100 founders' and 20,000 ordinary shares of £5 each, of which 66 founders' and 18,592 ordinary have been taken up. £5 per share has been called up on 66 founders' and £4 per share on 3,132 ordinary shares.

THOMAS PARKER (LTD.)—According to the annual return to July 13 the capital is £75,000, in £10 shares, all of which have been taken up. £10 has been called up and paid on 5,750 shares, and £17,500 is considered as paid on the remaining 1,750.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28½d. per oz. (Aug. 23). Consols (2¾ per cent.) 98⅛—98¼ for money, 98¼—99⅜ for account; 2½ per cent. 97—99 (Aug. 23). Stocks and Shares Continuation Days, Aug. 28 and Sep. 12; Ticket Days, Aug. 29 and Sep. 13; Pay Days, Aug. 30 and Sep. 14; Mining Share Carry-over Days, Aug. 27 and Sep. 11.

LONDON PLATINO-BRAZILIAN TELEGRAPH CO. (LTD.)—The half-yearly coupons, due Sept. 1, of the £100,000 6 per cent. debentures of this company will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, E.C.

STOCK EXCHANGE NOTICES.—29th inst. has been appointed a special settling day for the further issue of 10,000 £5 shares (10s. paid and numbered 20,001 to 30,000) of the *Calcutta Electric Supply Corporation (Ltd.)*. The committee has also ordered the further issue of 100,000 ordinary £5 fully-paid shares (Nos. 490,001 to 590,000) of the *National Telephone Co. (Ltd.)* to be quoted in the official list.

WEST AFRICAN TELEGRAPH CO. (LTD.)—Notice is given that the half-yearly interest on the £300,000 5 per cent. mortgage debentures of this company, due Sept. 1, will be paid by the National Bank of Scotland, 37, Nicholas-lane, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Aug. 18	4,475	+ 300	6	27,469	+ 1,324
Blackpool Corporation...	„ 16	1,801	+ 444	20	15,888	+ 3,424
Blackpool and Fleetwood	„ 18	1,973	+ 54	7	9,760	- 140
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 19	516	+ 18	20	10,019	+ 1,797
Brisbane Trams	July 4	1,672	+ 279	26	47,582	+13,118
*Bristol Trams & Carriage	Aug. 17	3,605	+ 121	7	25,092	- 355
*Buenos Ayres & Belgrano	July 22	2,046	- 315	3	6,648	- 445
Central London Railway	Aug. 18	4,579	- 463	3	13,944	...
City & South London Ry.	„ 19	1,534	+ 454	7	10,535	+ 3,768
Cork Elec. Trams	„ 16	577	+ 44	33	13,239	+ 1,242
Dover Corporation	„ 18	354	+ 33	20	4,641	+ 345
Dublin & Lucan Rly. ...	...	...	...	...	...	...
Dublin United	„ 17	4,354	+ 793	7	27,108	+ 3171
Dublin Southern Dist....	„ 17	1,362	+ 204	7	7,953	
*Glasgow Corporation ...	„ 18	9,788	- 575	...	...	...
Hull Corporation	„ 18	1,357	+ 779	7	9,433	+ 5,406
*Liverpool Corporation...	„ 11	8,779	- 293	32	241,154	+26,783
Liverpool Overhead Rly.	„ 19	1,818	+ 123	7	12,193	+ 431
*Sheffield Tramways	„ 19	2,641	+1,246	33	70,704	+24,768

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 15.	Price Wednesday, Aug. 22.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 23. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£232,720	Stock	15/0	Anglo-American	58 61	59 61	6 0 11	Feb., May, Aug., Nov.	...	...
£2,088,640	Stock	20/0	Do. Preferred	110½ 111½	110½ 111½	5 7 7	„ „	111½	110⅝
£2,088,640	Stock	27/0	Do. Deferred	12 12½	12½ 13	10 7 8	„ „	12⅝	12½
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,539,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	103⅜	102½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	„ „	...	...
13,921	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,800	50	4½%	Do. 4½ per Cent. Debentures	100% 101%	100% 101%	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	11 11½	11 11½	6 1 9	Jan., Apr., July, Oct.	...	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	145 150	145 150	4 13 4	Jan., Apr., July, Oct.	147½	147
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	96 99	96 99	3 10 8	„ „	...	...
£1,422,288	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	2/6	Eastern Extension.....	14⅜ 15⅛	14⅜ 15⅛	4 11 10	Jan., Apr., July, Oct.	15⅛	14⅜
£330,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110 115	110 115	3 9 7	February and August	110	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	99 102	3 18 6	February and August	99	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) .	103% 103⅞	103% 103⅞	3 17 8	May and November ..	...	...
180,227	10	4/6	Globe Telegraph and Trust .....x l	11 11½	11 11½	4 11 10	Jan., Apr., July, Oct.	11½	...
180,042	10	3/0	Do. 6 per Cent. Preference.....xd	14⅜ 15⅝	14½ 15½	3 19 0	„ „	15	...
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July.....	32	...
£94,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	99 101	99 101	4 9 1	June and December ..	...	...
17,000	25	37/6	Indo-European	52 56	51 55	4 10 11	May and November ...	51	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 104	3 17 9	June and December...	...	...
11,839	8	4/0	Reuter's	7⅞ 8⅛	7⅞ 8⅛	4 14 1	April and October.....	8⅛	...
3,881	£100 Cert.	6%	Submarine Cables Trust	125 131	125 130	4 12 10	„ „	...	...
15,000	10	...	West African Telegraph	2⅛ 3⅛	2⅛ 3⅛	4 9 8	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	99 101	93 101	5 0 4	March and September	...	...
30,000	2½	...	West Coast of America.....	¾ 1	¾ 1	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 14 7	January and July.....	...	...
88,221	10	1/0	West India and Panama	⅜ ⅞	⅜ ⅞	...	May and November ...	...	...
24,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7⅛	6½ 7⅛	8 0 0	„ „	6 15/16	6⅞
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 5	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	...	...	4 15 3	June and December ...	...	...
207,980	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜ 15⅛	14⅜ 15⅛	4 11 10	Mar., June, Oct., Dec.	15⅛	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid) ....xd	2⅛ 3⅛	2⅛ 3⅛	5 14 4	August	...	...
234,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November	...	...
96,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
510,000	5	3/0	National	3⅜ 4⅞	4⅜ 4⅞	6 3 1	February and August	4⅜	4⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	13 15	13 15	4 0 0	„ „	13⅛	..
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	12 14	12 14	4 5 9	„ „	13⅜	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	4½ 5⅛	4⅜ 5⅛	4 17 7	„ „	5	4
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December ...	99	98
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4⅞ 5⅛	4⅞ 5⅛	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference.....	5 5⅛	5 5⅛	4 10 11	June and December ...	...	...
£. 79,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Aug. 15.	Price Wednesday, Aug. 22.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 23. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜	⅜	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅛ 12⅛	11⅜ 12⅜	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref. xd	9½ 10½	9½ 10½	4 5 9	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord. xd	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference xd	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6 6¼	6 6½	...	...	6	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp. xd	9 10	9 10	4 12 6	February and August	9⅜	...
20,000	5	2/3	Do. 4½ per Cent. Preference xd	5 5⅛	5 5⅛	4 1 10	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7⅛	6½ 7⅛	4 0 0	March	...	...
†£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	103 111	103 111	4 1 6	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	7⅛ 8⅛	7⅛ 8⅛	4 14 2	February and August	8⅛	7⅝
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 16 0	January and July	12⅝	12 7/16
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 128	123 128	3 18 5	June and December	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary xd	8⅛ 9⅛	8⅛ 9⅛	6 6 4	...	9	8⅞
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference xd	11 12	11 12	5 0 0	March and September	11 1/16	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1⅛	1 1⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4 4⅛	3½ 4⅛	6 13 4	...	4⅛	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98 100	98 100	4 0 0	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord. xd	14 15	14 15	3 13 4	April and October	14 15/16	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December	113	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	96 98	3 11 6	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary new	15 16	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5½ 6½	5½ 6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric xd	9/16 11/16	9/16 11/16	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14 15	14 15	4 16 8	February and August	14⅜	11½
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 3	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3 4	3 4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary xd	12 13	12 13	5 0 0	March and September	12½	12⅜
29,437	5	...	Do. £2 10s. paid	8½ 9½	8½ 9½	...	...	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref. xd	⅞ 1⅛	⅞ 1⅛	4 8 11	...	...	...
120,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜ ½	⅜ ½	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅜ ½	⅜ ½	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	1/16 1/8	¾ ⅞	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11⅛ 12⅛	11⅛ 12⅛	4 0 0	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅞ 6⅞	5⅞ 6⅞	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅜ 5⅜	4⅜ 5⅜	...	...	...	...
90,060	2	1/2 2/3	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	4 5 4	September	...	...
90,000	2	1/2 2/3	Do. 6 per Cent. Pref. Non-Cum.	2 2⅛	2⅛ 2⅜	5 1 1	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108 113	108 113	4 1 1	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 103	101 103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13 14	13 14	5 7 2	,, ,,	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6⅛	5½ 5⅞	4 6 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	6 8 0	...	1 1/16	1⅛
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7 1/16	Do. 6 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	5 6 8	...	...	...
32,098	3	2/8 3/16	Crompton and Co. (Nos. 1 to 32,098) xd	3¾ 4¼	3¾ 4¼	5 5 10	January and July	4	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅜ 1⅛	⅜ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid) xd	1⅞ 2⅛	1⅞ 2⅛	8 0 0	February and August	1⅞	...
17,139	5	2/9⅜	Do. (£5 paid) xd	3⅜ 4⅛	3⅜ 4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91 93	91 93	4 6 0	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	68 72	63 72	...	...	...	...
26,100	5	6/0	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛ 5	4⅛ 5	6 0 0	Half-yearly	4 1/16	4⅛
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	93 102	91 102	4 8 3	...	...	...
112,100	2	1/2⅛	Electric Construction Co. (Limited)	1⅞ 2⅛	1⅞ 2⅛	5 12 11	January and July	...	...
25,000	2	2/9⅛	Do. 7 per Cent. Cumulative Preference	2⅛ 3⅛	2⅛ 3⅛	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	102 105	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13 14	13 14	6 15 9	February and August	13⅜	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5 5⅛	5 5⅛	4 1 10	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	2⅛	2 1/16
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 104	101 104	3 17 10	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	35 39	35 39	4 12 4	March and July	3⅞	3⅞
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 5⅞	5½ 5⅞	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½ 11½	10½ 11½	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7	6½ 7	4 5 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103 105	103 105	4 17 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	22 23½	21½ 22½	3 3 10	February and August	22½	21½
25,000	10	4%	Do. Cumulative Preference (fully pd)	10½ 10¾	10⅛ 10⅜	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10½ 10¾	10 10⅛	4 15 3	May and November	10½	...
45,000	10	11/0	British Elec. Trac. Ord.	14 15	14 15	4 0 0	...	14⅜	14⅜
50,000	10	6/0	Do. 6% Cum. Pref. xd	12 13	12 13	4 12 4	February and August	12 1/16	14⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123 125	123 125	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	121 124	121 124	...	...	123½	122½
40,000	5	2/8 3/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	5	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 15 0	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	98 99	96 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10 10½	10 10½	2 17 2	June and December	1 1/16	10 1/16
£855,000	Stock	1¼%	City and South London Railway Con. Ordinary xd	55 58	55 58	2 7 2	February and August	...	...
37,500	10	1/5 7/16	Do. (Nos. 22,501 to 60,000)	5 6	5 6	2 9 4	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) xd	138 143	133 143	3 9 11	,, ,,	...	...
£200,000	Stock	5%	Do. (1896) xd	130 135	130 135	3 14 1	...	...	...
£241,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary xd	21 22	21 22	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference xd	14½ 15	14½ 15	3 18 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	1/16 ⅛	...	...	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	1/16 ⅛	1/16 ⅛	...	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	...	9½ 10½	4 17 7	May and November	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary x1	8⅜ 9	8 15/16 9 1/16	4 8 8	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	13 13½	13 13½	3 15 6	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103 105	103 105	3 16 2	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3¾	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4⅜ 5⅛	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	...	18 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	...	10½ 10¾	4 15 3	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12½	11⅛ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	9½ 10½	4 15 3	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary xd	89 92	90 93	3 4 6	June and December	94	91

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption

† The London Stock Exchange Committee refuses to quote these s

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,163. [No. 19. Vol. XLV.] FRIDAY, AUGUST 31, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 80c., or 70pf.

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NOTES.

THE Dublin Corporation is fully bent on having its own municipal electric light works. It will be remembered that the rival scheme of the Dublin Electric Lighting Syndicate, which fought its way through the House of Commons Committee stage, was thrown out on the motion for the third reading owing to the vigorous opposition of the supporters of the Corporation scheme. On Monday last, at a meeting of the Corporation, this municipal authority was given one last chance of avoiding the mistake of erecting a costly lighting station three miles from a city which already possesses an electric tramway power station capable of supplying all the current required for electric lighting. The Dublin United Tramways Co., the owners of that power station, made an offer at this meeting to sell to the Corporation all the current required for public and private lighting and electric supply; but after a long and heated discussion the proposal was rejected by 38 votes to 14, the Corporation deciding to proceed immediately with its own scheme. Indeed, tenders for contracts for machinery to the value of £46,000 were on that day accepted. In view of the fact that the extensive system of electric tramways now being built up in and around Dublin, with its central and admirably equipped power station, will, at some future date, be liable to compulsory purchase by the Corporation on the modest, if not exactly reasonable, terms of the Tramways Act, we regard it as decidedly short-sighted for the Dublin Corporation to erect a separate power station at the Pigeon House Fort. However well this may serve as a temporary expedient until the time of purchase arrives, and perhaps as a political move at the present moment, we cannot but regard it as a measure which conflicts with the future and lasting interests of the capital of the sister island.

WE invite the attention of our readers to a letter we publish this week, in which Mr. H. E. MAVOR discusses the relation of the improved value of land to the success of any electric power scheme. It will be remembered that in our last issue we commented upon a letter from Mr. MAVOR which appeared recently in the *Glasgow Herald*. The letter in our columns to-day is a clearer and more explicit statement of his main position. He avows that his object is "to direct attention as strongly as possible to the importance of the element of increment in value of land to promoters of power transmission schemes." Incidentally the question is stated to be one of importance to electrical manufacturers, because if a power scheme is successful it will bring grist to their mill. Mr. MAVOR illustrates his main proposition by a "concrete example on a small scale," and one under his own personal observation. Factory buildings adjoining the place where his company's engineering works have been erected have been so greatly improved in value by being supplied with cheap electric power, that, though they formerly did not let, now the rents bring in a handsome profit to the company; but the company is supplying current at a rate which, taken by itself, would not be remunerative.

SUCH is the illustration; and we may believe that Mr. MAVOR would have us apply it, on a suitably magnified scale, to the large electric power schemes which are now so prominently before electrical engineers and the industrial world. In other words, to secure success an electric power scheme must not be an electric power scheme *pur et simple*, it must necessarily also be a commercial land development scheme. Simple power schemes cannot be expected to succeed; combined with the business of purchasing and letting land and factory buildings they may prove sufficiently remunerative to justify their existence. This we take to be Mr. MAVOR's proposition; and, if we mistake him not, we unhesitatingly assert that, so far at any rate as concerns the industrial districts of England, he is wrong.

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Mr. Mavor directs attention to Niagara—the most glorious instance of a successful combination of electric supply and commercial land development. Granted; but Niagara is not England. The conditions which prevail there are totally different from those to be found in our own industrial counties. Other conditions, besides cheap power and land, combined to create the industrial town of Niagara Falls. Cheap land would have been still cheap land, and as wild a waste as ever, had there not existed ready to hand cheap inlets for raw materials and cheap outlets for finished products—the water-way and the railway. But in England the cheaper and more ready inlets and outlets have already been utilised, and industrial cities and towns have sprung up at the places where they occur. Steam has done already there what electric power has done at Niagara, and what Mr. Mavor expects electric power still to do in this country. Here the pick of the land has already been developed and is now teeming with industries. The electric power undertaking that will bring really cheap power to the doors of the existing factories will reap a far better harvest from the already tilled field than will the combined electricity and land development scheme that goes out prospecting in regions hitherto despised by the industrial manufacturers.

But though we cannot concede that land development is a *sine quâ non* in electric power schemes, we are quite prepared to admit that throughout the country there are hundreds, perhaps thousands, of acres of idle land that would be substantially improved in value through being converted by electric power from the industrially unsuitable to the industrially suitable. It may be questioned even here, however, whether it would be advisable for the electric power company to risk the annexation of such property, or whether it would not be better to leave this class of speculation to individual landlords. Mr. Mavor's concrete example may be safe to imitate on a correspondingly small scale; but it is extremely doubtful whether it would be to the advantage either of the electrical or of the general industrial world for electric power undertakings covering half a county or more to be mixed up with land speculation. Besides, there is the politico-economic aspect of the question, which, however far afield its consideration may lead us from electrical matters, is not less significant in its warning against the alliance Mr. Mavor advocates. Shall the great financial corporations that are to supply us, by the county-full, with light and power, who are to operate and control our tramways and electric railways that carry us and our industrial goods, be also our landlords? It is a condition fraught with much danger.

Some time ago a dispute arose between Messrs. Brown, Boveri & Co. and the local authorities controlling the Stansstad-Engelberg and Zermatt-Görnergratt three-phase electric railways with regard to the pressure at which these lines should be worked. The contractors proposed 750 volts, but the authorities refused to allow more than 500 volts owing to the alleged danger. Accordingly the contractors engaged Prof. H. F. Weber, of Zurich, to report as to the danger of pressures exceeding 500 volts, and to this end Prof. Weber conducted a series of experiments on the physiological action of electric pressures on the human body, using his own *corpus vile* for the purpose—not without considerable risk. A description of the experiments undertaken, and results obtained, will be found in an article by Mr. William Rung, of the firm of Brown, Boveri & Co., in our Danish contemporary the *Civilengeener*.

Two classes of experiments were made with a view to settle, firstly, the risk when both hands simultaneously touch both bare leads, or when both leads come in contact with a bare part of the body; and, secondly, the risk when a person standing on the railway or on a car touches one or other of the leads. Prof. Weber investigated the first case by using an iron ring wound with 680 turns of wire carrying an alternating current at a frequency of 50 ∿. The voltage between the first and last turns was 210 volts, and connecting wires were soldered to each successive thirtieth turn, thus giving intermediate voltages, to which Prof. Weber subjected himself in ascending scale.

With wet hands the limiting safe pressure appeared to be 50 volts, this pressure causing instantaneous paralysis of all the muscles of the fingers, hands, and arms. With dry hands as high as 90 volts could be taken, though this pressure produced instantaneous paralysis of the hands. From these experiments Prof. Weber infers that all pressures exceeding 100 volts are dangerous when contact is made with both poles of an alternating-current circuit; and, since this pressure produces muscular fixation, there is a decided risk of fatal consequences, the victim being unable to release himself. In the second class of experiment Prof. Weber, standing on moist gravel soil, subjected himself to gradually ascending pressures by touching intermediate points in a series of 20 glow-lamps, each taking 100 volts, and all well insulated. When the live conductor was slightly touched a pressure of 1,000 volts produced a stinging resembling a burn by a flame, but when the live conductor was firmly gripped a pressure of only 700 volts produced intense trembling of the fingers, hands, arms, and ankle joints. It was therefore inferred that to touch a single pole is not dangerous if the pressure does not exceed 1,000 volts. These experiments, it appears, were regarded as sufficient justification for running the two railways at 750 volts.

Although we cannot but admire the pluck which Prof. Weber displayed in seeking to discover by his own body the danger limit of alternating electric pressure, we fear that his experiments are far from conclusive. In the first place it is now fairly well established that pressures which to some individuals are highly dangerous, if not fatal, can be taken with impunity by others under precisely similar conditions. But Prof. Weber's experiments are open to more searching criticism than this, for there is no evidence that they were conducted under conditions at all resembling those met with in practice in traction and overhead electric lighting circuits. To investigate the mere pressure which the human body can stand is not sufficient. We ourselves

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have frequently been subjected to several millions of volts with impunity. The shock from a small Leyden jar, though produced by millions of volts, is quite harmless. Regard must therefore be paid, not merely to the pressure, but to the amount of horse-power at the back of it, as well as to the inductance and electrostatic capacity of the circuit from which the discharge is taken. In the first series of experiments the danger limit would probably have been considerably lowered if, instead of a small choking coil, carrying a comparatively weak current, the circuit of a large alternator of several hundred horse-power had been employed. In the second series of experiments, the risk would certainly have been enhanced and the danger limit would have been lowered by the introduction of a considerable electrostatic capacity or electromagnetic inductance into the circuit touched by one hand, for in either case, though the pressure might have been the same, the impulsive discharge through the body to earth would surely have been attended by greater danger. We regard it, therefore, as being by no means proven that all pressures between 100 and 1,000 volts are equally safe, and until the matter has been investigated under circumstances more resembling those in actual practice, it would be unwise to act on the incomplete evidence afforded by Prof WEBER'S experiments.

A CURIOUS phenomenon has occasionally been observed in the glow lamps on the circuits of the Calcutta Electric Supply Co. at times when Calcutta has been visited by exceptionally severe thunderstorms. Immediately following each lightning flash the brightness of the glowing lamps has been observed to increase suddenly, gradually returning to the normal incandescence. This phenomenon has so frequently been observed, that the engineers of the company have sought every possible explanation of the curious phenomenon, but have been unable to find any defect in their circuits—which are on the overhead wire system—that might offer an explanation. Indeed the only conceivable explanation is one which appears so extraordinary that many may find considerable difficulty in accepting it. It is well known that carbon, acting as a coherer in a wireless telegraph apparatus, undergoes the usual sudden decrease in resistance when subjected to electric radiation. It is possible that the carbon filaments of a glowing lamp may undergo a similar change when exposed to the influence of a tropical thunderstorm in its immediate vicinity. This sudden decrease in the resistance of the filament would, of course, produce a correspondingly rapid increase in its candle-power, after which the gradual self-decoherence of the carbon would account for the return of the lamp to its normal incandescence. We are not aware that this remarkable effect has been detected in any other electric supply circuit, but should this have been the case it might further elucidate the phenomenon if the engineers who have observed it would now make the facts public.

Wusung-Chefoo Cable.—The Eastern Telegraph Co.'s new cable steamer "John Pender" left Shanghai on Tuesday to lay a cable between Wusung and Chefoo (China).

Electric Luggage Cranes at Dover Pier.—It is intended shortly to erect electric cranes on the Admiralty Pier at Dover for the purpose of handling the passenger luggage and mails between the trains and steamers.

Opening of the Rathmines Municipal Electric Supply Works.—The official opening of these works by their Excellencies the Lord-Lieutenant of Ireland and the Countess Cadogan is announced to take place this afternoon.

The British Association.—Among the attractions at the British Association meeting at Bradford next week is to be an exhibition of wireless telegraphing between a captive balloon and the ground. This exhibition will be conducted by Mr. J. M. Bacon and Messrs. Maskelyne of the Egyptian Hall.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

Alternate Current Drop and the Westinghouse Compensator.—We have received from the Westinghouse Electric and Manufacturing Co. a pamphlet embodying a reprint of a Paper by R. D. Mershon on "Drop in Alternate Current Lines," which appeared in the *American Electrician* in 1897, together with a description of the Westinghouse compensator, an instrument based on the principles set forth in this article, for the purpose of indicating at the power station without the use of pressure wires the voltage at the feeding point under any condition of drop in the feeders. The pamphlet is illustrated and gives technical particulars of the instrument.

Wireless Telegraphy in the Navy.—Orders have been issued by the Admiralty for the equipment with wireless telegraph apparatus of 18 of Her Majesty's battleships and for shore stations at Malta and Gibraltar. The battleships include the "Alexandra," "Powerful," "St. George," "Gibraltar," "Brilliant," "Gladiator," and "Juno"; also four ships on the Mediterranean station—viz., the "Ramillies," "Andromeda," "Theseus," and "Venus," and two ships at Hong Kong. The Admiralty have also ordered estimates from the Portsmouth Dockyard for fitting wireless telegraph apparatus to shore stations at Dover, Culver Cliff, Rames Head, Scilly and Roche Point.

Atlantic Cable Extensions.—The Telegraph Construction and Maintenance Co.'s cable steamer "Anglia" on Tuesday last completed the laying of the cable for the Deutsch Atlantische Telegraphen Gesellschaft from New York to Fayal, Azores. It is a coincidence that the communication was completed on the fiftieth anniversary of the laying of the first sub-marine cable—that between France and England on 28th August, 1850. This cable establishes direct communication with Emden, Germany, and is the second line from Fayal to North America, the Commercial Cable Co.'s line working from Canso (Nova Scotia) to Fayal.

Thunderstorms.—Considerable damage has been done by lightning during the past week. At Inverness Post Office lightning set fire to the instruments, apparently through the failure of the lightning guards. The damage, however, was slight. During a violent storm at Stevenston, in Scotland, lightning caused an explosion at Messrs. Nobel's dynamite and gun-cotton factory. It appears that the lightning struck two gun-cotton drying stores; two men were injured, but not fatally. At Clapham, the Board School in Wandsworth-road was struck by lightning, a portion of the masonry being detached and falling into the roadway. Damage also resulted from storms at Durham, Felling, Gateshead, and other places in the North of England.

The "Demon" Water Motor.—A new pattern of impulse turbine or water motor on the Sellon wheel principle has recently been put on the market by Mr. P. Pitman, of Halifax. The revolving wheel is contained within a wheel-case, there being somewhat less than the usual amount of clearance between the vanes and the inside of the case. Instead of the water from the jet being received by the vanes and thrown out radially the vanes are bifurcated so as to throw the water out sideways, the water being thus discharged clear of that part of the wheel-case in which the wheel revolves. It is claimed that with this construction a minimum of friction is obtained between the water and the wheel, and that a high efficiency is the result.

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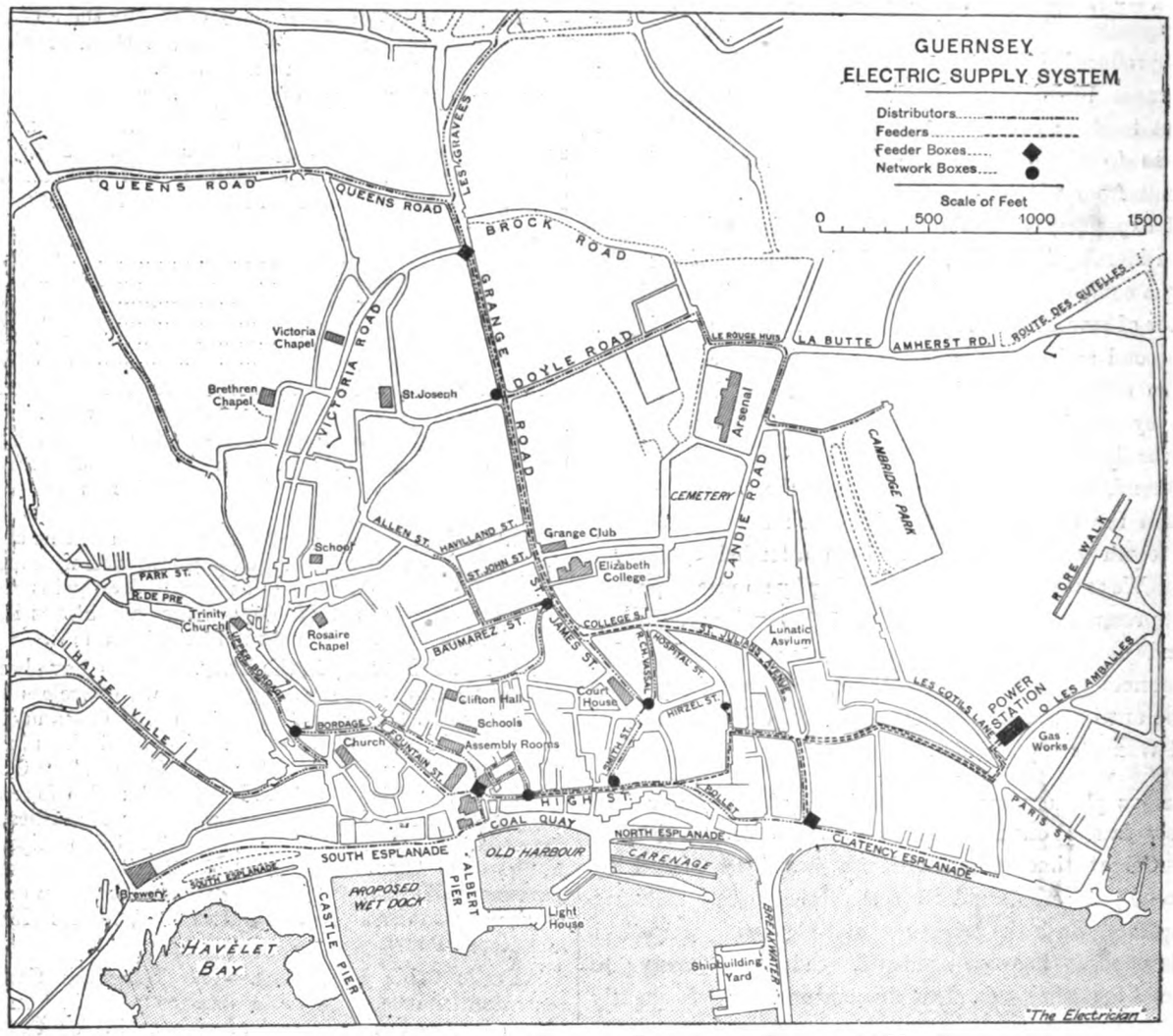
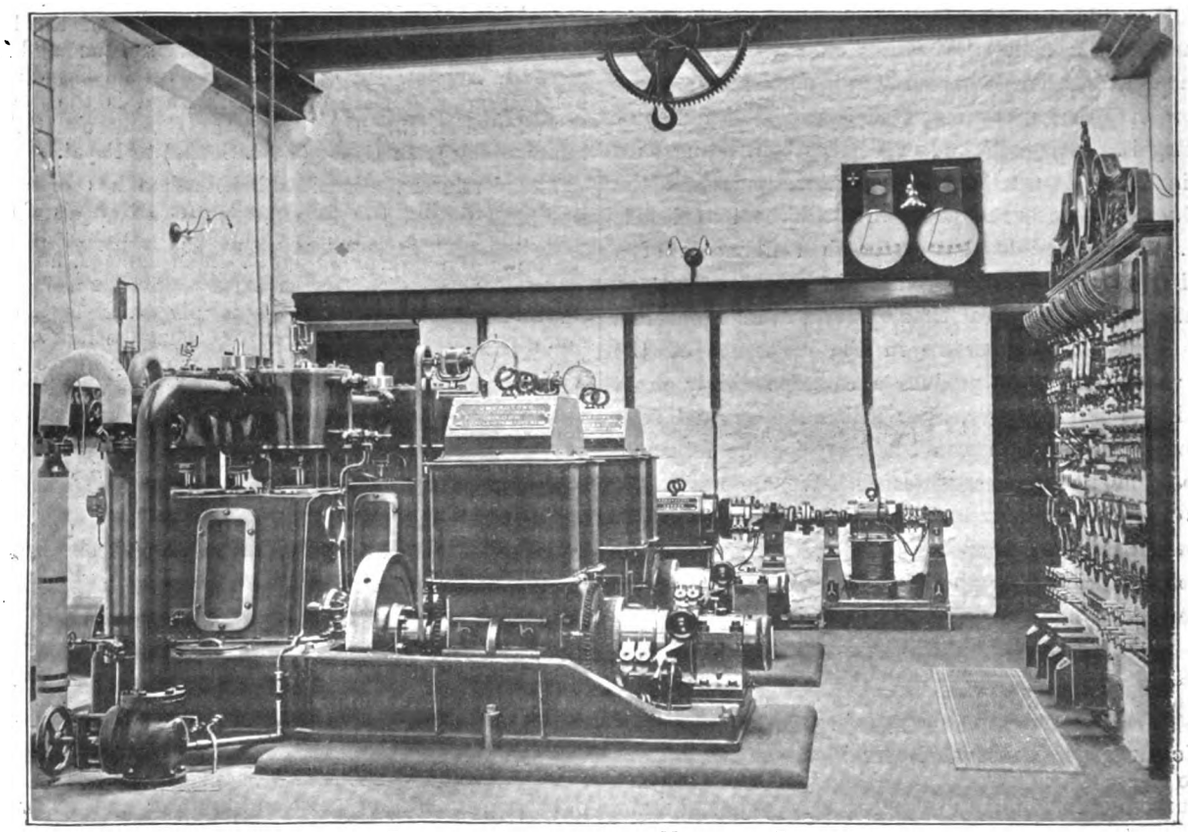
GUERNSEY ELECTRIC SUPPLY WORKS.



GUERNSEY : MAP SHOWING POWER STATION, FEEDERS AND DISTRIBUTING MAINS.



GUERNSEY : INTERIOR OF THE MACHINERY ROOM.

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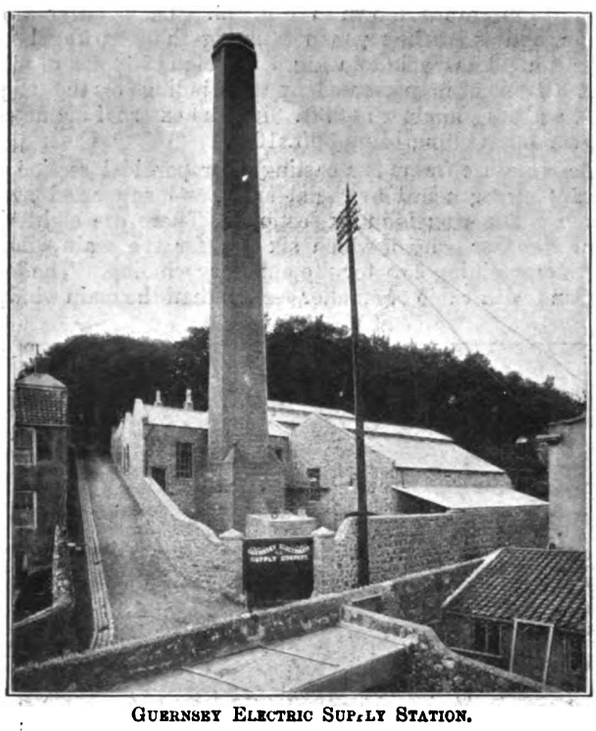
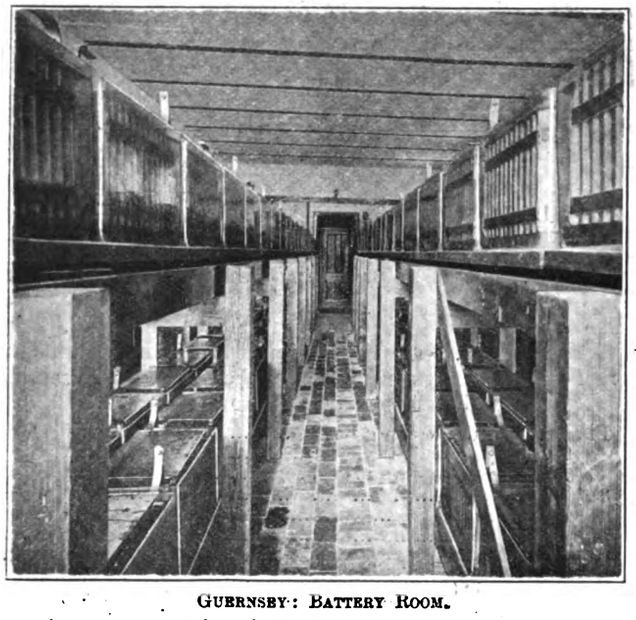
GUERNSEY ELECTRIC SUPPLY WORKS.

On July 25th last the opening took place of the electric supply works erected by Edmundson's Electricity Corporation at Les Amballes, a suburb of St. Peter Port, in the island of Guernsey. These works have been erected for the supply of electricity for lighting and power in St. Peter



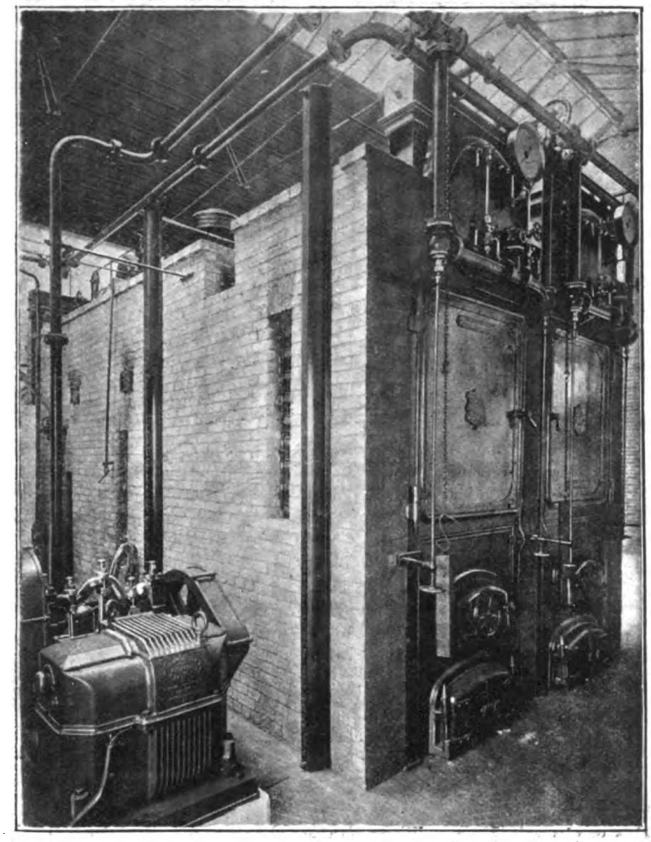
GUERNSEY ELECTRIC SUPPLY STATION.

Port, the principal town in the island. The accompanying map indicates the area at present supplied with current, and our other illustrations are from photographs of the power station and its various departments. We may mention that the entire capital for this undertaking has been found by Edmundson's Corporation, no subscriptions having been invited as yet from the outside public.



GUERNSEY: BATTERY ROOM.

The present capacity of the works is 2,000 8 c.p. lamps, but extensions are in hand which will largely increase this capacity. In the machinery room, that is to say, space has been left for two additional generating sets, each capable of supplying 5,000 lamps, and one of these is to be erected almost immediately. The boiler-house is equipped at present with two Babcock and Wilcox boilers, each having 1,218 sq. ft. of heating surface, and generating steam at 160lb. pressure. Steam is superheated by means of a Babcock and Wilcox superheater. The feed pumps include a Worthington steam feed pump with a capacity of 10,000lb. per hour and a Hayward-Tyler three-throw electric pump having a capacity of 13,000lb. The steam pipe range consists of a ring main of wrought steel with welded seams. The feed pipes are arranged in duplicate, allowing either pump to supply either of the boilers, and there is a by-pass allowing of either cold or hot feed. The feed water is heated by means of a Green's economiser having 96 tubes. Within the machinery room there are at present erected two generating sets each consisting of a 100 B H.P. Belliss steam engine, running at 500 revs. per min., direct-coupled to a 74kw. Parker dynamo developing 160 amperes at from 410 volts to 460 volts. The switchboard shown in one of our illustrations is of marble, with four generator and four feeder panels. It is fitted with Kelvin measuring instruments. About 7 miles of cable have at present been laid, the feeders being of triple concentric cable



GUERNSEY: BOILERS AND FEED PUMPS.

and the distributors of three-core cable. All the cables are lead covered and armoured. They have been manufactured by Callenders Cable and Construction Co. Storage plant has been erected in a battery room at the power station, and consists of 230 D.P. cells having an aggregate rated capacity of 715 ampere-hours at 80 amperes discharge. The battery, however, is capable of a maximum discharge of about 120 amperes.

Extensions, as already mentioned, are in hand. These include another Babcock and Wilcox boiler fitted with a superheater, and having 2,487 sq. ft. of heating surface; also another generating set consisting of a three-crank, triple-expansion Belliss 270 B.H.P. engine, running at 420 revolutions, direct-coupled to a Parker dynamo capable of giving 420 amperes at from 410 volts to 460 volts.

Although the supply of electric current at Guernsey is at present in the hands of a company, we understand that the States of Guernsey have made provisions for taking over the works and business at a future date, viz., at the end of 14 years, or subsequently at any multiple of seven years.

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THE PARIS EXHIBITION.—V.*

(BY OUR SPECIAL CORRESPONDENT.)

Of the four large German machines in operation in the electricity building, that of the "Helios" company is probably the most striking. Its general appearance is shown in Fig. 22. Although only 1,020kw. single-phase was asked for by the exhibition authorities, the Helios Co. decided to exhibit a machine of larger capacity; and in order that a use might be found for it more readily after the exhibition was ended, the machine is designed so that it can generate either single-phase or three-phase alternating current, or, if required, both forms of current simultaneously. The machine conforms, therefore, more or less with the firm's standard 3,000kw. three-phase pattern, but it is wound with a main winding for 2,000kw, single-phase and an auxiliary winding for 1,500kw. three-phase, the latter being branched by the Scott connection from the middle of the main phase and its voltage being only $\sqrt{3}/2$ that of the main winding. Thus the machine can generate 2,000kw. single-phase with a power factor of 0·7, or 1,200kw. single-phase and 1,500kw. three-phase simultaneously. The pressure decided upon by the exhibition engineers was 2,000—2,200 volts at 50 ∿ per second, but here again the makers had in view the future disposal of the machine, and have built it in such a way that it can be connected in three parallel circuits to give 2,000 volts, in two parallel circuits to give 3,000 volts, or all in series for 6,000 volts.

Fig. 23 gives a front and end elevation of the machine, and also part sections of the armature and magnets on a larger scale. As is seen, the field magnet is made up of 84 poles, carried as usual by a casting which serves at the same time as the fly-wheel of the engine. The poles are circular in section, and each is fixed to the rim of the flywheel by two bolts. Pole-pieces are added of such a form and width as to make the curve of E.M.F. approximate as closely as possible to a sine curve. Each pole of the magnets is provided with a coil of bare copper wire wound edgewise; the total resistance of the existing coils is 0·7 ohm, and, assuming a power factor of 0·7, 24kw. (roughly 1 per cent. of the total capacity of the machine) is required for excitation at full load. As seen in Fig. 23, the poles are sunk in the casting of the flywheel, and the latter is covered in with boiler plates, presenting the unusual appearance shown in Fig. 22. These latter are in tension, and assist the arms in resisting the centrifugal force on the rim. The whole rotating part weighs 76 tons, of which about 3½ tons are represented by the windings on the magnet poles, and its diameter is 26ft. 8in., the external diameter of the armature casting being 30ft. 10in.

The armature frame is a casting of trapezoidal section (see Fig. 23) strengthened by radial arms, and supported at the bottom. The ring is in six sections. There are eight slots in the core per pole, of which six are for the main winding and the remaining two for the auxiliary winding. The latter is wound with cable of smaller section than the main winding.

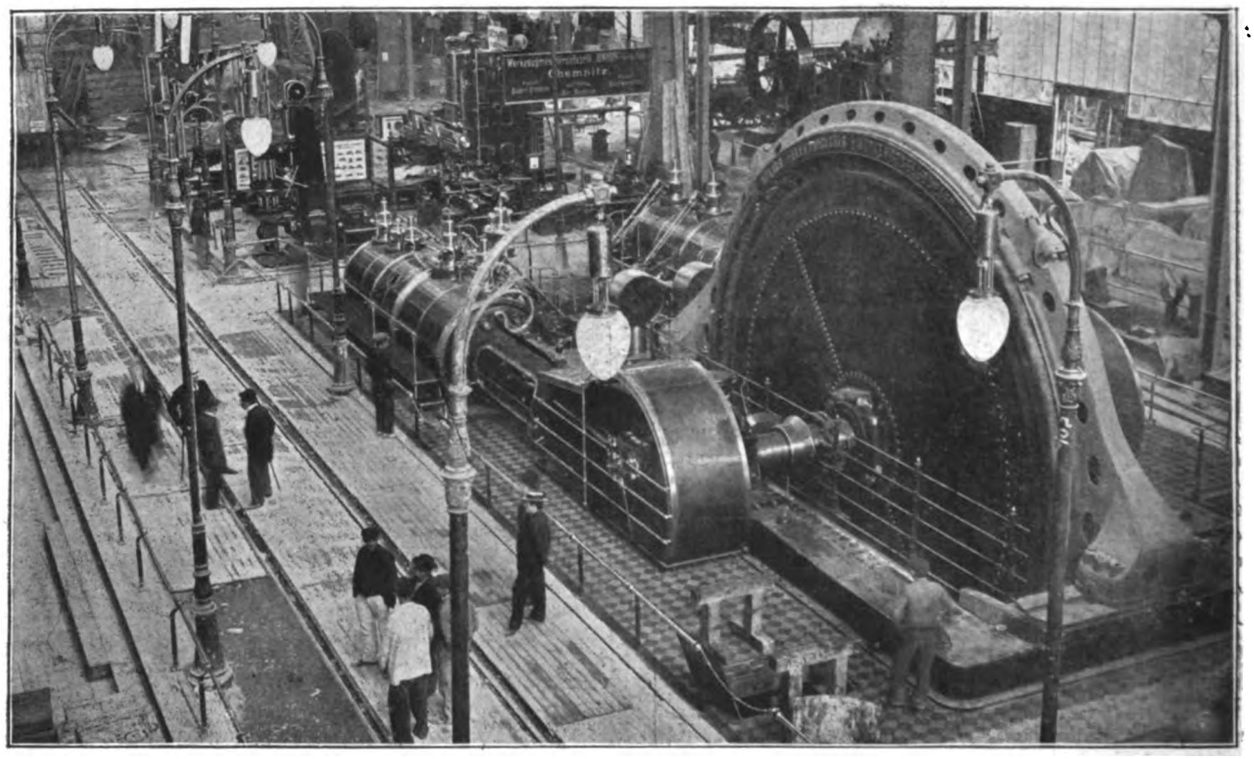

FIG. 22.—GENERAL VIEW OF "HELIOS" ALTERNATOR DRIVEN BY AUGSBURG ENGINE.

The exciter is considered as a separate exhibit, and is driven independently by a small vertical compound engine. It is six-polar, runs at 240 revs. per min., and furnishes 50kw. at 110 volts.

The engine driving the alternator is a horizontal triple expansion engine, with two low-pressure cylinders, and has been made at the Augsburg works of the Augsburg-Nuremberg Co. The main dimensions are as follows:—

Diameter of high-pressure cylinder	700mm.
„ intermediate cylinder	1,100mm.
„ each low-pressure cylinder	1,150mm.
Stroke	1,600mm.
Speed	72 revs. per min.
Steam pressure	12 atmospheres.
Cut-off of high-pressure cylinder	About 25 per cent.
Average capacity	1,600 H.P.
Maximum capacity	2,000 H.P.
Length over all	18·25 metres.
Width	8·9 metres.

All the cylinders and intermediate receivers are jacketed. The cranks have counterweights, and the brasses of the crank shaft bearings are in six parts. The two low-pressure cylinders are of course on opposite sides, placed in front of the H.P. and intermediate cylinder respectively. The valve

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3 and 24.

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gear is shown in the view of the engine given in Fig. 24. It is on the trip system, each cylinder being provided with four

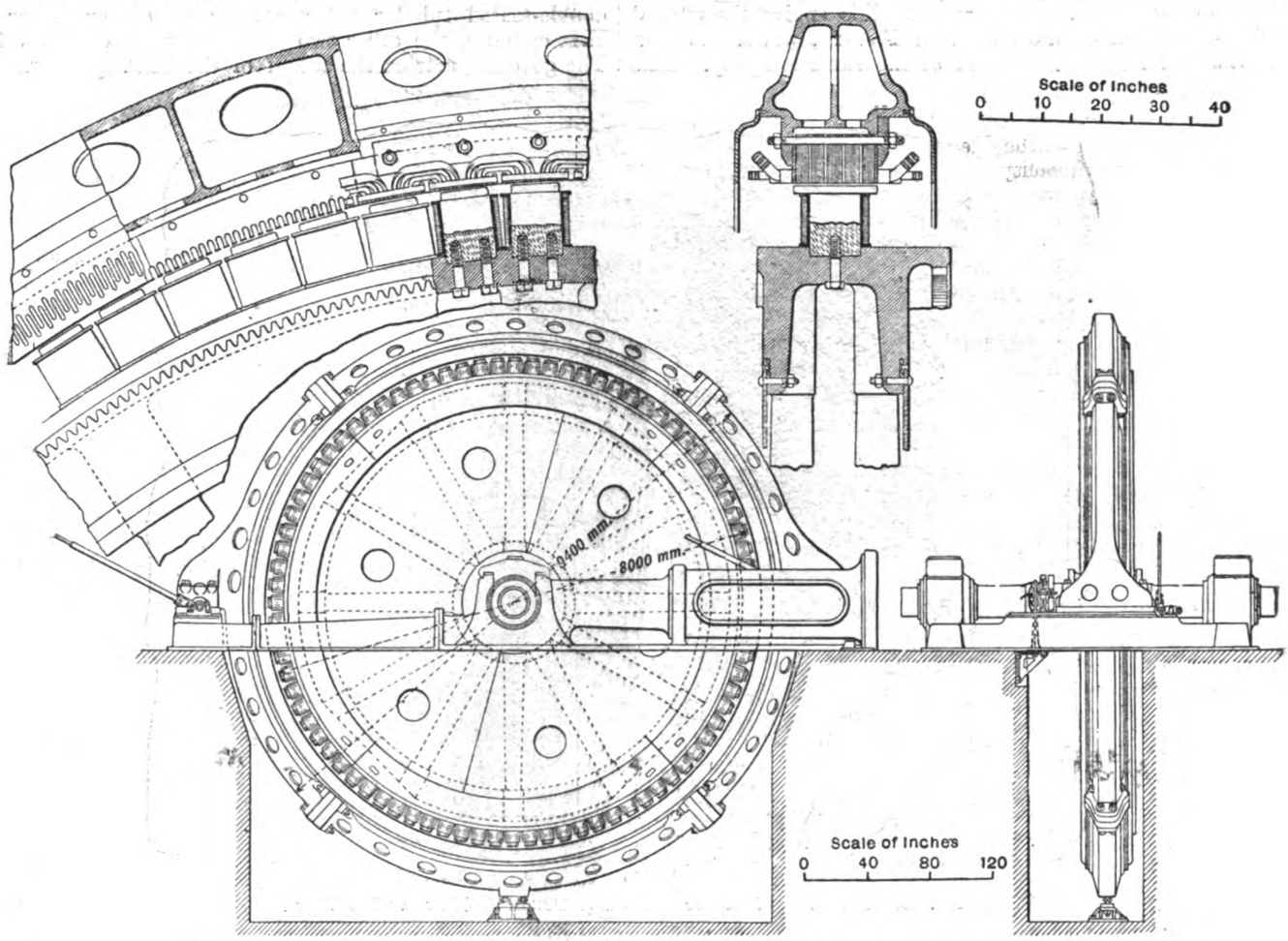

FIG. 23.—FRONT ELEVATION, END ELEVATION AND PART SECTIONS OF "HELIOS" ALTERNATOR.

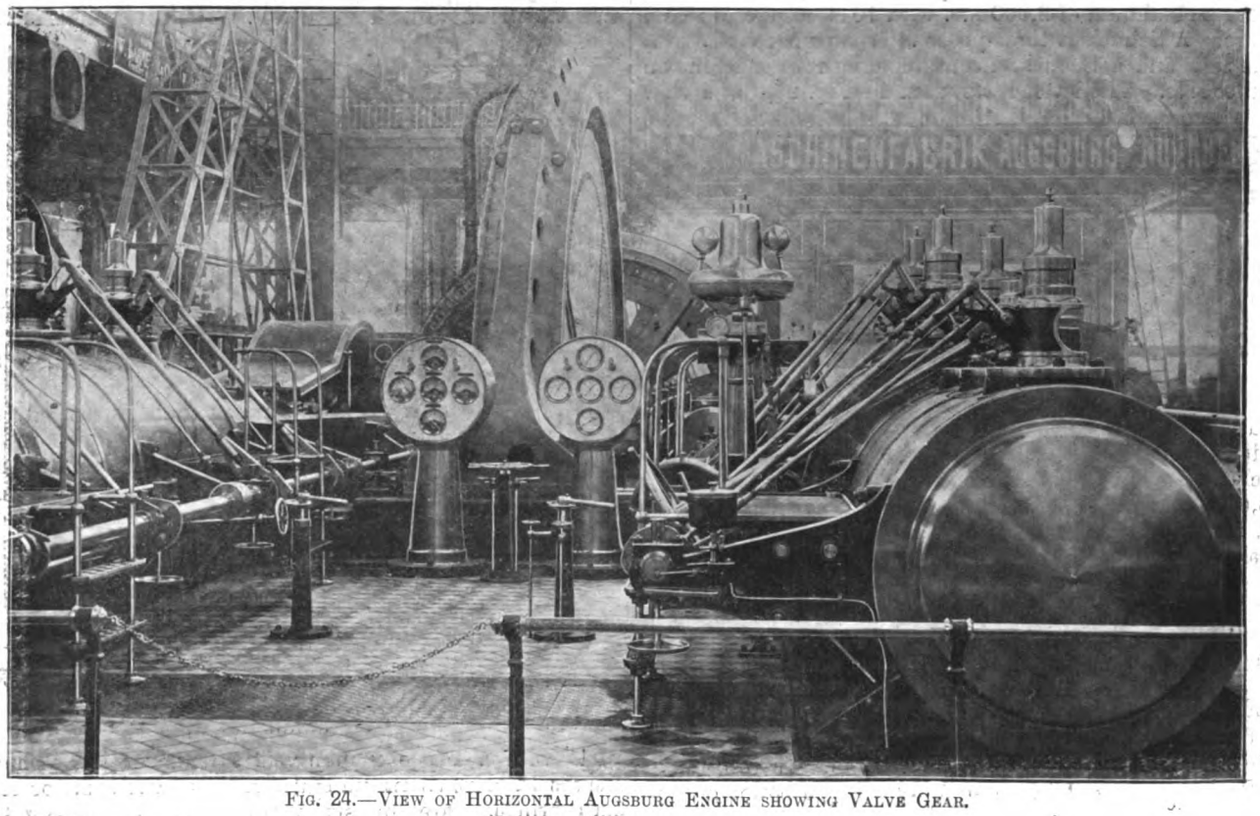

FIG. 24.—VIEW OF HORIZONTAL AUGSBURG ENGINE SHOWING VALVE GEAR.

double-seated valves, actuated by eccentrics and cams from wiper shafts, which are driven from the main shaft through bevel gearing. The governor acts on the cut-off of the H.P. cylinder, but it can be arranged to act on the intermediate cylinder if desired, or on the L.P. cylinder only. The cut-off can also be regulated by hand while the engine is running. If

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required the engine can run as a tandem engine with the H.P. and L.P. cylinders only.

It is interesting to compare with this engine the vertical triple-expansion engine shown in Fig. 25, which has been built at the Nuremberg works of the same company. This engine is rated at 2,500 H.P., at a speed of 100 revs. per min., but at the exhibition it runs only at 83 revs. per min. and develops a maximum of 2,000 H.P. with 10 atmospheres steam pressure. A Schuckert three-phase alternator is coupled to it on one side, and a Schuckert continuous-current machine on the other side. The latter is not seen in Fig. 25, but a view of the dynamo alone is given in Fig. 26. The bed-plate of the engine is in three parts bolted together, and the castings supporting the cylinders are stiffened by pillars seen in Fig. 25. The H.P. cylinder is placed between the other two. Its diameter is 775mm., and the diameters of the other two cylinders are 1,200mm. and 1,800mm., with a stroke of 1,100mm. The H.P. and intermediate cylinders are jacketed, but only the covers of the L.P. cylinder. While a double-seated tubular valve gearing is employed for the H.P. cylinder, the other two are fitted with Corliss valves. The governor acts on the cut-off of the H.P. cylinder. The valve-gear shaft, placed behind the cylinders, is horizontal, and is driven by worm gearing. A noticeable feature is that this shaft is fitted with a flywheel. The crank shaft is in two parts with a flange coupling. Its diameter is 380mm., it weighs 14 tons, its length is 9 metres, and it is supported on six bearings.

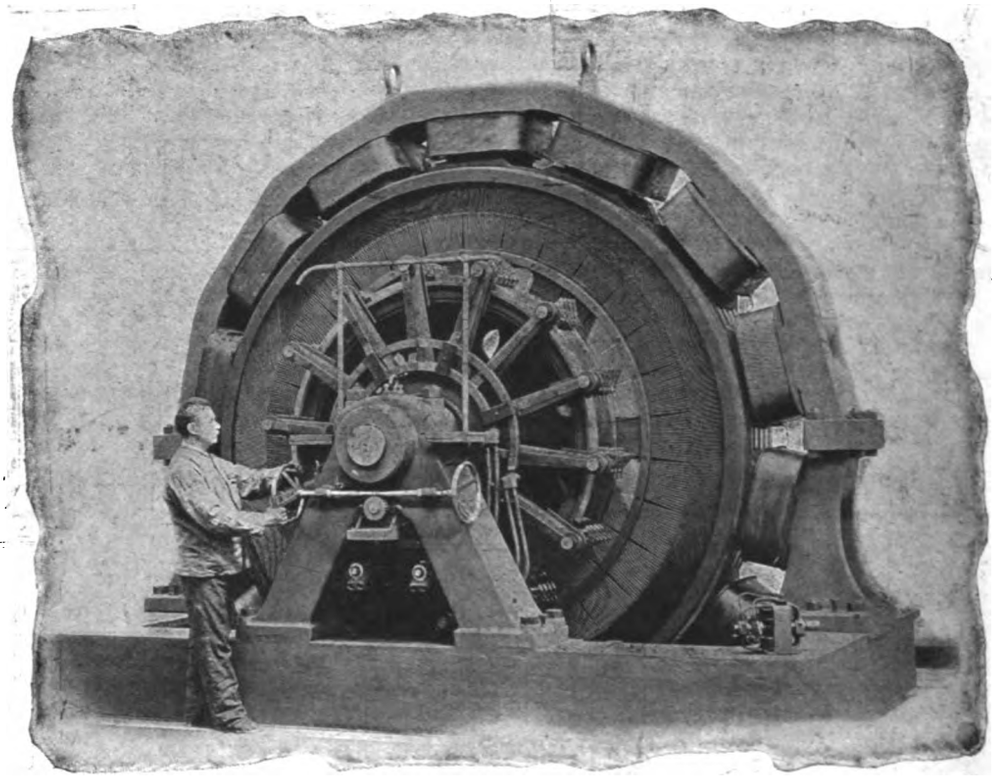

FIG. 26.—SCHUCKERT CONTINUOUS-CURRENT DYNAMO, 900KW. AT 500 VOLTS.

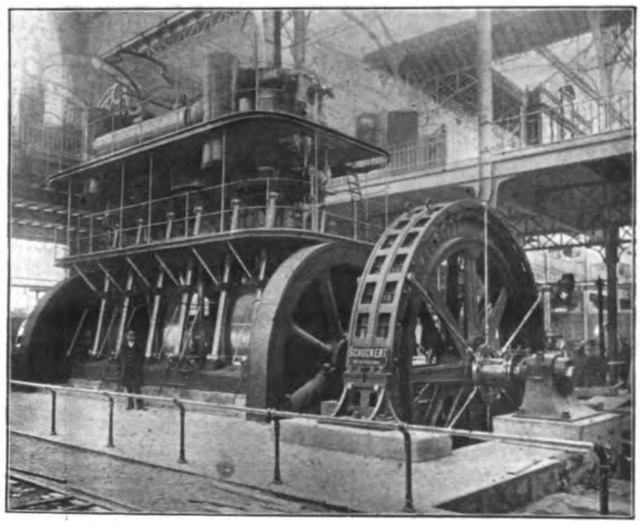

FIG. 25.—2,500 H.P. AUGSBURG-NUREMBERG ENGINE DRIVING 900 KW. CONTINUOUS-CURRENT DYNAMO AND 850 KW. 3-PHASE ALTERNATOR.

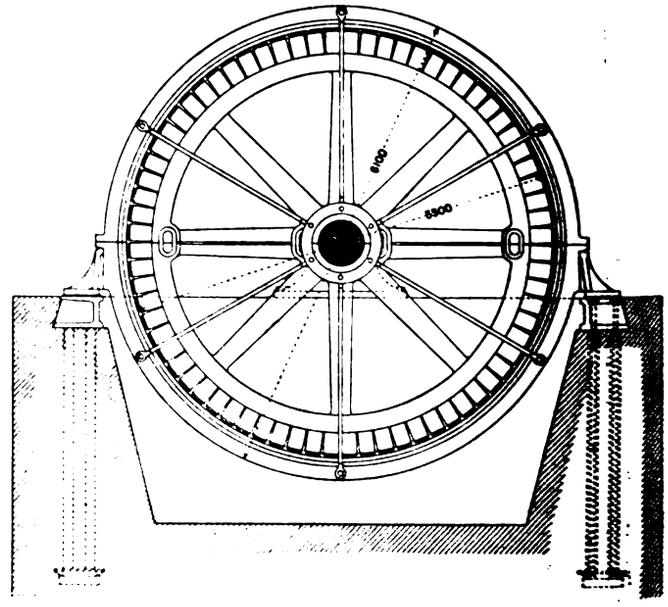

FIG. 27.—ELEVATION OF SCHUCKERT THREE-PHASE ALTERNATOR, SHOWING METHOD OF STIFFENING ARMATURE.

While the French dynamos are frequently driven by single-cylinder engines, it appears that some of the German makers have on the other hand made up their minds to secure an even

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turning movement at all costs. This triple-expansion engine, in addition to the rotating magnets of the alternator, which weigh 26 tons, has two flywheels, one on either side, weighing each about 20 tons. I understand that this is because the engine is to be employed for a tramway power-house, Mr. Raworth's doctrine of light flywheels for traction generators not having found any more favour in Germany than in this country.

On this engine, as on several others, an electric motor is employed for "barring," the exhibition engineers having expressed a wish that auxiliary plant should be motor-driven as far as possible. The motor is a Schuckert continuous-current one, developing 10 H.P. at 600 revs. per min. It is so geared that it can turn the flywheel a complete revolution in three minutes.

The continuous-current dynamo (Fig. 26) has been built for a capacity of 900kw. at 100 revs. per min., but at the exhibition it is only run at 88 revs. per min. and can develop 750kw. at 500 volts. As seen in the illustration, it is of the external-pole type, the magnet casting being in two parts and maintaining 14 poles fitted with pole-pieces. The armature core is smooth, not slotted or tunnelled. It is made up of core-discs and paper in the usual manner, and is drum-wound with windings of rectangular section. The bars are spaced in groups, and the end connections curved to facilitate

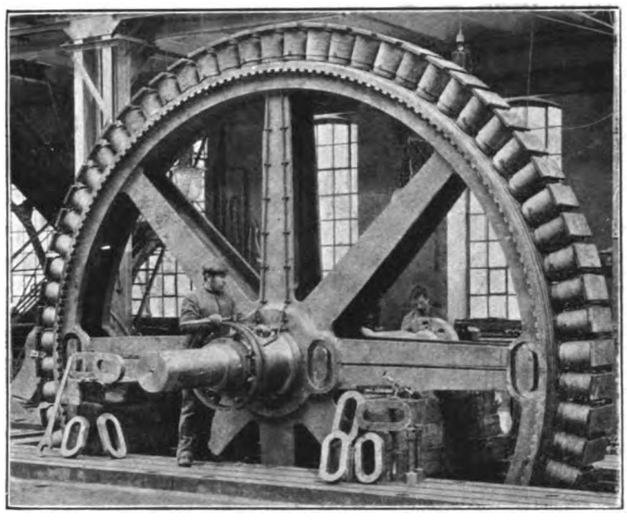

FIG. 28.—FIELD MAGNETS OF SCHUCKERT THREE-PHASE DYNAMO.

ventilation. Mica is used to insulate the binding-on wire from the winding. The commutator has 536 segments. The weight of the whole dynamo is about 45 tons.

The feature in the three-phase machine that attracts attention is the peculiar way in which the armature frame is stiffened by radial bars starting out from a ring concentric with the shaft, but of course clear of it by some inches. This construction, clearly seen in Figs. 25 and 27, is also adopted on one of the French alternators, which appears, however, to be similar in some other respects to the Schuckert machine, and is therefore possibly the work of a designer trained at the Schuckert works. The capacity of the Schuckert three-phase dynamo is 850kw. on a non-inductive load, at a pressure of 5,000 volts. The dimensions marked in Fig. 27 are in millimetres. The armature core is built up of soft iron sheets held in the ring-shape casting in the usual manner, a gap being left between sets of core discs, so that the armature may be ventilated satisfactorily. The method of supporting the armature casting is seen in the illustrations; to turn the armature round in order to repair the lower portions the brackets which support it on the bed-plate beams are removed. The lower part of the armature casting weighs 7·75 tons, and the upper portion 6·6 tons. Fig. 28 shows the magnet wheel of the machine in process of construction. The wheel is a steel casting, and 72 poles are bolted to its rim in such a manner that by removing two screws any pole can be pulled out sideways without disturbing the remaining parts of the machine.

There are two separate pillars for the continuous-current and three-phase switches. The former is fitted with both maximum and minimum automatic cut-outs, in addition to the usual apparatus for a dynamo panel. In conformity with the customary German practice, the measuring instruments of the high-pressure machine are connected to the secondaries of small transformers made for the purpose, and only these low-pressure instruments and the handles of the switches are on the front of the board. The high-pressure switch (Fig. 29) is of interesting construction.

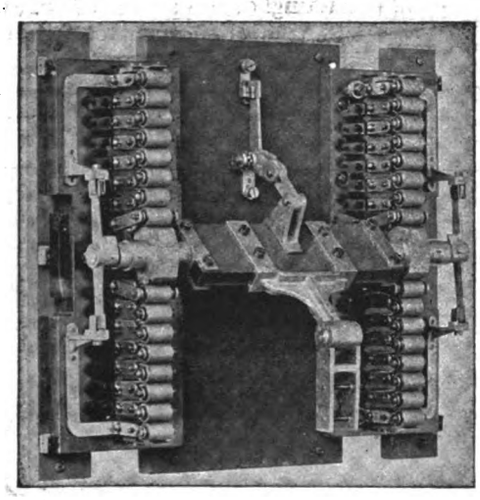

FIG. 29.—SCHUCKERT HIGH-PRESSURE SWITCH.

It consists of a number of metal rollers mounted on flat springs in such a way that each roller can revolve freely about its own axis. When the double cam, connected to the handle of the switch, is turned in the vertical position seen in the figure, corresponding to the "On" position of the handle, the rollers make contact with one another. A strong flat spring presses against each of the end rollers. When the cam is in its horizontal position the rollers are no longer in contact, and both when switching on and off they turn slightly, so that a rubbing contact is produced and a fresh contact surface is always exposed.

THE ST. GABRIEL-QUEBEC TRANSMISSION PLANT.

This scheme provides electrical energy, generated by water power at St. Gabriel, for transmission at high pressure to Quebec. The system, owned by the Jacques-Cartier Water

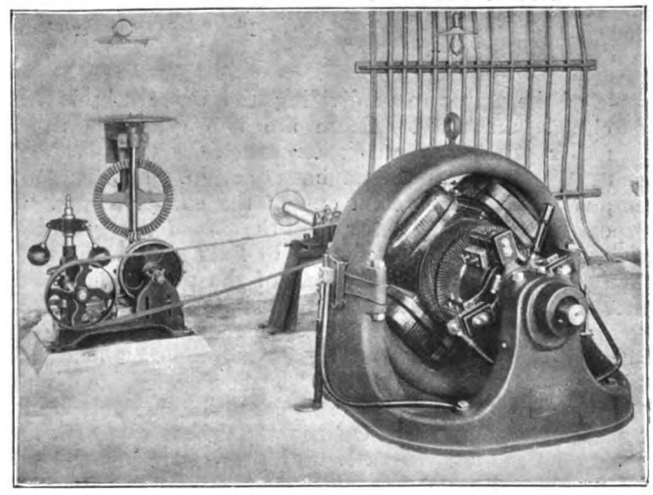

FIG. 1.—ONE OF THE EXCITER SETS.

Power Co., commenced operations in February last. At St. Gabriel, on the river of the same name, there is a fall of 20ft. on a rapid of 200yd. length; at the head of this rapid is

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the dam, a strongly-built stonework structure, 300ft. in length. The generating station is situated in a depression near the river and about 270ft. below the dam. The water is conveyed by two penstocks 13ft. in diameter to two Morgan-Smith turbines in the power-house. The wheels run at 150 revs. per min., and are each direct coupled to a 750 kw. Westinghouse three-phase generator, producing current at 2,000 volts pressure at a frequency of 60 periods per second. The two small exciting machines (Fig. 1) are also each coupled to a separate water motor. These sets run at 350 revs. per min. the generators being of the Westinghouse type of 37kw. capacity, and 125 volts pressure. The arrangement of the electrical machines is well shown in Fig. 2, as is also the position of the switchboard. The switchboard is mounted on a gallery standing against the partition which runs right along the centre of the power room dividing the water wheels from the electric machines. There are two generator panels, two feeder panels and an exciter panel, the whole being of the usual well-known Westinghouse design. A small rotary pump is driven by belt from one of the exciter shafts. Its purpose is to draw any water from the pits of the generating machines which may collect there by leakage from the water-wheels or condensation. The half of the power-house at the other side of the partition is divided into three floors. On the ground floor are the turbines. A room on the first floor is used as the transformer room, wherein are six 250kw. self-cooling, oil-insulated Westinghouse transformers, stepping up the generating pressure of 2,000 volts to the transmission line pressure of 20,000 volts. On the top floor are installed the choking coils of the Wurt's lightning arresters and the extra high-pressure cutouts.

Current is transmitted by overhead lines to Quebec, a distance of 18 miles. The pressure is reduced in a sub-station situated just outside the city boundary. The sub-station is a brick building 15ft. square, which receives from the overhead lines the 20,000 volt three-phase current and transforms it to 2,200 volt two-phase. This is then transmitted direct to a main distributing board in the centre of the city, distant about one mile, from which mains are branched off to various transformer sub-stations. The pressure of the 2,200 volt feeders is regulated from this main switchboard, pilot wires from various points of the house distribution network being brought to voltmeters here. The substations contain transformers which reduce the feeder pressure from 2,200 volts to 220 volts, which is distributed to the customers on the three-wire system.

Very low prices are charged for current. A flat rate charge is made of 0·5d. per lamp per day, or one farthing per 16 c.p. lamp per hour. The operating expenses of the plant are exceedingly low, and the supply is remunerative with these low charges. Only four men are required for the attendance of the generating plant, two by day and two by night, the wages account amounting to not more than £50 per month.

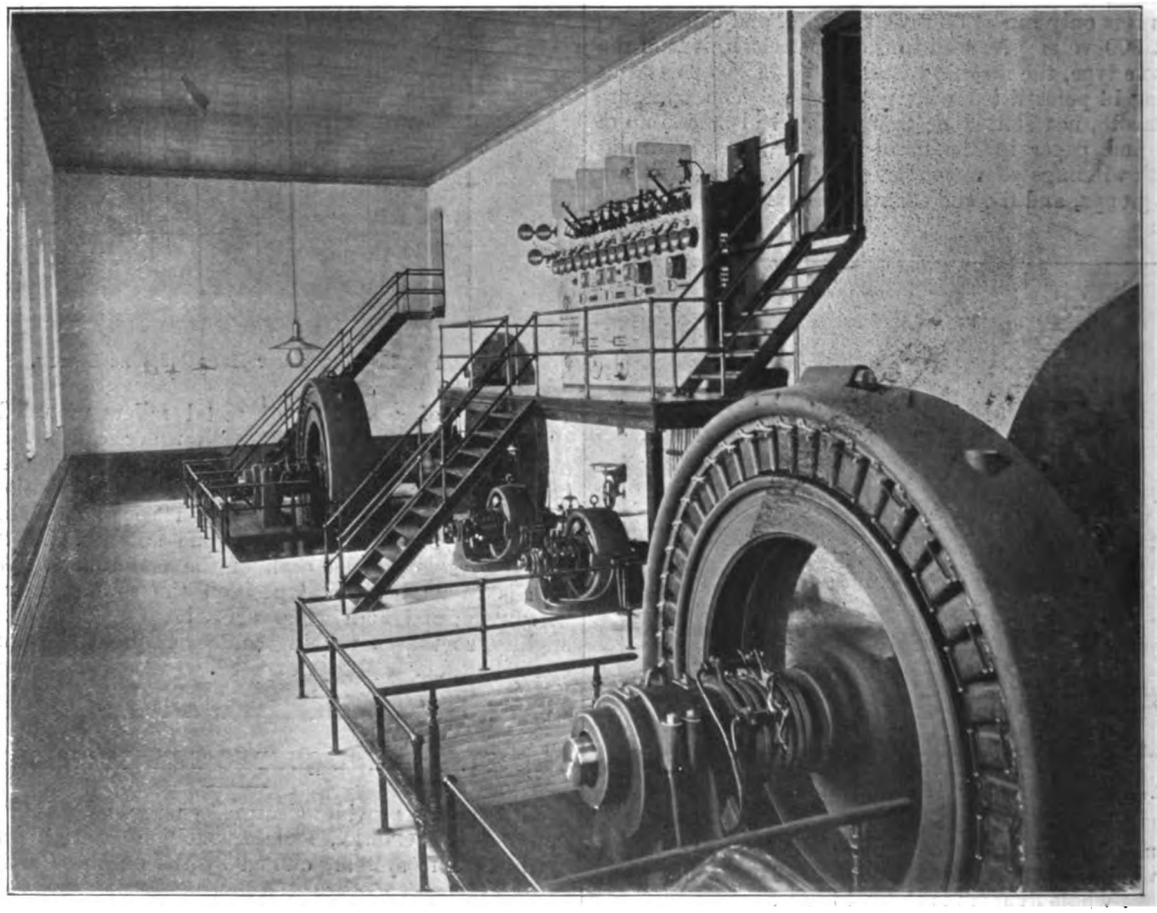

FIG. 2.—MACHINERY ROOM AT ST. GABRIEL POWER STATION.

THE ELECTRIC DRIVING OF IRONWORKS AND ROLLING MILLS.*

BY O. LASCHE.

The Allgemeine Electricitäts Gesellschaft of Berlin has been driving the rolling mills of its Oberspree cable works by electric motors for the past year and a half. A view of the copper rolling mills is given in Fig. 1. In a shop 66ft. wide and 148ft. long, are the rough rolls with four frames and the fine rolls with seven frames. The rolling mills were built by the Gebrüder Klein of Dahlbruch. The rough rolls make 108 revs. per min., and are driven through ropes by a three-phase motor. The motor develops an average of 200 H.P. at a speed of 380 revs. per min. at 500 volts, and the diameters of the driving and driven pullies are 4ft. 7in. and 16ft. 5in. respectively. It was decided at the time to gear down, although it is possible to build three-phase motors with

* Abstract from the *Technisches Centralblatt.*

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the requisite slow speed. The fine rolls are driven by a 400 H.P. motor at 420 revs. per min.; this motor is direct-coupled, and a flywheel is employed.

In 11 hours the two sets of rolls can roll out 27 tons of copper from bars weighing about 130lb. and 12·4 sq. in. sectional area to wire of 7mm. (0·275in.) diameter—*i.e.*, about 12½ miles of wire per diem. As the present plant is fully occupied with copper wire and strip, two new sets of rolls are to be built in the adjoining room for producing trolley wire. Power is taken from a neighbouring supply station. During the one and a-half years the works have been in operation no interruptions have occurred, and the installation has given the fullest satisfaction. The advantages, as compared with steam driving, are quick, reliable work, saving of space and of attendance to the motors, and increased light and cleanliness. The output is considerably higher than with steam driving.

In large ironworks hitherto many dozen steam engines, of various sizes, and separate boilers are employed, and the circumstances are usually such that the full advantages of superheating, economisers, a common condensing plant, &c., cannot be enjoyed. Experiments have shown that the blast furnace gases can be employed in gas engines, and units up to 1,000 H.P. have been successfully built for this purpose. But even in cases where neither water-power nor blast-furnace gases are available, and where, in consequence, steam engines and boilers must be used, the centralisation of the power-generating plant rendered possible by electrical distribution has great advantages.

The three-phase motor has no commutator and requires no attention and practically no repairs. It can therefore, if desired, be placed in a fairly inaccessible position, and this, together with its little sensitiveness to dust and dirt, renders it easier than other motors to combine with the machines it is to drive. The simple design and low weight of three-phase motors cause their price to be lower than those of other types.

Having regard to safety, a higher pressure than 500 volts should not be employed for continuous currents. With alternating currents pressures of several thousand volts can be used without hesitation, and 30 H.P. motors even are built for 2,000 volts. Thus alternating currents require only smaller conductors, and the aggregate sectional areas of the conductors for three-phase distribution is less than that for single or two-phase.

The simplest form of motor is that with a short-circuited armature. Small motors can be started and stopped by an ordinary three-pole switch, and up to 5 H.P. or 10 H.P. motors the turning moment at starting is nearly double the normal turning moment during running. Larger motors can also be employed with short-circuited armatures by starting the motor and dynamo at the same time. This method of working is employed most frequently for electrically-driven drainage or pumping systems. The motors are switched on before starting or else are never switched off. They are thus, so to say, electrically coupled with the generators and run up to speed with them. For starting with higher turning moments and as slowly as desired, adjustable resistances are placed in the armature circuit. This also enables the speed to be regulated between wide limits while running. By this arrangement, the three-phase motor can develop at starting up to three times the normal turning moment, and thus the armature with slip rings should be employed wherever the motor has to be started on full load. If the slip rings are only to be employed for starting, a device is added to short-circuit the armature within itself after the motor has run up to speed, so that the brushes can be lifted from the slip rings.

The speed of the three-phase motor decreases by a certain percentage as the load increases. This effect of slip of the motor armature may be compared with the slip of a belt on a pulley. If no power is being taken from the countershaft, and the pulley is therefore running light, the slip is quite small and the speed of the belt is but very little greater than that of the pulley. But if power is taken from the countershaft to enable the pulley to exercise a turning moment, the slip of the pulley increases—*i.e.*, the pulley lags behind the driving belt. A similar phenomenon takes place in

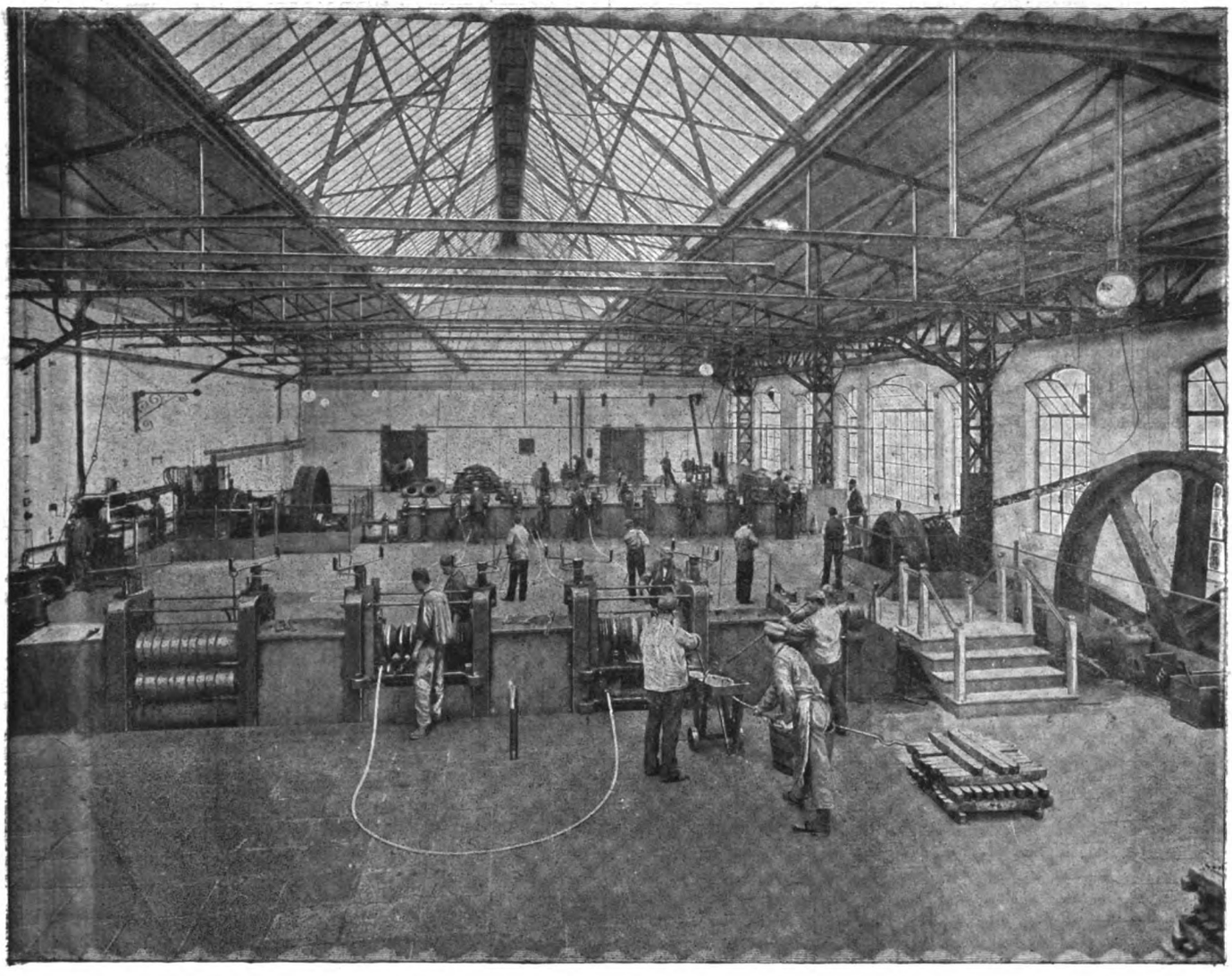

FIG. 1.—ELECTRICALLY-DRIVEN COPPER WIRE ROLLING MILLS OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.

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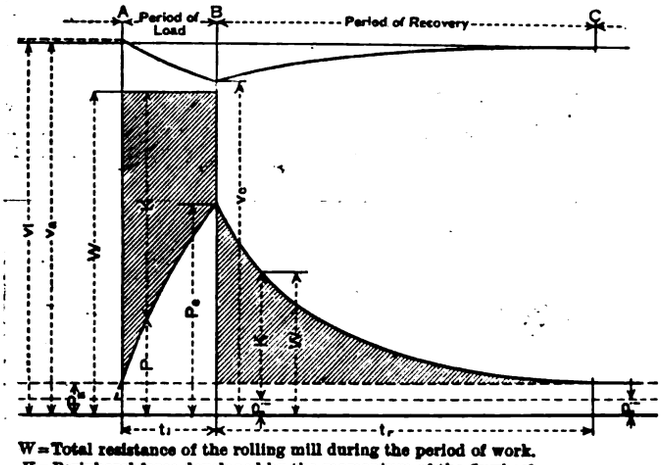
the three-phase motor in the mutual action between the armature and the so-called rotatory field of the stator winding. When the armature is delivering no power to its shaft it rotates with approximately the same speed as the rotatory field, but as the load increases the armature begins to slip, that is to say it lags behind the field. This slip of the motor is within the limits of normal load, approximately proportional to the increasing load. For instance, if it amounts to 1½ per cent. at half load, it will be about 3 per cent. at full load. In designing a three-phase motor, the slip can be taken at a less or greater value, and the speed of the motor with increasing loads



W = Total resistance of the rolling mill during the period of work.
K = Peripheral force developed by the momentum of the flywheel.
P = Peripheral force developed by the motor.
P_l = Peripheral force developed by the motor when the rolling mill is running light.
P_a = Peripheral force developed by the motor at the commencement of the period of load.
P_e = Peripheral force developed by the motor at the end of the period of load.
v_l = Peripheral speed at no load.
v_a = Peripheral speed at commencement of period of load.
v_e = Peripheral speed at end of period of load.
t_l = Duration of the load in seconds.
t_r = Duration of period of recovery in seconds.

FIG. 2.

will drop more or less accordingly. This slip of motors represents a small percentage loss, just as in the case of belt driving.

Having regard to the efficiency of the motor, therefore, as small a slip as possible is desirable in motors for ordinary work. In the case of electrically-driven rolling mills, however, it is the total efficiency of the installation that has to be considered, which, in view of the general advantages, may be very high, even with a large slip. Through this property of slip—viz., that speed the motor diminishes as the load increases—the momentum of a flywheel can supply momentarily a part of the requisite power. Thus the motor might

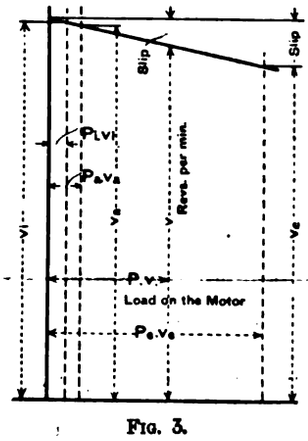


FIG. 3.

be considerably smaller than corresponding to the maximum mechanical resistance it has to overcome.

In what follows, the working of flywheel rolling mills only will be dealt with; motors for driving reversing rolls will not be considered, since they come under entirely different working conditions. It will first be examined in what way the motor must be reinforced by the flywheel, and what are the considerations to be made in calculating the size of the motor and the flywheel energy. We must consider two main periods in the cycle of operations: first, that in which work is done, and, secondly, the period of recovery. The latter implies the time during which the motor stores up energy in the flywheel to be employed usefully in the next period of work. Assuming that the resistance (P_l) of the motor and rolling mill when running light and also the total resistance (W) of the rolling mill are constant during the working period, the following relations are obtained, in which all the forces and peripheral velocities are reduced to a radius of 1.

Period of Load.—To overcome the resistance W during the working period, we have the peripheral force of the motor and that part of the momentum of the flywheel which is liberated by the drop in the speed—*i.e.*, $W = P + K$, where K is the part

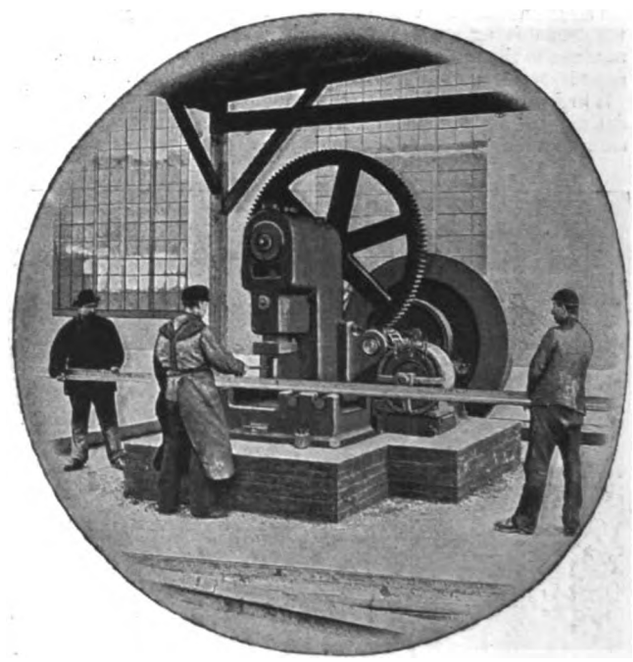


FIG. 10.—Straightening Machine.

contributed by the flywheel. During this period the speed falls from V_a to V_e as shown in the portion A B of the top curve in Fig. 2. This upper curve gives the variation in V, while the lower curve shows the varying relation between K and P—*i.e.*, the relation between the power supplied by the motor and that supplied by the flywheel. In the fundamental equation $W = P + K$, $K = m\frac{dV}{dt}$.

The determination of P is made in Fig. 3, in which the velocities V for the various loads P V of the motor are marked off. The relation between V and P V in a three-phase motor is taken as a straight-line one, for greater convenience in the calculation. Suppose, at the commencement of the period of load the actual resistance corresponding to no load has not yet been reached, and let the momentary value of V be V_a, somewhat smaller than V_l, which is the speed at no load; and let the value of PV be $P_a V_a$. The values of V_a and V_e corresponding to $P_a V_a$ and $P_e V_e$ are known from the dimensions of the motor. Then we have

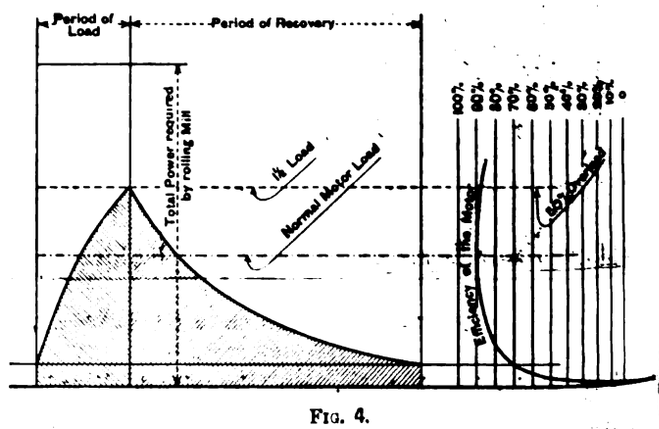


FIG. 4.

$$P = \frac{P_e V_e (V_a - V) + P_a V_a (V - V_e)}{V(V_a - V_e)}$$

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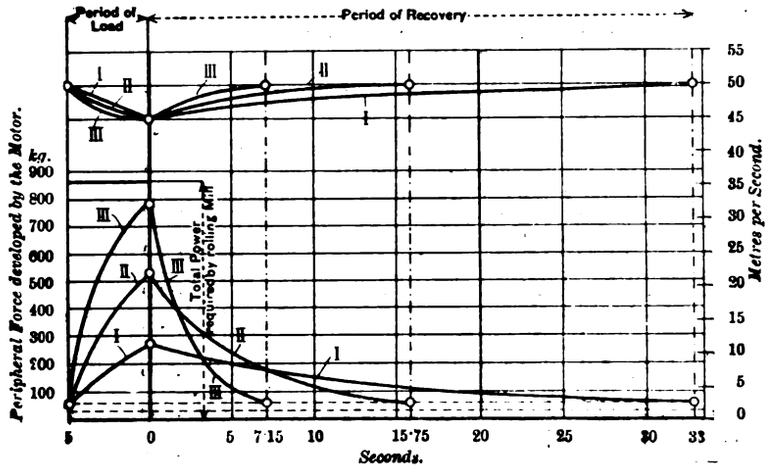
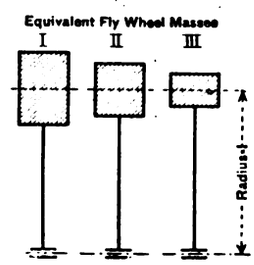
Inserting these values of K and P in the fundamental equation, we get

$$W=\frac{P_e V_e(V_a-V)+P_a V_a(V-V_e)}{V(V_a-V_e)}+m\frac{dV}{dt}.$$

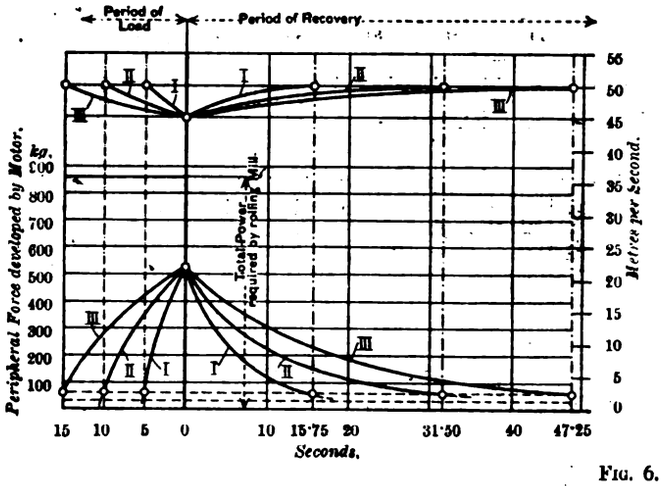
From this the equations of the curves for P and V as functions of the time may be developed, and we can plot off for each second the constant light-load resistance P_i and the resistance K which the inertia of the flywheel opposes to its acceleration. At each moment $P=K+P_i$. The curves between B and C show the increase in the velocity and the diminution of the peripheral force P required from the motor. In the fundamental equation, $P=K+P_i$, K has exactly the same value as during the period of load, viz., $K=m\frac{dV}{dt}$. The

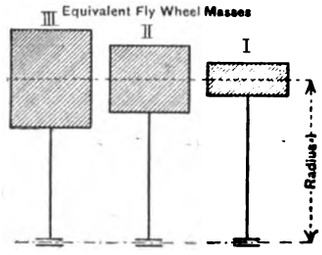




Maximum Power from Motor	170 H.P.	320 H.P.	470 H.P.
Slip $\frac{V_a - V_e}{V_a}$	10%	10%	10%
Period of Load	5 sec.	5 sec.	5 sec.
Period of Recovery	33 sec.	15·75 sec.	7·15 sec.
Equivalent Flywheel Masses	690	530	318

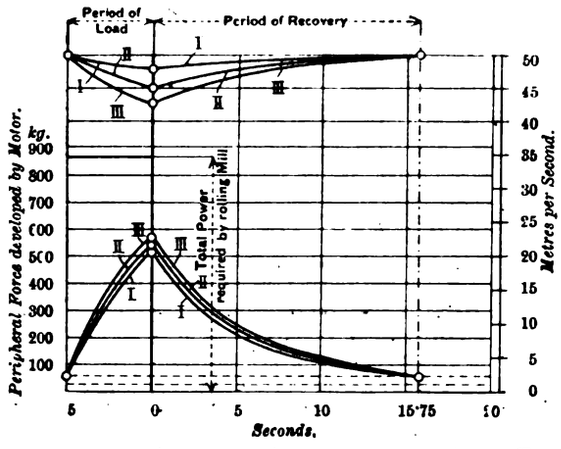
FIG. 5.

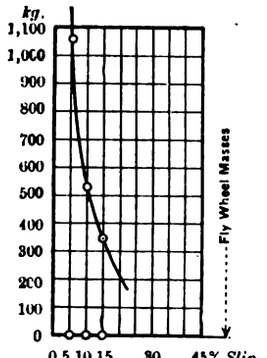




Maximum Power from Motor	320 H.P.	320 H.P.	320 H.P.
Slip $\frac{V_a - V_e}{V_a}$	10%	10%	10%
Period of Load	15 sec.	10 sec.	5 sec.
Period of Recovery	47·25 sec.	31·50 sec.	15·75 sec.
Equivalent Flywheel Masses	1,590	1,060	530

FIG. 6.





Maximum Power from Motor	320 H.P.	320 H.P.	320 H.P.
Slip $\frac{V_a - V_e}{V_a}$	5%	10%	15%
Period of Load	5 sec.	5 sec.	5 sec.
Period of Recovery	15·75 sec.	15·75 sec.	15·75 sec.
Equivalent Flywheel Masses.	1,060	530	353

FIG. 7.

reduction in speed of the flywheel and the corresponding load on the motor.

Period of Recovery.—The flywheel must be accelerated by the three-phase motor from the velocity V_e at the end of the period of load to the velocity V_a which it is to have at the commencement of the cycle. During this period the motor has to overcome the value of P is obtained from Fig. 3, and is

$$P=\frac{P_e V_e(V_i-V)+P_i V_i(V-V_e)}{V(V_i-V_e)}.$$

Inserting those two values in the fundamental equation, we have

$$\frac{P_e V_e(V_i-V)+P_i V_i(V-V_e)}{V(V_i-V_e)}=m\frac{dV}{dt}+P_i,$$

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and from this the curves for P and V can be determined as before. With the assistance of the formulæ derived for P and V out of these equations, the curves in Figs. 5 to 7 are calculated and plotted. In all the examples the power required by the rolling mill during the period of work has been assumed to be constant, as also the power required when running light.

It may be added here that the efficiency of the motors is nearly constant within very wide limits, or at least only drops to some 85 per cent. (see Fig. 4).

the periods of recovery as well as the flywheel weights increase proportionally with the duration of the period of load, and, therefore, that for long periods of load heavy flywheels must be chosen, and there must be long periods of recovery.

In Fig. 7 another set of three examples is plotted, in which the period of work and the size of the motor are assumed to be fixed. Three different values for the slip of the motor are chosen, and the necessary flywheel weight and period of recovery calculated. The smaller the slip allowed, the larger must be the dimensions of

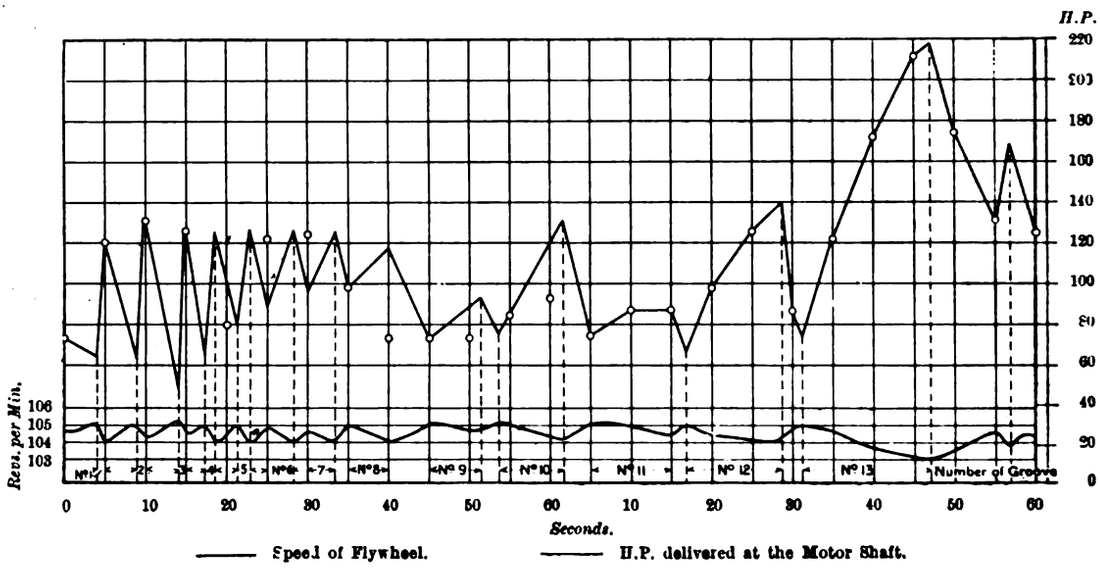

FIG. 8.—Rough Rolls. Motor N D 2,000 (rope drive).

In Fig. 5 three examples are worked out, in each of which the duration of the period of load as well as the slip of the motor (i.e., the decrease in speed owing to increase in load) is taken at the same value. A different size of motor has been taken in each case, however, and the necessary weight of flywheel and time required for recovery has been calculated. As maximum load on the motor one and a-half times the normal load has been assumed. It follows from these diagrams that when there are only small pauses between two roller grooves, and thus only a short period of recovery, a large the flywheel. In the curve to the right of this figure the values of the slip are plotted as abscissæ and the flywheel masses as ordinates. These diagrams show how much the necessary flywheel weights are diminished by increasing the permissible slip.

The results of measurements of power consumption and velocity in the rough and fine rolling mills at the cables works of the Allgemeine Elektricitäts Gesellschaft are represented graphically in Figs. 8 and 9. The speed measurements were made with a tachometer. To determine the power developed by the motor, voltmeter, ammeter and

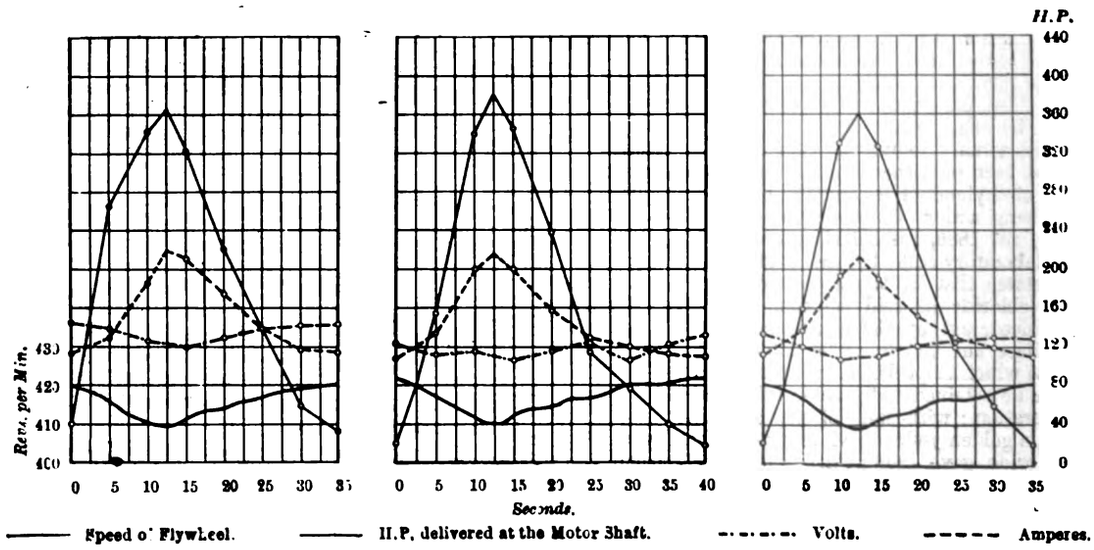

FIG. 9.—Wire Rolling Mill. Motor N D 6,000 (directly coupled).

motor in connection with a light flywheel must be chosen, while with longer waits between two individual grooves a smaller motor with a correspondingly heavier flywheel suffices. In Fig. 5 also the weights of flywheel necessary for the various sizes of motor are sketched as mathematically equivalent flywheel masses.

In Fig. 6 a comparison is again made of three examples, but here the sizes of the motor and of the slip are taken the same in the three cases, and the duration of the period of recovery and the necessary flywheel weights determined for different periods of load. From this diagram it is seen that if the size of the motor remains the same, wattmeter measurements were taken every five seconds, the efficiency of the motor being known.

In other machines, such as stamping machines, shears, presses, straightening machines (Fig. 10), &c., in which short periods of work alternate regularly with short periods of rest, and are therefore provided with flywheels, the determination of the size of the flywheels and motors is determined on the same lines as for rolling mills. It is to be noticed, however, that, in these other machines, the period of recovery is comparatively great compared with that of the period of load, so that a fairly small size of motor can be selected.

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ELECTRO-CHEMISTRY IN A DYE AND PRINT WORKS.*

BY A. E. SUNDERLAND.

The action of the electric current upon dyewares and intermediate products may be brought about in several ways, of which the following are the most important: The action of the electric current upon the substance itself, at the ordinary temperature if a liquid, or if a solid, above its melting point. The action of the current upon the body dissolved in some solvent. This gives the best results.

The first method does not give such good results as when dealing with inorganic substances, for it is too severe in its action, and usually resolves the compound into its elements. Certainly, intermediary products are formed, but these are so difficult to isolate that as a commercial method it is not to be recommended. Most members of the aliphatic and aromatic series in a molten state can be resolved into CO_2+H_2O, &c., with the production of intermediate products such as oxalic acid and glycollic acid in the aliphatic series, and hydroquinone ethers and hydro-oxy carboxylic acid in the aromatic series. The simplest apparatus employed consists of two tubes joined together by a water-tight V joint, each leg containing a circular disc pole. The dimensions of the tube, the quantity of liquor, the strength of the current, and the amount consumed should all be known.

The nature of the products obtained by the electrolysis of organic bodies depend upon two things—(1) Whether the body is a good electrolyte or not, and if not, what bodies are used to make it so. (2) Whether the decomposition takes place in an acid or alkaline medium; totally different products being usually obtained by electrolysis in each medium. The primary action which takes place in an electrolytic cell is an oxidising action at the positive pole and a reducing action at the negative pole, and the best results are got by adapting the process so that the products thus formed are immediately removed from the field of action. This may be done in several ways.—(1) Automatically by making use of the different densities of the solutions. (2) By raising or lowering the temperature of the cell. (3) By using different electrolytes in the anode and cathode chamber. (4) By using such an electrolyte that the body formed is totally insoluble in it, and thus falls out of solution, and is unacted upon by the current.

The chief interest in the electrolysis of organic compounds centres in the behaviour of the hydro-carbon radicle, which both in the aliphatic and the aromatic series seems to be very stable. The most important reactions are, however, the reduction of aromatic nitro bodies in alkaline solution, first to azo compounds and then to hydrazo compounds, these changes being produced in a very satisfactory manner, and the yield being equal nearly to the theoretical. If the same electrolyte is used in the anode and cathode chambers, the electrical osmosis is very noticeable, and is one of the chief difficulties in adapting these processes on the large scale, and the results obtained tend to emphasise the law of Clausius and Hittorf, that the electric current does not overcome affinities, but that the chief reactions are produced by the primary electrolysis of the electrolyte into hydrogen and oxygen.

As regards the actual production of dyestuffs by electricity, very few results have been published, and the known cases, such as the production of methylene blues, alizarin black, &c., simply depend upon the oxidising action of the electric current in the anode cell. Goppelsroeder, in 1886, published several results which he had obtained on a laboratory scale by the oxidation of various primary amines. He states that by the action of the electric current on aniline hydro-chloride in acid solution, emeraldine and aniline black are produced, and by the electrolysis of aniline salt alone a brown precipitate and red to violet colouration only is obtained. Further results which Goppelsroeder recorded are as follows: With methyl aniline he obtained a blue colouration; with diphenylamine, a violot colouration; with salts of napthylamine, brown bodies; with napthol, a golden yellow; while magenta, methyl alcohol, and potassium fluoride gave Hoffmann's violet. Goppelsroeder also produced aniline from nitro-benzene, and alizarin from anthraquinone.

Electricity may be applied in the dyeing process itself in two ways—(1) in printing, (2) in the dye bath. With regard to electric printing, Goppelsroeder proceeded as follows: A plate of lead or other suitable conducting material is used as the negative pole, and the stencil pencil or plate is used as the positive pole. Between these is fed the cloth impregnated with the various chemicals. On passing the current, decomposition of the various chemicals take place wherever the stencil plate touches, and the design is produced. As instances: (1) If the cloth be impregnated with an acid solution of aniline salt an aniline black figure is produced. (2) If the cloth be impregnated with potassium thiocyanate a yellow to orange figure is produced. Goppelsroeder also found that some dyes, such as Turkey red and indigo blue, could in the same way be discharged white by the electric current, and thus, by combination with the aniline black and canarin yellow, he could produce white, black, and yellow prints on red or blue ground. If metallic oxides were used, the oxide was precipitated, and the cloth, on dyeing with alizarins, would show a design where the current had passed.

These results, as obtained by Goppelsroder, are very interesting, and with the azo dyes some equally interesting results have since been obtained. The diazo compounds are so unstable that they are decomposed by ordinary daylight. I have subjected such to the ordinary current, and find that with a current of 20 volts to 40 volts 5 amperes a five seconds' contact will in some cases cause the decomposition, and on developing, the print will remain undeveloped. This discharge, however, is not quick or good enough, but it can be intensified by mixing along with the diazo compound a certain amount of sodium chloride, nitrate, chlorate, or other suitable chemical, which will, on the passage of the current, liberate compounds capable of discharging the diazo compound more thoroughly. Such reactions may be greatly extended, and by making use of the colours themselves instead of bases which contain the amido group, some very useful effects can be obtained, such as, for instance, with rosaniline, red and dark brown patterns can be obtained; with safranine, red and dark blue; and with cyanole some very peculiar combinations can be obtained. Cyanole on diazotising becomes yellow, but wherever exposed to air or some oxidising agent, such as an electric current, it turns a fine peacock blue shade, and on washing the print with a phenol or soda the effect is permanent. This, along with the use of bases such as thiotoluidines, gives some useful results. Another branch of printing by electricity, which also offers some very interesting information, is the combination of organic cases along with the use of metallic anodes. This may be made use of for the production of effects of the opposite kind to the above, and most certainly in cotton and paper printing it is worth experimenting with.

There are only two machines I have seen recommended for electrical dyeing, and these in no way offer any advantage over ordinary processes. From my own experiments, I consider that a machine for this purpose should fulfil the following requirements: (1) The poles must not be of metal, but of carbon or biscuit porcelain, which conduct by becoming saturated with the electrolyte. (2) They must be as near to one another as possible. (3) The cloth must pass between the poles in the open width. (4) The poles may be perfectly smooth, and preferably cylindrical, revolving freely. These particulars are necessary, because in the ordinary passage of the electric current across any dye solution, the tendency of the dye is to concentrate itself around the negative pole, and not to circulate freely in the whole dye vessel, thus there is always a great danger of unevenness.

In the finishing of goods the peculiar effect which is produced by calendering a piece in two different directions, one impression upon another, is well known. This is technically termed water-marking or moire, and is due to the irregular reflection from the surface of the material, one part of the light being totally reflected, and the other part dispersed. This effect can be introduced in several ways. One way is by displacing the warp or weft threads in an irregular manner by means of combs. Another method is by placing the chief reflecting surface below an upper gauze surface, which being free to move causes a constant change of reflections, and produces this effect in a very pretty manner. But still another method is by electricity. The new process resolves itself practically into the local application of electrolysis. A platinum plate of suitable size is connected with the positive pole of the source of current. On this conducting surface is placed some absorbent material saturated with a solution of common salt. On this pad is placed the fabric to be water marked, and the plate engraved with the water mark connected with the negative terminal is pressed down upon it. The salt solution is decomposed, and a facsimile of the water mark is printed on the cloth. To produce opaque designs, the absorbent material is saturated with a solution of barium chloride, which is decomposed on passing the current.

The electrical pressing machine introduced by Schreihage may also be mentioned. By its employment it is possible to hot-press any description of fabric for any duration of time, at any required temperature, and all this in an apparatus which is perfectly clean and dry, and in an atmosphere free from superfluous waste heat and steam. An ordinary press is used, and may be operated hydraulically or by any other method. The press is identical with those in ordinary use. Press boards are provided, composed of suitable insulating material, inside which are embedded the heating wires. The ends of these wires terminate in a double plugway in front of each plate. The switchboard is mounted on wheels for convenience. It can thus be utilised for any press, or can be wheeled into a corner out of the way when not required. The fabric is placed in the press in the ordinary manner, and the current switched on. The plates become warm almost immediately, and when the current is switched off are soon cool enough to handle. The cost of the process is, I understand, not more than the present method of pressing when everything is taken into consideration.

* Paper read before the Society of Dyers and Colourists at Bradford Technical College.

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Editorial, Publishing and Printing Offices,

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STATE MONOPOLIES.

Following upon Mr. HENNIKER-HEATON'S four-column indictment, an anonymous correspondent of *The Times* last week declared that "the greatest living English economist" had been heard to say that the POST OFFICE ought, in the public interest, to be deprived of its statutory monopoly. Whether the present LORD FARRER answers to this description is more than we can say; apparently he thinks he does, for in a letter published in the same paper last Monday he assumes the leadership of a crusade against that monopoly on purely economic grounds, and recommends its suspension for an experimental period of (say) four years, predicting that the result would prove beneficial both financially and commercially. Great as was LORD FARRER'S authority in matters commercial and financial, we do not think that his son's reputation will be increased by this presentation of the case against the POSTMASTER-GENERAL'S monopoly. It is indeed so feeble and inconsequential that we suspect that the real mainspring of attack is a doctrinaire objection to all monopolies whatsoever; and it is on this account that Lord FARRER'S attitude, which is sure to find many imitators, may do serious mischief. Post Office monopolies are not the only monopolies in which the State as a whole is deeply concerned. Similar privileges have been granted or are being acquired by municipalities all over the country in respect of electric lighting, electric supply, electric traction, and, in a qualified form, also for telephony. Vast sums of public money are being sunk in these enterprises with the implicit, though not perhaps explicit understanding, and in the confident expectation, that they will be allowed to run their course as virtual monopolies free from risk of non-municipal competition. Should Lord FARRER'S doctrine gain acceptance in political as well as in economic quarters these expectations will be rudely disappointed, further developments in those directions will be appreciably checked, and the money already invested rendered dangerously insecure. The Post Office might survive the application of an experiment prescribed by these economic purists, but assuredly the municipalities could not.

Our readers need not be told that we are not warmly enamoured of municipal trading, but we should strongly protest against its being treated unfairly; and for this reason we greatly deprecate the attacks now being made against the very principle on which alone this line of business can

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be made successful. Our view is, that, with free competition, municipal trading is, to use a homely phrase, "out of it"; if, therefore, municipal trading we must have, the municipality must be protected against unrestricted competition—at all events so long as it does its work to the satisfaction of its constituents. In this relation it may be noticed that Lord FARRER does not base his recommendation on the alleged shortcomings or incompetency of the Post Office; he seems merely to have taken advantage of the heedless outcry against that department during the past few weeks to air in public his secretly-cherished conviction that all monopolies are bad, and that the Post Office monopoly should be the first to go. If he were asked, he would certainly admit that it ought not to be the last. He regards as a "mere bagatelle" the possible loss of three and a-half millions of national revenue; the local taxpayers' loss under a similar infliction he would, no doubt, consider a mere fleabite. Of course, he professes not to anticipate any loss whatever; brains would be quickened on all sides, and everybody would make the same income as before. Lest this bold statement should not find credence, it is added that in any event the public service would be cheapened and improved.

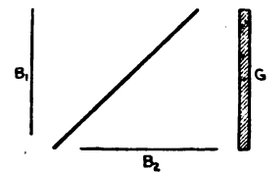
Now this assertion as to cheapening and improving is, we contend, a pure assumption. Commercial history does not bear uniform testimony even to cheapening; and it tells pretty generally against improving. The case of the telegraphs, which is very pertinent to the matter under discussion points all in favour of combination and uniformity—in other words for monopoly. Rates were vastly higher, the service greatly inferior when they were ruled by private companies; whilst the multiplication of lines not connected as a whole was a public inconvenience of the most serious kind. The same statement applies to the telephone service; and disregard of these considerations in recent years has led to the present altogether intolerable muddle, out of which there is no escape but by resort to the principle of combination and monopoly—whether under the State or in private hands is a matter of little moment. This essential element of a monopoly such as we are now considering—namely, its uniformity and universality—is utterly ignored by economic writers like Lord FARRER; and, strange to say, by *The Times* newspaper when commenting upon their propositions. The case for a State monopoly is not covered by advantages derived from remunerative areas paying for the unremunerative. It includes the supreme merit of a single administration, and of the public knowing exactly where it is, what it is, and how to use it. How great would be the inconvenience were this advantage relinquished we can faintly realise by picturing the state of things under a reversion to competitive inland telegraphy. One may argue that the telegraphs would do better in other hands than the Post Office; but no sane person in these days will deny that they must be in hands belonging to one body.

It does not follow, however, that what is good and even indispensable for the welfare of national telegraphs is good or desirable for all the other electrical concerns of which mention has been made. Circumstances differ in different localities, and different principles may be safely applied to them. All that we contend for is that, where there is a clear field and a monopoly is granted, nothing should be said or done to interfere with its growth or endanger its stability. That such interference is foreshadowed in Lord FARRER'S communication, and the support he has received, nobody can doubt; and it behoves all local authorities as well as private promoters to take whatever steps are possible for permanently safeguarding their concessions. Any direct attack upon them or any threat of it in the not distant future is sure to inflict financial loss upon the community generally; but the radical financial iconoclast will not be deterred by considerations of that kind. Perhaps the best shield against such assailants is a good character. There are two kinds of monopolies, one the monopoly of expediency, the other of merit. We agree with *The Times* that the Post Office monopoly would never have been challenged had it not exposed itself to the criticisms of its enemies. Those municipalities who carry on their business thoroughly well will have the best chance of remaining undisturbed. They have many enemies: their safety depends upon disarming them beforehand.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Temperature of a Radiating Body.—The temperature of the surface of a radiating body is usually supposed to be equal to that of the interior; but this is by no means strictly the case, especially when the body is a bad conductor and a good radiator. To determine the actual difference in a concrete case F. Kurlbaum makes an experiment, the principle of which is indicated in the annexed diagram, where P is a sheet of platinum foil 1μ thick, covered on both sides with platinum black. Light falls through the glass plate G upon the platinum, and the heated platinum sends heat rays to the bolometers B_1, B_2,



placed symmetrically with regard to the sheet. Any difference between the temperatures of the two surfaces will be indicated by a difference in the deflections of the two bolometers. As a result, the author finds a difference of temperature of 0·016deg. when the sheet is heated 1deg. above its surroundings, and 0·068deg. when the sheet is blackened with lampblack instead of platinum black. This difference is, of course, only that which applies to the special case, but anyhow it is smaller than usually supposed.

[F. KURLBAUM, *Ann. der Physik*, No. 7, 1900.]

Thermodynamics of Cells.—It is now pretty generally admitted that every current of heat produces an electric current, and vice versa. C. Liebenow attempts to account for this by assuming that the heat consists in the vibrations of the negative particles, now usually called electrons. Anything which moves these negative electrons will move the heat attached to them by convection, and so every electric current will go hand in hand with a heat current. The amount of heat can be calculated from the equation

$$9 = -0{\cdot}24\,\mathrm{T}\,i\frac{d\mathrm{E}}{d\mathrm{T}},$$

which gives the amount of heat conveyed by a current i through any cross-section of the metal in one second. For copper, the amount of heat thus supplied to each gramme-atom precipitated from solution would be 870 calories at 0deg. But since the total heat of the gramme-atom is about twice that amount, it may be said that half the total heat of the metal is conveyed by the negative electron, and the other half by the positive electron. The author further shows that all metals in the solid state are monovalent, and that the atomic heat of negative and positive electrons is $870/273 = 3{\cdot}2$, or about the same as the atomic heat of monatomic gases at constant volume.

[C. LIEBENOW, *Ann. der Physik*. No. 7, 1900.]

New Mercury Interrupter.—E. Grimsehl has designed a mercury interrupter on a novel and ingenious principle, for which he claims that it absorbs little energy and mercury,

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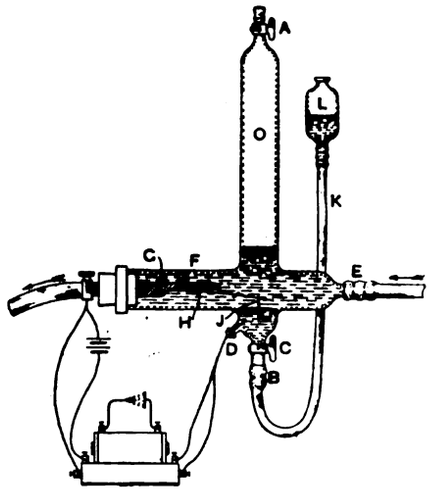
costs little, and is efficient on circuits provided with a low supply of power. The interruptions are produced by the reed of an organ pipe "blown" by a current of water, which serves the additional purpose of keeping the mercury clean and cool. The construction is shown in the diagram, where G is the organ pipe, H the reed, J a plantinum tip attached to it, O a cushion of air which serves to impart the necessary elasticity to the water, and E the tube through which the water flows in. The level of the mercury is regulated by the tap C and the reservoir L, connected to it by the flexible tube K. Interruption is very abrupt, owing to the high resistance of the water, and the rate of interruption is of course much steadier than in the Wehnelt interrupter, but on the other hand it cannot be brought much higher than 100



per second. Any mercury carried off by the water can be collected in a wash bottle inserted in the water current. The platinum point shows very little wear, owing to the cooling effect of the water.

[E. GRIMSEHL, *Elektrotechn. Zeitschr.*, June 14, 1900.]

Spectrum of Radium.—Among the radio-active substances discovered since Becquerel's description of the peculiar properties of uranium rays, radium has proved to be the most interesting. It is capable of sending out both cathode rays and Röntgen rays without being electrically excited. It emits these rays in great intensity, comparatively speaking, and with an apparently unlimited supply of energy. We know now that even if the energy of the body is being spent and diminished in the process, such diminution would not become apparent for a number of years, and this consideration saves the law of the conservation of energy in our estimation. But the mode of excitation of radium is as yet unknown, nor has the metal itself been as yet isolated, although it has been obtained as a chloride. This might produce suspicions as to its elementary character were it not for the almost conclusive evidence of the spectroscope. Some time ago (see *The Electrician*, Vol. XLIV., p. 140) E. Demarçay identified certain spectrum lines with radium, and he now produces further evidence for the identity then established. In addition to the strong and bright lines of wave-lengths 3,815, 4,341, and 4,683, he noticed a band at 4,627 and another at 4,455. This brings the spectrum into close analogy with the spectra of the metals of the alkaline earths. It would be interesting to determine how the spectrum rules discovered by Kayser and Runge are obeyed by these new lines.

[E. DEMARCAY, *Comptes Rendus*, July 23, 1900.]

Thermodynamics of a Voltaic Cell.—The theory, commonly known as Thomson's, that the electrical energy of a reversible voltaic cell is the equivalent of the chemical energy transformed, has been abandoned as an exact expression of the facts since the appearance of Helmholtz's Paper on "The Thermodynamics of Chemical Processes," in 1882, and Jahn's experimental corroboration. Some of the chemical energy may appear as heat direct, as in the Clark cell, which has a negative temperature coefficient. Helmholtz's calomel cell, which has a positive temperature coefficient, absorbs heat and cools down in generating a current. In Daniell's cell, on the other hand, there is a strict equivalence between the electrical energy evolved and the difference between the heat of combination of the zinc sulphate formed and the copper sulphate decomposed. H. S. Carhart has studied this process in detail, and has for this purpose treated the positive and negative sides of a cell separately. He shows that the most important determining quantity—the temperature coefficient of the E.M.F. of the cell—is made up of the sum

$$\left(\frac{dE}{dT}\right)_p + \left(\frac{dE}{dT}\right)_n$$

at the positive and negative poles respectively. These are the Peltier effects at the junction between each electrode and its liquid. In practice the quantitative values obtained are complicated by changes of concentration, which, however, the author has succeeded in eliminating.

[H. S. CARHART, *Phys. Review*, July, 1900.]

ELECTRICITY WORKS ACCOUNTS.

Liverpool Overhead Railway.

A comparison of the figures in our analysis of the accounts of the Liverpool Overhead Railway for the two half-years ended June 30, 1899 and 1900 shows that in spite of the much higher price of coal the working expenditure per train mile in the latter half-year was practically 1d. under what it was during the corresponding period in 1899. This, and the fact that the fuel charge itself was reduced, is explained by the existence of a very advantageous contract to the company for the supply of coal. The expiry of this contract entails a payment of nearly double the old price of coal so that there is cause to fear a decided increase in the expenditure during the current half-year.

The train mileage run showed an increase of a little over 7 per cent.—the figures including the traffic on the tramways, or car mileage—and as the number of pasengers carried increased only by 4·75 per cent., the receipts per train mile show a diminution, although not to the same extent that the costs have.

We heartily congratulate the company upon their increased dividend, and also, as we learn from the chairman's report, upon the splendid punctuality of the train service—97·3 per cent. of their trains having, during the past half-year, been up to time, thus maintaining the company's record in this respect.

It is satisfactory to learn that the lighting of the trains is engaging the attention of the management, and that the batteries for the improvement of the lighting are nearly completed. A new train for accelerating the traffic by 15 minutes is also nearing completion, and we understand that the distance of 6½ miles with 15 stoppages will be covered in 20 minutes. A mineral traffic over the line during night time is under consideration.

The following table furnishes particulars of the traffic over the line and the dividends distributed since the opening:—

Half-year ended	Passengers.	Train mileage.	Per cent. dividend	
			Pref.	Ord.
March 6 to June 30 1893	1,370,742	...	...	..
Dec. 31, 1893	2,475,639	243,539	5	1
June 30, 1894	2,861,437	...	5	1
Dec. 31, 1894	3,641,379	314,472	5	2
June 30, 1895	3,460,060	311,346	5	2½
Dec. 31, 1895	3,780,375	321,417	5	2½
June 30, 1896	3,739,575	313,010	5	2½
Dec. 31, 1896	3,919,134	320,993	5	3
June 30, 1897	4,269,260	363,399	5	3
Dec. 31, 1897	4,467,490	371,773	5	3½
June 30, 1898	4,472,941	362,690	5	3
Dec. 31, 1898	4,894,921	371,773	5	4
June 30, 1899	4,475,279	375,500	5	2½
Dec. 31, 1899	5,214,957	402,752	5	5
June 30, 1900	4,687,862	402,344	5	3

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City and South London Railway.

Increased working expenses and diminished receipts per train mile on this railway were to be expected with the opening of the extensions to Moorgate-street and Clapham Common and until these extensions had had time to develop their traffic. It is very satisfactory, however, to learn from the directors' report that since the opening of the above portions of the system, on Feb. 26 and June 4 respectively, the receipts have been steadily improving.

Looking down the costs column attention is arrested at the increase in the traffic expenses, amounting to more than 1d. per train mile. Other items which have naturally increased are those of coal and oil and stores. These together account for an increase of nearly 0·5d. per train mile. All the other important items of expenditure have been reduced, with

	LIVERPOOL OVERHEAD RAILWAY.				CITY AND SOUTH LONDON RAILWAY.			
Worked by	The Liverpool Overhead Railway Co.				The City and South London Railway Co.			
Date of Commencement of Working	March 6, 1893.				December 20, 1890.			
System	Third-rail surface conductor at 600 volts.				Third-rail surface conductor at 500 volts.			
Chief Engineer	S. B. Cottrell.				P. V. McMahon.			
Half-year ended	June 30, 1899.		June 30, 1900.		June 30, 1899.		June 30, 1900.	
QUANTITIES.								
Train mileage	*375,500*		*402,344*[c]		*235,254*		*299,723*	
Passengers Carried	**4,475,279**		**4,687,862**		**3,540,098**		**4,169,717**	
Length of railway authorised	7 ml. 5 ch.		9 ml. 45 ch.[d]		6 ml. 64·5 ch.		6 ml. 64·5 ch.	
Length of railway constructed	6 ml. 57 ch.		7 ml. 65 ch.[e]		3 ml. 12 ch.		5 ml. 42 ch.	
Length of Railway Worked	**6 ml. 57 ch.**		**7 ml. 65 ch.**[e]		**3 ml. 12 ch.**		**4 ml. 60 ch.**	
Length of railway under construction	nil		1 ml. 32 ch.[f]		3 ml. 52·5 ch.		1 ml. 22·5 ch.	
Rolling stock, number of cars	7*		7*		84		84	
" number of locos.	44[a]		44[a]		20		30	
CAPITAL.								
Authorised (Total)	**£760,000**		**£826,500**		**£2,198,000**		**£2,198,000**	
Authorised (share)	570,000		620,000		1,680,000		1,680,000	
Authorised (loan)	190,000		206,500		518,000		518,000	
Received (Total)	**740,000**		**744,471**		**1,630,771**		**2,030,830**[a]	
Received (share)	570,000		570,000		1,395,070		1,579,985	
Received (loan)	170,000		174,471[g]		235,701		413,593	
	Total.	Per mile of working railway.	Total.	Per m of working railway.	Total.	Per mile of working railway.	Total.	Per mile of working railway.
Expended (Total)	**£753,630**	**£112,200**	**£775,166**	**£99,200**	**£1,705,401**[b]	**£541,000**	**£2,050,089**[c]	**£431,700**
On line open for traffic	630,343	94,000	641,181[h]	82,100	841,872	267,200	841,877	177,100
On line in course of construction	—	—	—	—	702,612	225,900	1,113,121	234,300
On working stock, including power station	123,287	18,360	133,985	17,150	66,242	21,020	80,787	17,000
Balance of Capital Account	**-9,159**	**-1,364**	**-30,694**	**-3,930**	**-74,630**	**23,680**	**-19,260**	**-4,053**
Renewal Fund	**12,700**	**1,892**	**16,200**	**2,073**	—	—	—	—
Contingent Fund	**800**	**119**	**1,000**	**128**	—	—	—	—
REVENUE.	Total.	Per train mile.	Total.	Per train mile.	Total.	Per train mile.	Total.	Per train mile.
Total	**£36,492**	**23·32d.**	**£38,023**	**22·68d.**	**£28,125**	**28·70d.**	**£35,145**	**28·15d.**
Passenger traffic	35,960	22·98d.	37,404	22·32d.	26,749	27·31d.	33,608	26·92d.
Parcels, rents, transfer fees, &c.	532	0·340d.	618	0·369d.	1,376	1·404d.	1,537	1·231d.
EXPENDITURE.								
Total	**£23,624**	**15·10d.**	**£23,613**	**14·09d.**	**£15,851**	**16·18d.**	**£20,861**	**16·71d.**
Maintenance of way, works, & stations (less *depreciation*)	*2,809*	*1·795d.*	*2,493*	*1·496d.*	*772*	*0·788d.*	*723*	*0·579d.*
Maintenance of way	879	0·562d.	922	0·550d.	525	0·536d.	535	0·428d.
Repairs of structure, stations, &c.	1,930	1·234d.	1,571	0·937d.	246	0·251d.	188	0·151d.
Locomotive power	*6,747*	*4·310d.*	*7,189*	*4·290d.*	*5,731*	*5·850d.*	*7,459*	*5·970d.*
Coal and coke	1,636	1·046d.	1,595	0·952d.	1,621	1·654d.	2,623	2·100d.
Wages at power station	3,037	1·974d.	3,061	1·826d.	2,402	2·453d.	2,966	2·375d.
Oil and stores	423	0·270d.	643	0·384d.	420	0·429d.	600	0·481d.
Repairs and renewals	1,600	1·023d.	1,890	1·128d.	1,289	1·316d.	1,269	1·017d.
Repairs and renewals of cars	*715*	*0·457d.*	*444*	*0·265d.*	*475*	*0·485d.*	*609*	*0·488d.*
Traffic expenses	*9,065*	*5·794d*	*9,277*	*5·536d.*	*6,018*	*6·142d.*	*8,965*	*7·180d.*
Salaries and wages	5,973	3·835d.	6,035	3·600d.	3,865	3·945d.	5,480	4·39d.
Other charges	3,092	1·976d.	3,242	1·944d.	2,153	2·198d.	3,485	2·790d.
General charges	*2,210*	*1·412d.*	*2,144*	*1·280d.*	*1,942*	*1·982d.*	*2,027*	*1·624d.*
Directors	350	0·224d.	350	0·209d.	650	0·664d.	650	0·521d.
Salaries of Secretary, General Manager, and Clerks	1,047	0·670d.	1,071	0·639d.	493	0·503d.	533	0·427d.
Other charges	813[b]	0·520d.	723[i]	0·431d.	799	0·816d.	844	0·676d.
Rent, rates, taxes, &c.	*1,886*	*1·206d.*	*1,905*	*1·136d.*	*855*	*0·873d.*	*975*	*0·781d.*
Miscellaneous items	*193*	*0·123d.*	*161*	*0·096d.*	*57*	*0·058d.*	*104*	*0·083d.*
FINANCIAL RESULTS.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
Working Profit for Half-year	**£12,868**	**1·714%**	**£14,409**	**1·885%**	**£12,274**	**0·784%**	**£14,284**	**0·760%**
Sum carried to depreciation fund	1,300	0·173%	1,500	0·196%	—	—	—	—
Net interest on loans	3,209	0·428%	3,299	0·432%	1,748	0·112%	2,336	0·124%
Balance from last half-year's account	4,586	0·611%	4,592	0·601%	1,420	0·091%	1,267	0·067%
Balance Available for Dividend	**12,945**	**1·725%**	**14,203**	**1·858%**	**11,945**	**0·762%**	**13,215**	**0·703%**
Ordinary Dividend paid at per cent. per annum	**2½%**	—	**3%**	—	**2¼%**	—	**1¼%**	—
Percentage of total expenditure to revenue	64·8%	—	62·1%	—	56·4%	—	59·4%	—
Revenue per Mile of Working Railway	**£5,440**	—	**£4,870**	—	**£8,930**	—	**£7,400**	—
Expenditure per mile of working railway	£3,520	—	£3,024	—	£5,030	—	£4,390	—
Revenue per Passenger	**1·956d.**	—	**1·942d.**	—	**1·906d.**	—	**2·043d.**	—

LIVERPOOL OVERHEAD RAILWAY.—REMARKS—* Trailers. *a* Motor carriages. *b* Includes £284 office expenses, £224 insurance, £100 contingent fund, £38 Liverpool Tramways and Omnibus Co., and £53 auditing. *c* Inclusive of 2,344 train miles on tramways. *d* Includes 2 ml. 40 ch. of tramways. *e* Includes 1 ml. 8 ch. of tramways. *f* Of tramways. *g* Includes £4 471 premium on mortgage debentures. *h* Includes £12,409 on Waterloo—with Seaforth and Gt. Crosby Tramways. *i* Includes £303 office expenses, £223 insurance, and £100 contingent fund.

CITY AND SOUTH LONDON RAILWAY.—REMARKS—*a* Includes £37,252 premium account. *b* Includes £94,675 balance of discount, brokerage and commission after deducting premium received *c* Includes £10,000 dividend to December 31, 1899, on £200,000 of pref. stock, and £4,304 interest on £37,500 ordinary shares at 3 per cent. per annum.

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the result that the aggregate costs show an increase of but 0·58d. per train mile.

In view of the expected opening in March of the Islington extension 10 additional locomotives are being provided.

The progress of the company's traffic is indicated by the following figures :—

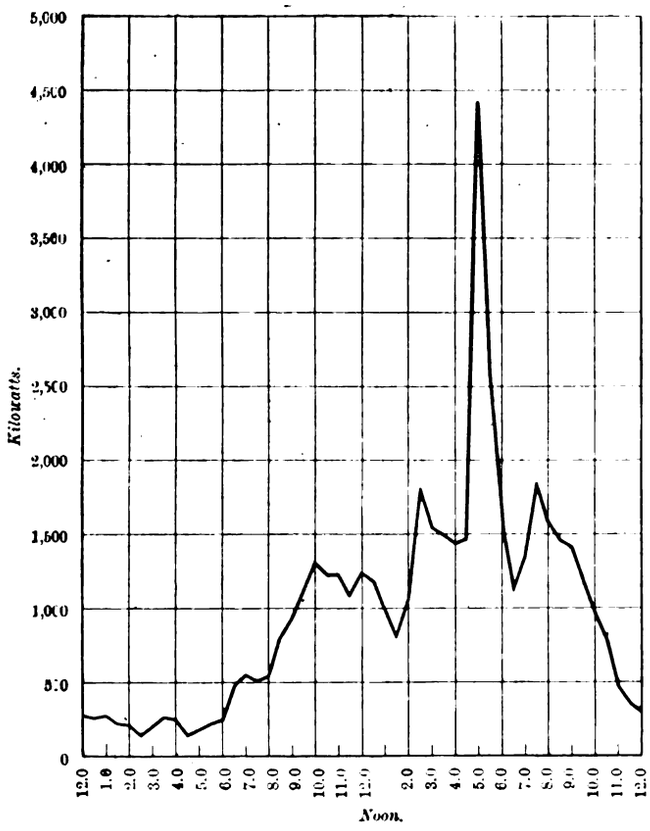
Half-year ended	No. of passengers.*	Train mileage.	Receipts. †	Ratio of expenditure to total rev. Per cent.	Dividend per cent. Pref.	Ord.
Dec. 31, '90 (11 days)	165,000	...	£1,568	...	5	...
June 30, 1891	2,412,343	...	19,403	79 0	5	...
Dec. 31, 1891	3,749,055	...	19,799	76·0	5	...
June 30, 1892	2,813,162	...	20,931	70·0	5	½
Dec. 31, 1892	3,117,602	...	22,003	67·9	5	⅝
June 30, 1893	3,146,656	...	22,458	64·6	5	⅝
Dec. 31, 1893	3,093,351	...	22,068	64·6	5	⅝
June 30, 1894	3,383,154	...	23,565	61 7	5	1
Dec. 31, 1894	3,276,649	...	23,541	60·9	5	1⅛
June 30, 1895	3,113,199	...	23,711	61·6	5	1⅛
Dec. 31, 1895	3,172,438	227,350	23,780	59·6	5	1¼
June 30, 1896	3,192,672	225,554	24,022	60·0	5	1⅜
Dec. 31, 1896	3,368,480	231,489	25,456	56·8	5	1½
June 30, 1897	3,437,810	232,703	26,403	57·6	5	1⅝
Dec. 31, 1897	3,337,861	230,396	25,473	56·7	5	1⅝
June 30, 1898	3,478,977	235,342	26,357	56·7	5	2
Dec. 31, 1898	3,462,814	234,166	26,320	56·2	5	1¾
June 30, 1899	3,540,098	235,254	26,749	56·4	5	2¼
Dec. 31, 1899	3,442,942	241,973	26,198	58·1	5	2
June 30, 1900	4,169,717	299,723	33,608	59·4	5	1½

* Exclusive of season ticket holders.

† From pass traffic inclusive of that from season ticket holders.

AN ABNORMAL LIGHTING LOAD CURVE AT MANCHESTER.

Through the courtesy of Mr. C. H. Wordingham, the Corporation Electrical Engineer at Manchester, we are



Load Curve at Dickinson Street Generating Station.

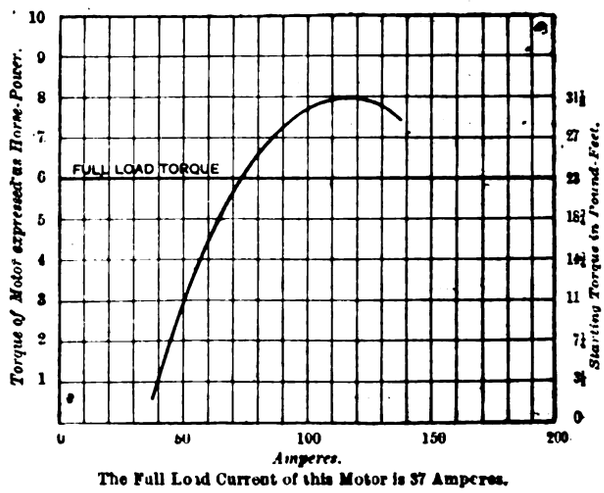
enabled to publish the accompanying diagram showing a lighting load curve possessing unusual features of interest. The curve is for the Corporation electricity supply works at Manchester, for Tuesday, August 21. On that day Manchester was visited by a very heavy thunderstorm, which occurred between 4.30 and 6 o'clock p.m., causing, as will be seen, a sudden and heavy demand on the generating plant and batteries. It may be questioned whether a more severe tax on the electric generating plant in a supply station has ever been imposed even by a metropolitan fog.

ALTERNATING-CURRENT INDUCTION MOTORS.*

BY A. C. EBORALL.

(*Concluded from page 679*).

Performance.—The Heyland motors standardised for circuits of 40, 50, and 60 cycles are designed in three ways, as follows :—(*a*) To start without load. Under these circumstances the starting current does not exceed four-fifths of the full-load running current. (*b*) To start with two-thirds of the full-load torque. Under these circumstances the starting current does not exceed one and a-half

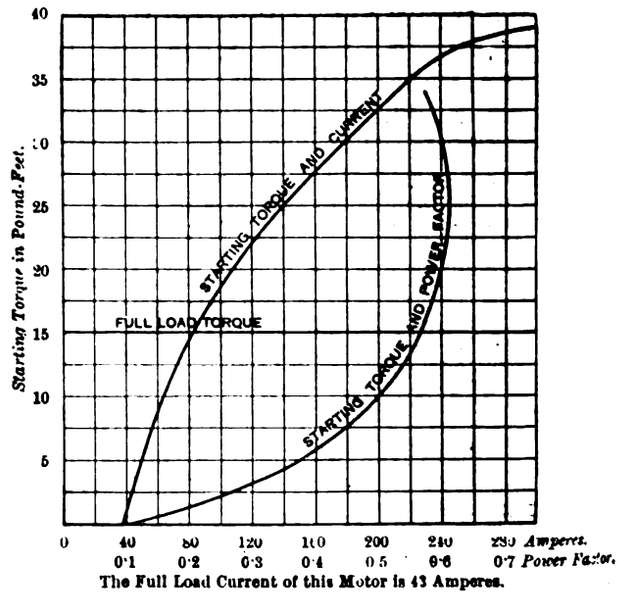


The Full Load Current of this Motor is 37 Amperes.

FIG. 11.

times the full-load running current. (*c*) To start with full-load torque. Under these circumstances the starting current does not exceed twice the full-load running current.

Design (*a*) has been evolved in order to conform to the ideas of many station engineers in this country. Design (*c*) represents the normal winding, while design (*b*) is frequently asked for. The



The Full Load Current of this Motor is 43 Amperes.

FIG. 12.

starting torque with the standard stampings is determined purely by the number of turns of the starting coils and the permissible current ; this torque can be arranged to have a value equal to two or three times the full-load running torque, if enough current is given to the starting coils, the limiting value occurring at the saturation point of the iron. Fig. 11 and Fig. 12 illustrate the starting

* Paper read before the Institution of Electrical Engineers.

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performance of two motors designed to fulfil conditions (b) and (c) respectively, while Fig. 13 illustrates the running performance of the motor, whose starting curve is given by Fig. 11. All these curves represent the results of actual brake tests, and many motors built have given better results than indicated here. Particular attention is given in all the designs to the overload capacity of the motor, and all motors are guaranteed to stand a 25 per cent. overload for one hour. The small overload capacity (varying from 0 per cent. to 10 per cent.) found with the alternating-current motors hitherto used*, has been one of their worst features, as for most work it is impossible to fix the amount of power required so exactly as this, with the result that the motors installed are invariably too large and costly for the work they have to do. This reacts on consumer and supply company alike: the former has to pay for a larger motor than he wants, which will be working on the average at low efficiency, while the latter most of the time is supplying an underloaded motor having a low power factor.

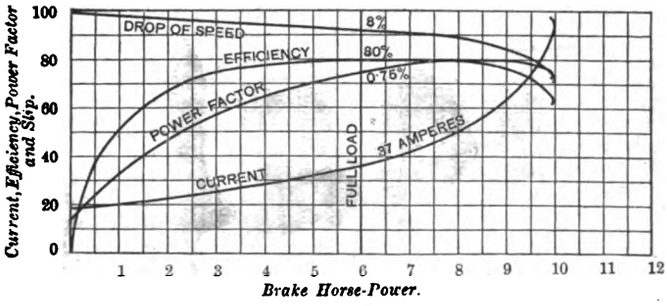

FIG. 13.

The results obtained with the Heyland motors for circuits of 80 cycles and 100 cycles are not quite so good as those given above, with regard to starting torque. That is to say, these high-frequency motors as built up to the present take a relatively greater current for a given value of starting torque, the values being—(a) when starting without load current is equal to the full-load current; (b) starting with half the full-load torque the current is one and a-half times the full-load current; (c) starting with full-load torque the current consumption is two and a-half to three times the full-load current. The increased values of current consumption are, of course, due to the larger number of poles necessary to bring the speed to a reasonable figure; particularly in small motors the number of poles has a very great effect on the amount of magnetic leakage with a given design. As, however, the Heyland motors are not yet fully standardised for 80 cycles and 100 cycles, the designers hope to effect considerable improvements within the next few months in the direction of reducing the current for a given value of starting torque.

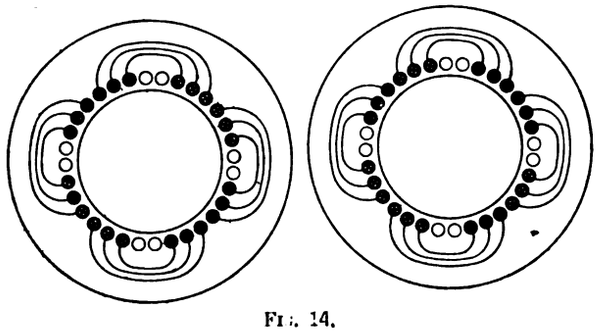

FIG. 14.

Before leaving the subject of these motors, the author would like to draw attention to an exceedingly neat method Mr. Heyland has devised for regulating the speed of induction motors, single and polyphase. As is well known, there are two principal ways of altering the speed of such motors, the supply frequency being constant * The first is by rheostatic control, a non-inductive regulating resistance being in circuit with the rotor windings, while the stator windings are connected directly to the mains; the second is by altering the number of stator poles by means of a suitable controller, together with those of the rotor, unless the latter is of the "squirrel-cage" type. Here the motor is wound for the maximum number of poles, and when it becomes necessary to pass from a greater to a less pole number, in order to get increased speed, the windings on some of the poles are reversed, thus producing fewer poles, which are in consequence much broader. For instance, in order to double the speed, half the poles have their windings reversed, the stator having now half the number of poles, each of double the former breadth. While rheostatic control is simple and easy to use, it has the great objection of being very uneconomical. The waste of energy brought about by its use is entirely analogous to that found with shunt-wound direct-current motors, with constant field excitation and a regulating resistance in the armature. The case of the induction motor is really more unfavourable, because it has been found by experience that the motor has to be rated very liberally in order to get the necessary power. On the other hand,

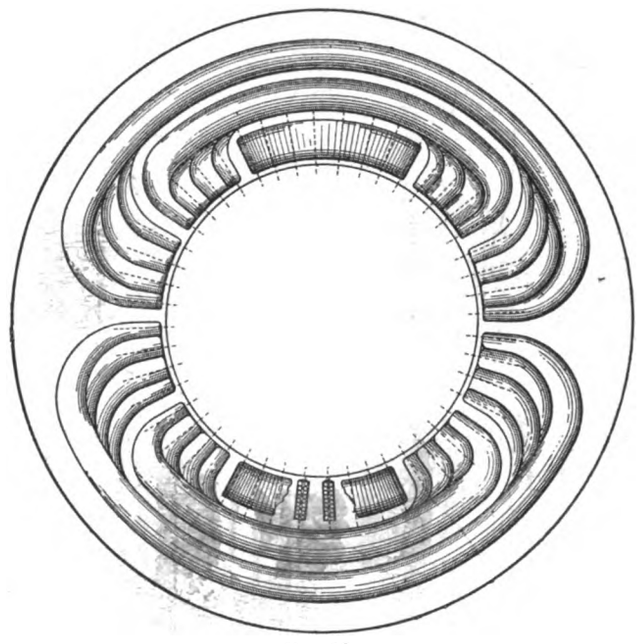

FIG. 18.

the method of altering the number of motor poles has two serious disadvantages. Firstly, the reduction of the number of poles causes an unfavourable distribution of the magnetic flux, a large increase of magnetic leakage and a loss of winding space. This is of course owing to the fact that after the reversal of the appropriate coils the currents flowing down one side of these coils are neutralised by the currents in the adjacent side of the unreversed coils, as will be readily seen from Fig. 14, illustrating the single-phase case. Secondly, unless the motor has a squirrel-cage rotor, the rotor circuits become very complicated; the polarity of the rotor

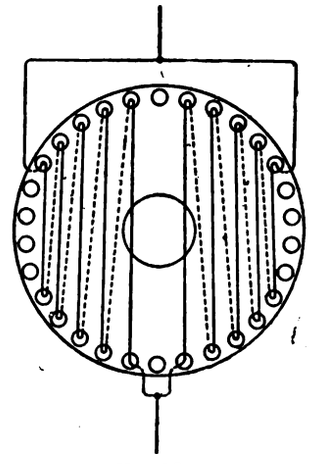

FIG. 19.

windings has to be changed each time in accordance with the stator polarity, which means that a large number of slip-rings have to be used in order that this may be done. Mr. Heyland's method consists of certain winding arrangements, which, when it is desired to change the number of poles, render any reversal of the rotor windings superfluous, and to a large extent obviate the drawbacks stated above in the reversal of the stator coils. The method of winding the stator, as applied to single-phase motors, is illustrated in Figs. 15, 16, 17, and 18, the last figure showing how the stator coils are wound in practice. In all cases the winding is carried out for the smaller number of poles, and divided into sections, one or more of

* The author would here like to make an exception in favour of the Wenström motor, whose overload capacity (as found with examples tested by him) is everything that can be desired.

* The method of "tandem parallel control" for two motors, while excellent theoretically, is hardly likely to come into commercial use at present, on account of the great complication involved, and because of the bad conditions under which the motors have to work.

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these sections being reversed to obtain a greater number of poles. Thus, for instance, in Fig. 15, the stator being wound initially for two poles, by reversing one of the sections of the winding a four-pole stator results, as indicated, and it will be seen at a glance that there is no neutralising action between adjacent conductors, and that the distribution of magnetic flux in the air-gap will be perfectly goo d.

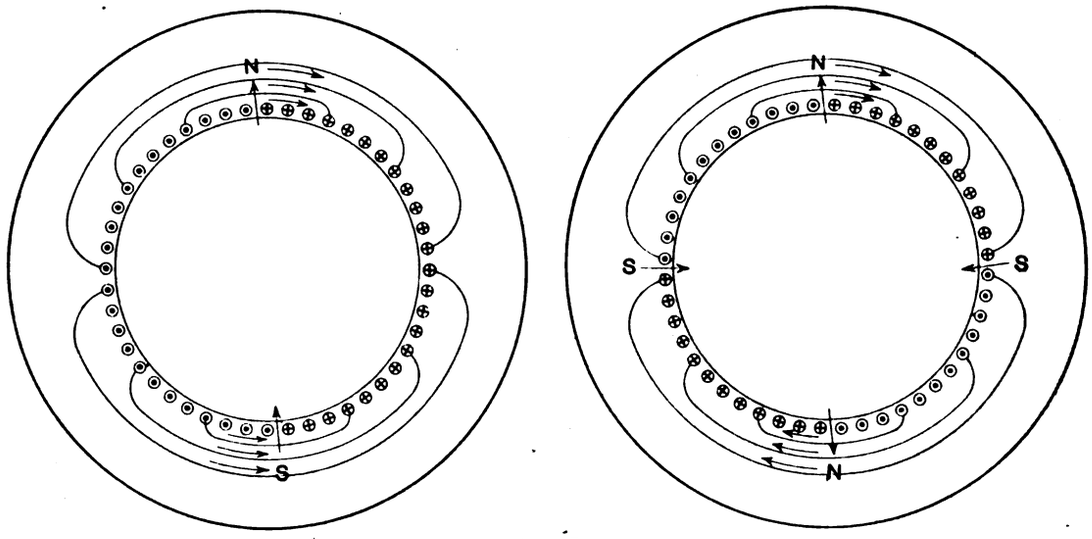

Fig. 15.

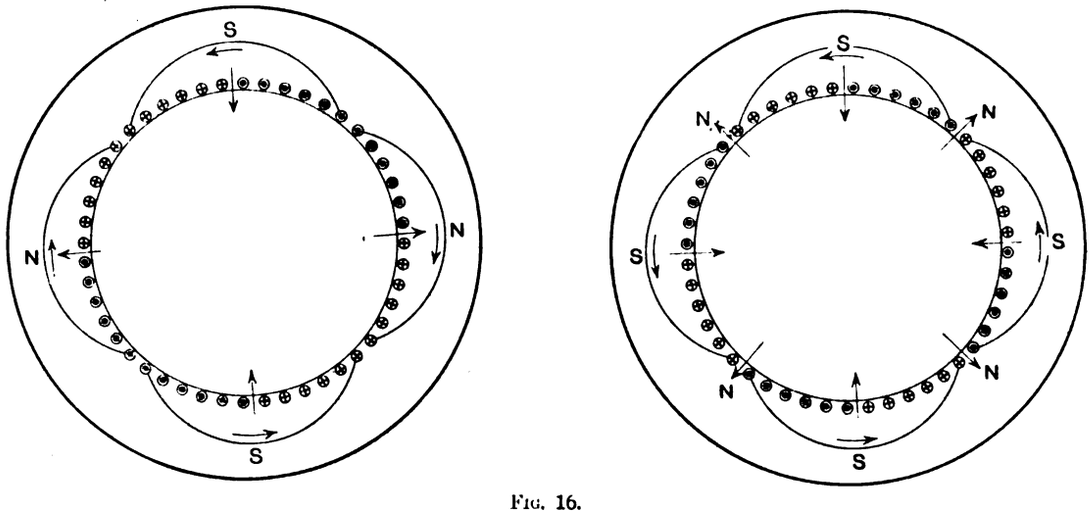

Fig. 16.

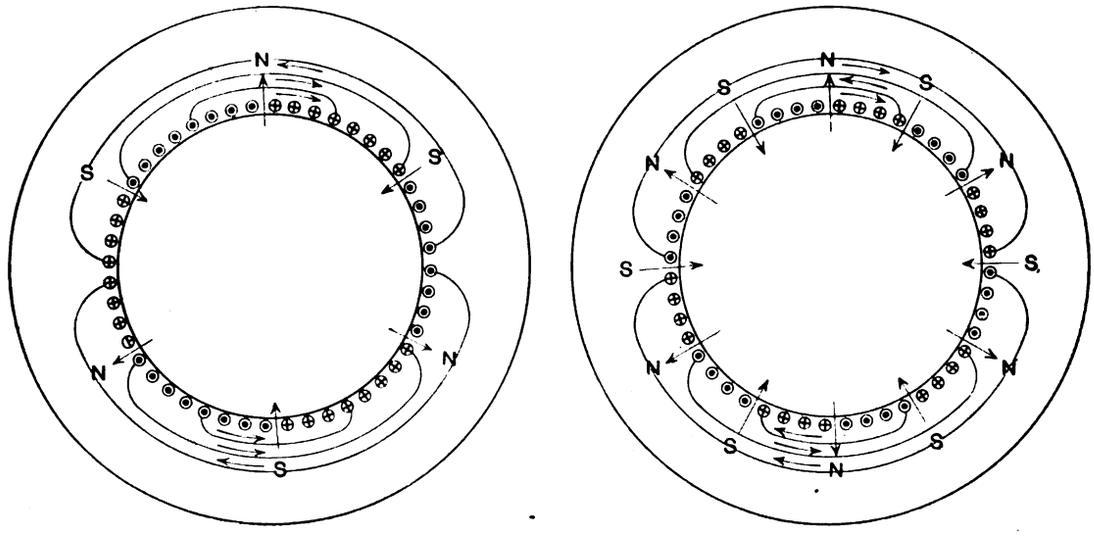

Fig. 17.

Fig. 16 shows the arrangement for a four-pole to eight-pole stator, and Fig. 17 that for a six-pole to twelve-pole, to which the same remarks apply. The manner of carrying out the stator winding for the last case actually employed is illustrated in Fig. 18.

For polyphase motors, exactly the same winding arrangements are used, applied of course to each phase. For these motors, if more than one change of speed is desired, the controllers get somewhat expensive, and it is therefore better on the whole in such cases to combine the method with rheostatic (rotor) control, the rheostat being used for the intermediate speeds only. For small motors having squirrel-cage rotors, no modification of the rotor winding is needed; but where wound rotors are employed the general method of rotor winding is illustrated in Fig. 19, which illustrates the single-phase case for simplicity. The general principle is to so arrange the windings of each phase that they are formed of a number of sections in parallel; with a certain number of poles the E.M.F. of one section will neutralise that of another section in parallel to it, and a current will flow through the sections only when they are externally short-

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circuited; on the other hand, with double the number of poles, the external short-circuit is superfluous. Thus consider Fig. 19, representing (diagrammatically) the winding for one phase of the rotor for a two-pole—four-pole stator. Each phase has two sections, permanently short-circuited one on the other. At starting the stator switch is put over to the two-pole position, and the slip-rings gradually closed through the starting resistance. So long as the slip-rings are open, no currents flow in the rotor windings, as the induced E.M.F. has the same value in each section, and the two E.M.F.'s neutralise one another, on account of the two stator poles. But the rotor currents circulate as soon as the rings are connected through the resistance—this latter is gradually cut out in the usual way as the motor comes up to speed. In changing over now to the four-pole position (if the higher speed is required) the slip-rings are not wanted, as the two sections are now in series, with the E.M.F. in the same direction, and so the rotor currents can circulate independently of the external short-circuit. The same general arrangement is used for motors to run at more than two speeds. Here the rotor windings (per phase) can have more than two sections, these sections being wound partly to overlap one another, while still being in parallel, so that the various E.M.F.s partly neutralise one another and partly add themselves together. With this arrangement, the same rotor winding can be effectively used with a stator having several different arrangements of the poles—that is, for a motor running at several distinct speeds. For induction motors having rotors with star-connected three-phase windings, which is the practical case, only three slip-rings are required, the (second) common junction being at the three slip-rings, as usual.

In the workshops of the author's firm, where many of the tools are driven by three-phase motors, the Heyland method of speed regulation is employed with great convenience. Several of the larger tools (such as planing machines and the like) are driven by independent three-phase motors wound for two speeds, the alteration of speed being effected by throwing over the reversing switch. It has been found by tests on these motors that the power-factor is diminished very little by the increase in the number of poles, attaining a high value at both speeds, while the efficiency is also high at each, there being but slight loss of energy involved by the change-over. At the same time, the increase of first cost with the two-speed motors is very small.

Concluding Remarks.

Although the author has dwelt at some length upon the subject of single-phase motors, it has been more on account of the technical interest attached to it than because of any belief in the present or future possibilities of single-phase systems. Regarding the Continent and the States it is not too much to say that single-phase supply is practically played out, and that engineers responsible for putting down new stations for either power or lighting consider single phase supply systems out of date and their employment bad practice. Moreover, indications are not wanting that the present tendency in this country is to follow in the same direction. It is certain that for all those cases where continuous-current systems are out of the question every requirement can be far more successfully met by three-phase systems than by any other. It is true that certain engineers in this country hold the opinion that pressure regulation troubles are bound to occur with three-phase working (an opinion not shared by the author), but, even supposing this to be the case, the complete solution is to hand—convert to continuous current by means of rotaries, or better, by means of motor-generators. The standardisation of the above two systems, together with that of two voltages for each system—220 volts and 440 volts—and one frequency—50 cycles—for the supply net-works is greatly to be desired, particularly from the point of view of the motor manufacturer and the motor user. With the hope that this ideal may be eventually realised, this Paper can be concluded.

IMPRESSIONS OF AMERICAN TRAMWAY PRACTICE.*

BY A. E. LE ROSSIGNOL.
(Corporation Tramways Engineer, Newcastle-upon-Tyne)

When I was asked to read a Paper I thought that, having paid a visit to the United States this year, some account of my impressions of the present state of tramway engineering practice in that country might be interesting to the members of this Association. The conditions governing tramway practice in America are essentially different from those prevailing in this country: on that side of the Atlantic the tramway concessions are almost without exception in the hands of companies who in very many cases have been granted them in perpetuity, and some cases at merely nominal rents, so that now the value of these concessions is very great. In addition, the process for obtaining leave to extend is very much simpler and quicker: there are practically no limitations set by law to any combinations or absorbtions the companies may choose to make with other companies, the speed of running is very great, and the doctrine that might is right holds to an extent we would not tolerate here. Contrast these with the conditions prevailing on this side of the water. In Great Britain concessions for tramway construction take a long time to carry through and are difficult to obtain; combinations or absorptions are jealously watched and difficult to bring about, and companies and corporations are very much hampered therefore in developing their tramway systems to anything like the scale which American tramway undertakings attain if successful, while the maximum speed allowed is so low that competition with railways is out of the question. Again, owing to the inherent conservatism and venerable age of British institutions, the delimitations of local authorities are very much more circumscribed and divided up than in America, so that extensions which involve trenching on the ground under the control of different and distinct local authorities involve much more difficulty in obtaining leave for extension, both to companies and to municipal authorities who may wish to extend a tramway system owned by them.

Need we wonder, then, at the great extent reached by some of the tramway systems in America; systems formed by the gradual acquisition by one master company of all the competing lines in any one city or district, till at last all the lines are under one control, and competition is entirely done away with. As you may have noticed, a typical instance of this spirit of absorption has just been completed in New York. Prior to this year there were two tramway companies in New York, the Metropolitan—which had gradually absorbed all the smaller companies, with the exception of one—and the Third Avenue Company—which owned two lines running from the heart of the city out to the Haarlem River, and beyond that owned a large extent of country lines. Early this year the Third Avenue Company got into financial difficulties over the provision of new capital to meet the heavy expenditure it incurred in converting the cable system into an underground conduit system, and the Metropolitan Company stepped into the breach, provided the capital required, and thus obtained control of the last opposition company left in New York. Latterly the American tramway world has become greatly exercised over the question of municipal ownership, the municipalities, who originally granted free wayleaves, and in some cases ground rights on the streets as well, to the tramway companies, in order to get them to run lines out into the country and create new populated districts, now find that these rights and privileges granted by them are becoming very valuable, and are seeking either to get hold of the tramways again or else to make the companies reduce the fares or pay higher percentages of their receipts to the municipal authorities. The companies are therefore deprecating in the Press municipal ownership, and as an argument in their favour compare the extent of the largest tramway system in a town in the States of a similar size, greatly to the advantage of the latter of course. In their comparisons, however, such reasons as I have given in the first part of this Paper are entirely overlooked, but there is no doubt that municipal ownership in the United States, under the conditions prevalent at present in municipal circles on that side, would give rise to a great deal of bribery and corruption, until in course of time a better moral condition of municipal life comes to the front. At the time the combination took place between the Metropolitan Traction Co. and the Third Avenue Company in New York, the former had very nearly finished a very large power station, from which they were already supplying the lines they had converted to electric traction, and the Third Avenue Company were only laying the foundations of a still larger power station, so that the amalgamation has in this case come at a suitable time when the question of the provision of the requisite amount of power for the combined system will not be complicated by the existence of too many power stations. In most previous amalgamations of this kind in the States—of which Philadelphia is a typical example—the combined company has left on its hands a multitude of small power stations, each of which have been owned by one or other of the smaller companies it has absorbed.

Due to the fact that conversion to electric traction was just in progress, the combined company in New York is now in a very favourable position to extend its large system in the best and most economical way, and the present tendency—one might almost say the fashion—in tramway construction in America, leans towards the erection of a large central station with high pressure distribution to sub-stations. Those companies which are hampered with a number of low-tension power stations do not, however, admit that their economical results are very greatly, if at all, inferior to those attained as yet by the larger single systems, and are in many cases providing for additional extensions by adopting battery sub-stations with charging mains to those fed for boosters. By the almost universal adoption of coal handling and storing machinery too, the fuel costs of stations in America are kept remarkably low; as they are all owned by private companies, however, a strict reticence as to these

* Paper read before the Municipal Electrical Association, at Leeds, June 23rd.

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costs is maintained, in complete contrast to the practice on this side of the water where we are accustomed to publish full details of all working costs.

As economy in current generation is greatly influenced by the expenditure on labour in the station, central station practice in America rightly tends to the introduction of very large steam power units, but these are all of the open slow-moving type, and so require a larger amount of attendance than would the same size units, if enclosed and provided with automatic lubrication, such as have been largely adopted in this country. A system of mechanical oil supply to these large open engines has been adopted; but if the enclosed type were made as strong in proportion and as reliable in operation as the large open type, there is no doubt that increased economy in labour would be obtained, and doubtless English manufacturers will awaken to this fact in a short time. Due to the heavy strains encountered in direct-current traction work, American steam units have gradually grown to huge proportions of the strain bearing part, the shaft, and even though the strains probable in alternate current work will be very much less, the same proportioned engines are being installed in the three-phase plants. Owing to the adoption of large steam units the question of provision of adequate boiler power in a reasonable amount of floor space to correspond with the engine floor space has been met by the adoption of two or more boiler floors one above the other, surmounted by huge coal bunkers at the top, and exemplify the trust placed by American engineers in steel-framed buildings.

The question of control of the large amount of electric power generated by the large units is now being taken into adequate consideration; up to the present switchboards have always been strongly suggestive of the instrument making days, but in the new power station of the Metropolitan Traction Co. the switches are built on engineering lines of generous proportions, and are worked by pneumatic power and controlled electrically. Three large galleries at one end of the engine house are given up entirely to the switches, each in a brick cell of its own, while the actual controlling boards take up very little space.

Underground open conduits seem to work very successfully, but have only been introduced in two cities, New York, and Washington, in both of which towns no sanction for overhead wires could be obtained, and the companies had to face the heavy costs of underground conduit construction. In both towns the companies were greatly assisted in the expense by having to convert a large extent of cable traction into underground conduit, a change that is and has been carried out without much interruption of the service. Two conductors are always used and means provided for changing these conductors on to either positive or negative bars so as to enable traffic to be kept running, even with one conductor grounded in any or every section.

Transformers are mostly of the air-blast cooled type, and have the low-tension side directly connected, without switches, to their rotarys. These latter apparently work very well, and do not give any trouble with overloading, providing no over-compounding is attempted. Compounding for a level voltage is provided for by the introduction of self-indication in the high-tension feeders and a series winding on the direct current of the rotary. Return-current automatic cut-outs on the high-tension feeders have been installed at sub-stations, but up to the present do not seem to be very reliable in their working.

In no case, so far as I am aware, are return current boosters used, the current having always to find its way back to the station by the rails and supplementary cables, so that even with good bonding the maximum fall of voltage from one end of a line to the station is sometimes very great. There is no limit fixed by law, and the only limit the companies recognise is an economic one when too much pressure is lost in the return circuit. A good deal of electric welding and cast welding of the rail joints has been done, and the last is looked upon, I think, with more favour; no bonds are used with this method of jointing, but if used in this country, with the Board of Trade limiting the total fall of potential to 7 volts, bonds would certainly have to be provided.

Overhead work in America does not compare at all with what is put up in this country, either as to strength or neatness, but in many other traction matters we have something to learn from our American cousins, especially from the way they have realised the great part electric traction plays in making adequate provision for the population of large cities, enabling poor people to live at a greater distance from their work and in better surroundings than is otherwise the case. In conclusion, I would like to express my thanks for the kind hospitality dealt out to me by all the engineers I met during my visit.

DISCUSSION.

Mr. C. H. WORDINGHAM (Manchester) noted that one of the principal features of the author's Paper was the advocacy of large schemes, and his conviction that in time the whole of the supply in a district will be in the hands of one authority for supplying light and power to large towns. This was very reassuring to him (Mr. Wordingham) as it was what he had advocated for Manchester. He would like to have Mr. Rossignol's opinion as to the use of motor generators and rotary converters for all the purposes to which these will be put. He would also be glad to hear his opinion as the relative advantages of the two and three-phase systems of distribution. He would like also to know more about the fuses mentioned—as to how they were arranged, the space occupied, &c. He referred to putting ways beneath the tramways into which cables could be drawn afterwards. He did not know whether there was any difference in America from here, but he had come to the conclusion that the surest way to ruin a cable was to pull it into a pipe. He thought all drawing-in systems would have to be given up as they were fatal to the cable.

Mr. S. Z. de FERRANTI (Hollinwood) said the Paper was one which he found exceedingly interesting. He had not had the advantage of going over to the States but he had many friends there. The special station called attention to in the Paper was that of the Metropolitan Company of New York, it was certainly a most magnificent station and everything was carried out on a large scale. So far as one could judge from reading the descriptions everything had been thoroughly provided and put into the best possible form for achieving the result they desired to obtain. There was one thing about the switch gear which the author had not mentioned. To show that they did not place too much reliance upon the gear he might say that all the important switches were placed two in series; there were two sets of switch gear separately controlled and connected with the generators. With regard to large schemes for supplying electricity they would be aware that no one had advocated this more than he had: it had been one of his pet ideas all along. The difficulty was that they involved such a large amount of transformation and controlling apparatus. The capital expenditure did not go down in these big schemes as one would like to see it. He had been conversing with Mr. Short, who had been the chief engineer of the Walker Company in America, and he informed him that they got the option of a number of sites in New York City for generating stations. They went into the matter at great length and he (Mr. Short) assured him that to have several stations came out at a less price as regards capital expenditure, and as regards running, than this great station which has been erected by this company in America. There was a point of particular interest in the Paper upon generating machinery. The author states that they use the open type engines and build them in good style, but these take more attention than the enclosed engines commonly in use in this country. The suggestion given was a good one, viz., to combine the advantages of the large open type engine with what they knew of the enclosed engines here. If they could only get plant which had both these advantages he was sure they would be able to go one ahead of America.

COUNCILLOR BERT (Glasgow) had a little experience some years ago in the States; they were then in favour of the cable system. He thought the Americans had great advantages; they started out with a clear field and had not any prejudices.

Mr. E. TREMLETT CARTER was reminded of a tour he made in the United States some time ago. When at Washington he saw there the conduit system, and he thought it worked excellently, his impression at the time being that as soon as the conduit system was a little more developed in the mechanical part of the construction it would be a good system for our own cities. He considered it was a great pity that our large cities would not expend a little more capital and use the conduit system. Since that time the conduit system had been greatly improved and was extensively used in New York; in fact, it was so perfect now that it might be used with advantage in congested streets working the trolley system for outlying districts. It was surprising to see in America how large stations kept an even load; being very different from the experience over here, where you can tell often when a car is going up a hill. As to instruments, it was common to see an automatic cutout propped up with logs.

Mr. A. G. COOPER (Colne) considered that the samples of American engines he had seen in this country did not come up to those manufactured over here. He found in one of the large stations in this country the governor was run by a small belt, and he thought the English makers could give the Americans a point there.

Mr. J. K. BRYDGES (Eastbourne) stated that he had lived eight years in America and had had something to do with railway practice. The overhead work in America was very poor compared with the work in this country. Many of these overhead tramways were erected with a view of helping the surrounding country.

Mr. A. E. LE ROSSIGNOL (Newcastle-upon-Tyne), in his reply, stated that it was really astounding to see how the small amount of capital expended in running these tramways developed the surrounding country and made it practically a part of the town. If only some alteration could be made on this side to get over the difficulties caused by different districts belonging to different local authorities so that one company or one corporation might own the tramways and run them into the country districts, then the working classes would be able to live in more salubrious surroundings than at present. He did not think any town would benefit more than Glasgow in this respect when their tramways reached all the districts around, as the population was very dense in the central portion of the city. With reference to rotary converters, what he saw in New York and Niagara the chief towns where these were employed, were working satisfactory. There seemed very little difficulty providing they were large enough and the fluctuations were not very great. He said it was quite true that the Metropolitan Company of New York had two switches in series on the large generators, but even assuming they were rather expensive he did not think they were out of proportion to what were used here with smaller units and a larger number of switches. The trouble in America was to find suitable sites at a reasonable price for erecting works. It was possible to find one or two sites where you could put down a large three-phase generating station, but you could not as a rule find half a dozen sites where you could put down large stations with the advantages of condensing water, &c,

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A MODIFICATION OF MANCE'S METHOD OF DETERMINING BATTERY RESISTANCE.*

BY LOUIS W. AUSTIN.

One of the most elegant methods of determining the resistance of a battery cell is undoubtedly the Wheatsone's bridge method of Mance. As ordinarily used, however, it labours under certain disadvantages. Leaving out of account the annoyance of adjusting the galvanometer-zero by means of the control magnet, the main difficulty in the use of the method lies in the fact that at each observation the battery circuit must be kept closed long enough for the galvanometer to come to rest, which in the case of open circuit batteries gives ample time for the errors due to polarisation to appear unless large resistances are inserted in the bridge, thus reducing the sensibility of the method and rendering impossible the use of the convenient slide-wire bridge for such cells. The placing of a condenser in series with the galvanometer as suggested by Prof. Lodge does away with the first and smaller difficulty, but does not help the second. The substitution of a low-resistance telephone in place of the galvanometer very largely obviates both. It possesses the advantages that it responds only to the changes of the current, and is always ready for an observation; hence no delay is necessary after the battery circuit is closed.

To carry out this modified method the slide-wire bridge is connected as in the ordinary Mance's method, the telephone being connected to the ends of the bridge, and an empty wire across from the point between the two resistances to the bridge wire. No sliding contact piece is used, but contact is made by touching the slide-wire with the empty wire with a stroking touch—a fine wire gives the best sound. A key is placed in circuit with the cell, which is closed only at the instant that the connection on the bridge wire is closed. The sharp click of the closing of the key differs so much from the rustling noise of the other contact that there is no trouble in distinguishing the one from the other. The closing of the battery circuit in a series of almost instantaneous contacts gives little chance for polarisation, and the resistances of even the most rapidly polarising cells in common use may be found with a considerable degree of accuracy. For approximate determinations the method is very rapid, the resistance being obtained with an accuracy within a few per cent. almost instantly, and with a little care the determinations can be made practically as exact and satisfactory as with the more complicated Kohlrausch alternating-current method.

INDIAN COAL.†

A noteworthy discovery of coal on the property of the Bengal Coal and Iron Co. was announced lately. Other finds have since been reported from various parts of India, the most important being that referred to at the recent annual meeting of the Nerbudda Coal and Iron Co. It is estimated that this particular deposit contains 10,000,000 tons of good quality fuel—not a prodigious quantity certainly, but still sufficient to represent a respectable accession to the reserves of the company. These discoveries of coal in various districts of India are of interest to the United Kingdom in two or three ways. They must help to solve the whole question of India's ability to cultivate a large iron manufacturing industry. One of the principal deterrents hitherto to any considerable development in this direction has been the lack of suitable coal in quantities large enough to ensure a continuity of supplies. We do not know much that is scientifically definite on the subject of the recent discoveries, and it is quite possible that they may be no better adapted than the bulk of that already produced for the purposes of iron manufacture. On the other hand, finds are so numerous, and are being made in so many widely-scattered districts of the Empire, that there is every likelihood before long of someone unearthing big deposits of good cokeable coal. In the meantime, it is to be noted that the Nerbudda Company expects great profit from its new seam, for it is to be well understood not that fuel of the right sort is not obtained in India, but only that at present there is no great quantity of it available; and the Indian iron industry could not possibly make strides even in the Indian markets if it had a mind to depend upon the United Kingdom for the necessary coal. The increase of production in the dependency is in another way of very direct interest to us at home, for it implies a decrease in the imports of steam coal for railway and factory consumption. Every ton mined is used up, and were double the quantity obtainable there would be little difficulty in disposing of it. For though in steaming qualities Indian coal is poor enough, as compared with that of South Wales, it is possible by the adaptation of furnace bars to use it with good results, and allowing for its initial inferiority, there is a great saving in fuel bills by its employment. The reason for this is quite clear. The chief colliery districts are not very remote from the centres of industrial consumption, especially Calcutta; they are in communication with railways, and what may not be used by the railways is snapped up eagerly by the mills. It is the misfortune of not a few localities where coal occurs in great profusion that they have not yet been brought within the network of railway lines that is gradually spreading over the whole of India. The remedying of this defect is a matter for the future, near in some cases, and rather remote, we are afraid, in some others. But we have much hope that private capital will, on the proper establishment of a gold currency in the country, be induced to supplement the official endeavours. The Government, however, might do something towards aiding the development of the mineral resources, and especially the carboniferous resources of the country.

The present output is in excess of 5,000,000 tons per annum, as compared with 3,537,000 tons in 1895, and less than 2,000,000 tons in 1889. The improvement in the decade is respectable, and would have been greater had the facilities been better. It is only in Bengal that these facilities are at all fair, and this accounts for the fact that that province takes credit at present for about three-fourths of the total for the whole country. Next in importance to it, but a long way behind, comes the Nizam's Territory, which boasts the Singareni Colliery, on the Yellandu field, where coal is estimated to be so plentiful as to be capable of supplying the needs of all the railways of India for the next 100 years. Assam, the Central Provinces, Punjaub, Central India, Burmah, Baluchistan, and other parts contribute to the annual output in fair proportion, and are each and all capable of much better things if only the disabilities were removed and communication given between the mines and the consuming centres. At present, and because the means of communication are imperfect, some districts are dependent almost entirely upon the requirements of the one particular railway which taps them. Thus, the Shahrigh, Khost, Dandot, and Bhaghanwala collieries are worked in connection with the North-Western State Railway. It would be possible, we know, to make too much of the country's future in this matter of coal, especially as the limitations on the basis of discoveries to date are quite clear. But that there is considerable room for the growth of a great home trade will probably be allowed without much dissent.

* From the *Physical Review*. † From the *Mining Journal*.

CORRESPONDENCE.

ELECTRIC POWER SCHEMES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have to thank you for taking up the consideration of the points raised in my letter to the *Glasgow Herald* of August 11th. The question is one of supreme importance to electrical manufacturers in this country, because the financial success or failure of electric transmission schemes very materially affects the prosperity of the industry. My object in opening a discussion on the question is to direct attention as strongly as possible to the importance of the element of increment in value of land to promoters of power transmission schemes. It is exceedingly difficult to distinguish between cause and effect in all such questions, and I do not hope to solve a problem which has baffled the ingenuity of professional political economists.

It is easy, as you say, to too markedly point this moral, but I think you will agree that the success of an electric transmission scheme is likely to be much greater if the promoters of the scheme can reap the fruit of their enterprise in the direction I have mentioned, and also that without the benefit of the return from the land which has improved in value by the transmission scheme, the enterprise has a comparatively small margin of possible profit.

In the present state of the industry it is to be feared that the public are not competent to differentiate between transmission schemes, and it is therefore important that the technical and other press should do it for them.

I am unable to adduce direct proof that the transmission schemes which have been carried out in America and elsewhere depend for their success on the increased capital value of the land, but so far as one can judge from a knowledge of the original capital cost of the land required for the station, the cost of construction and of plant, the annual income earned by these stations leaves an exceedingly small margin for working expenses and profit. Direct information of a qualitative character is easily obtainable and indicates that the most successful schemes have been in the hands of people who have attacked the question from a larger standpoint than

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simply the sale of electric energy. It may possibly be useful to adduce an example on a small scale.

My company purchased a piece of ground in Glasgow on which an industry now defunct had been carried on. I do not know what is the increment in value of this land due to the establishment of the company's works upon it, but I do know that certain large buildings which it had been found impossible to let, and which were standing empty and inoperative, have been filled with workers by the introduction of electric power supply to tenants at a price of 1d. per unit, which I do not think, on the scale on which it is supplied, would give anything like an adequate return for the capital required for its production. On the other hand, the rents of these premises are such as to afford a very handsome profit to the company on the whole transaction.

This concrete example on a small scale will better illustrate my argument than any amount of abstract reasoning. As an electrical supply the enterprise is hopelessly unprofitable. As a land and property speculation it pays well. That, I believe, is the condition of affairs at Niagara. He would be a bold man who alleged that the supply of electricity from Niagara to Buffalo could be carried out at remunerative prices were it the prime feature of the scheme, and not an incidental means of utilising a large available power at probably a very small profit.—Yours, &c.,

HENRY A. MAYOR.

Glasgow, Aug. 22.

LEGAL INTELLIGENCE.

Electrolytic Plating Apparatus Co. v. Evans & Son.

At the Birmingham Assizes last week the Electrolytic Plating Apparatus Co, of Birmingham and Walsall, sought to restrain defendants, Messrs. Thomas Evans & Son, Walsall, from infringing Letters Patent No. 5,274 of 1896, granted to Messrs. A. S., T. A., R. J., and S. Smith, and T. Deakin, and assigned to plaintiffs. The invention was an improved apparatus for the electro-deposition of metals, and had special application to the electro-plating of small articles. Not only was the deposition of the coating of metal—silver or nickel—obtained, but at the same time the deposition was burnished so that when the articles left the apparatus they were in a finished state. It was explained that each article must be brought into effective contact with the negative pole of the battery. This apparatus dispensed with the necessity of separately connecting or separately wiring each article, which involved a considerable amount of labour, and also simultaneously burnished the articles as they were plated. The plaintiffs alleged that defendants had manufactured and used an apparatus made in accordance with the description in plaintiff's specification. Defendants denied infringement, and pleaded that the patent was invalid.

Mr. COLEFAX, for plaintiffs, said the idea of their invention was old, but the apparatus itself was an absolutely novel invention.

Mr. JAMES SWINBURNE, for plaintiffs, said the only difference between plaintiffs' and defendants' apparatus was that in defendants' machine the tank revolved. That modification—as witness described it—of plaintiffs' apparatus was a disadvantage in his opinion.

Mr. HUGO YOUNG contended, on behalf of defendants, that if plaintiffs' claim were taken in the wide sense it included Zingzam's patent, and made their patent bad. Taken in the narrow sense, giving plaintiffs merely their own modification—the particular mode of contact they had adopted—then defendants had not infringed. Defendants were entitled to their modifications of the original idea, though plaintiffs might have been first to push their goods on the market.

Mr. DUGALD CLARK said plaintiffs' invention contemplated a fixed tank.

Mr. JUSTICE WILLS, in giving judgment, said he had come to the conclusion that judgment must be given for plaintiffs. It appeared to him that the claim was nothing like so wide a one as had been contended by defendants, and that the patentee must be given the benefit as well as be subject to the disadvantage of the common knowledge which existed at the time he gave the specification. To his mind, anybody who had seen the Zingzam patent (which had been cited as an anticipation) would have anything else suggested to him rather than what had been adopted by plaintiff. Therefore he did not think there had been any anticipation. Other inventions of this kind had led to no success, whereas plaintiffs' modification at once gave them success.

Judgment for plaintiffs and an injunction was granted, but, on defendants' application, execution was stayed.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"An Epitome of the Law and Practice connected with Patents for Inventions," by J. and J. H. Johnson. Third edition. (London: Longmans, Green & Co.) 2s. 6d.

"Electric Generators," by H. F. Parshall and H. M. Hobart. (London: Office of *Engineering*). £1. 11s. 6d.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—The accounts of the Tramways department for the past year have been issued. The average revenue per car mile of the electric lines was 10·56d. and of the horse lines 11·06d. Over the electric section a greater number of car miles were run than on the horse lines, thus providing greater travelling facilities. The working expenses were 8·31d. for horse traction and only 6·39d. for electric traction, so that the actual profit on the latter is 4·17d., against 2·75d. on the former.

Alfreton.—A curious state of affairs exists here in regard to public lighting. A dispute has arisen between the Council and the local gas company as to the price of gas for street lighting with the result that the town is in darkness at night. A town's meeting has been called by tradesmen to compel the Council to agree to the company's terms, but a resolution endorsing the action of the Council was carried by an overwhelming majority. As electricity works are being erected, it is probable the inconvenience arising from the gas company's action will be soon overcome.

Asylum Lighting.—The Lancashire Asylums Board are to borrow £5,500 to defray the cost of the electric lighing of the new infirmary buildings at Prestwich.

Bath.—Owing to the increased price of coal the charge for electric current for both public and private lighting has been increased a halfpenny per unit, making it 6½d. and 5d. for private lighting and 3½d. for power. Various extensions of the mains were authorised by the Electric Light committee on Wednesday. At the same time the city electrical engineer (Mr. G. F. Metzger) reported that the demand for electric current continued to increase—in fact, the electricity department had never been so busy in making connections.

Beverley (Yorks).—The Council have resolved to obtain electric lighting powers.

Brisbane.—The Council received various offers for the electric lighting concession, some particulars of which were given in our issue of 3rd inst., but after several discussions, it has confessed its inability to decide upon the relative advantages of municipal electricity supply and works owned by a company, and a poll of ratepayers is to be taken to decide this matter.

Bury St. Edmunds.—Electric current was supplied to private consumers for the first time on Tuesday evening last.

Cassier's Magazine.—The September issue includes the following articles: "Electricity in Large Cities," "The World's Coal," and "Gas Engines."

Congo Free State.—The construction of a telegraph line from the West to the East of the Congo State has been decreed. The total length of the line will be 3,750 miles, 775 miles of which is already constructed. The line will ultimately pass through Boma, Leopoldville, Coquilhatville, Stanleyville, Nyangwé, Katambaré and M'Toa.

Consett.—A special meeting of the Council was held last week to consider an application of the Northern Counties Electrical Supply Co. for sanction to a provisional order. Messrs. C. W. Fairweather and J. Pattinson, on behalf of the company, offered to give the Council the right to purchase the undertaking at 10 years at a figure to be determined by the Board of Trade. Electric current would be supplied at 7d. per unit to private consumers, and 4½d. for public lighting, the supply for street lighting to be ready by the season of 1902. After discussion, the Gas committee were instructed to make further inquiries and report.

Crieff.—The proposed application of a company for a provisional order is to be opposed, and the Council will themselves apply for an order.

Darlington.—The town clerk (Mr. H. G. Steavenson) has drawn up a scheme for wiring premises on the hire-purchase system. The wiring is to be carried on under the superintendence of the borough electrical engineer. To cover the cost of superintendence and drawing up a specification a charge of £1 will be made where the cost of wiring (including fittings) does not exceed £10, and for every additional £10, 10s. further will be charged on this account. On completion of the work the consumer will pay to the Corporation 10 per cent. of the total cost of the installation, including the fees referred to. The balance is to be paid in 20 equal quarterly instalments, with interest at 4 per cent. on the amount remaining unpaid, the Corporation making no profit on the work. The approximate cost of an installation of 25 16 c.p. lamps, to be repaid in 20 equal quarterly payments, with interest at 4 per cent. on the balance, has been estimated as follows: Average cost £20, specification £1, deduct 10 per cent. paid on completion of installation, £2. 2s., leaving £18. 8s. due. The first quarterly payment besides the £2. 2s. would be £1. 2s. 8d. At the beginning of the second year it would be £1. 1s. 11d., third year £1. 1s. 2d., fourth £1. 0s. 5d., and fifth 19s. 5d., the last payment being at the end of the fifth year.

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Devonport.—A lengthy report on public lighting has been prepared by the Lighting sub-committee, in which the Council are recommended to adopt electric lighting for the thoroughfares where electric lighting mains are about to be laid. It is suggested that in seven streets 41 500-c.p. arcs should be erected, to be used till midnight, when 82 16 c.p. incandescents would be substituted. By adopting the scheme the report states that at least 46 of the existing gas lamps would be displaced and the additional annual cost would be £710. 13s., making the total cost of public lighting for the year £3,068. The total illuminating power of the public lamps would be 42,400 c.p., against 13,000 c.p. at present, so that for a further expenditure of about £436 per annum the increased illumination would be over 29,000 candles, or 223 per cent.

Dublin.—At a special meeting of the Corporation on Monday the tenders for the supply of electricity generating plant for the new Pigeon House works (set out in our last issue) were accepted. At the outset communications from the Dublin United Tramways Co. and the Dublin Electric Lighting Syndicate were read. The former company offered to supply electricity in bulk, energy to be delivered to the Corporation mains at the company's Ringsend generating station within the city boundary. If the consumption did not exceed 1,000,000 units per annum the price would be 2¼d. per unit, not exceeding 2,000,000, 2d., and exceeding 2,000,000, 1⅞d. This, it was pointed out, would leave the Corporation complete control over the distribution of electric energy, and that would save them an expenditure on the generating station at the Pigeon House Fort, estimated by Mr. Hammond at £96,000, as well as the cost of mains from the Pigeon House to Ringsend, entailing a charge for interest and sinking fund of some £5,000 a year from the start. Alternatively the company offered to take over the assets, liabilities, and obligations of the Corporation lighting department, including the repayment of the Corporation loan, with interest. The company would then supply current at prices calculated not to exceed in any year an average of 4½d. per unit for the first million units; 4d. for the second million, and 3d. for all in excess, all current for public lighting to be supplied at 2½d. per unit. Should the average prices in any year prove on adjustment to exceed the foregoing rates all surplus receipts would be handed over to the Corporation. Should the average prove to be less than the specified rate, the company would make no claim for the deficiency. This proposal would save all capital outlay by the Corporation (estimated by Mr. Hammond at £254,000 to commence with) and would relieve the Corporation from the repayment of the loan for the existing lighting installation, amounting to over £80,000. The company would provide for taking over the employés on the staff of the Corporation, and, if desired, all street openings could be executed by the Corporation at the expense of the company. The communication of the Dublin Electric Lighting Syndicate stated that they would be prepared in three weeks to submit an offer to the Corporation which would include the following proposals:—The division with the Corporation of all profits after 5 per cent. dividend to the shareholders. The right to the Corporation to appoint two directors on their board. A right to purchase at the end of 20 years. A sliding scale for private lighting based on the average consumption. A right to the Corporation to open the streets at charges to be fixed by the borough engineer. The syndicate would also take over the existing staff and liabilities of the Corporation under their original order.

The Lord Mayor (Sir T. Pile, Bart.), in moving the adoption of the report recommending the acceptance of the tenders, gave a *résumé* of the history of the Dublin electric lighting. He made no apology for having written to these competing companies asking them to make at once whatever specific offer they had to make. What was the position of this question? In 1895 the question of the purchase of the Pigeon House was raised, and one of the strongest arguments in favour of getting it put forward by Mr. Harty, their city engineer, was that it would be a most valuable site for electric generating purposes. That report was unanimously adopted by the Council. On July 9, 1896, the borough engineer pressed on the Electric Lighting committee the urgent necessity there was that provision should be made for the extension of the electric lighting of the city, and on Dec. 2, 1897, the committee adopted, urged, and recommended the proposed erection of the Pigeon House Fort. The Council unanimously adopted the proposal. On Nov. 25, 1897, Prof. A. B. W. Kennedy was appointed their consulting engineer, and on Feb. 18, 1898, he reported that electric lighting from the Pigeon House could be successfully carried out. Sortly after that Prof. Kennedy reluctantly withdrew his connection with Dublin, and Mr. Robert Hammond was appointed in his stead. On Dec. 28, 1899, his scheme in all its details came before them and was adopted. Since that date they had had two of the most exhaustive and searching inquiries by the opponents of this scheme of Mr. Hammond—the Local Government Board inquiry and the Electric Lighting Bill of the Tramway Company promoted in Parliament. In the former case their scheme was declared to be a good one, and in the latter case they succeeded in doing what was practically an unknown thing in getting Parliament to throw out the bill after it had been approved by the Parliamentary Committee to whom its consideration was entrusted and had passed the report stage. Now, as to their proposed scheme. Their proposal was to supply electricity in three mains at 5,000 volts from the Pigeon House to Fleet-street station, and from thence direct to the 19 sub-stations over the city. He emphasised the three mains with three cables, because it had been contended lately, especially by their opponents, that they would be relying on one single main, which, if it gave out, would mean that Dublin would be in darkness. They were going to use two out of the three mains, and the other would be a stand-by; so they might leave out of consideration all likelihood of a breakdown. He would now deal with the offer of the Tramway Company, which was the only tangible offer before them. The committee's report they were now discussing meant the acceptance of tenders for engines, generators, boilers, and fuel economisers at a cost of £46,000, which was £5,000 less than Mr. Hammond's estimate. The practical question at the present point was really whether the Tramway Company were prepared to supply electric current for the lighting of the city at a cheaper rate than the Corporation could manufacture it. The original offer of the company was to supply current at 6d. and 4d. per unit for public and private lighting respectively, reducible at the expiration of two years to 5d. and 3d. That offer was made 18 months ago, and if they had accepted it they would have levied on the citizens a charge of nearly £40,000 a year. A second offer was sprung on the Council just as they were about to apply for a loan to carry out their own work, and now they had sprung a third offer just as they were about to accept tenders. It was not necessary to differentiate between the Tramway Company and the electrical syndicate, because the syndicate was made up by Tramway Company money and directors. They had forced the Council to an expenditure of, roughly, £5,000, and now asked the Council to consider a new offer. By the company's bill, rejected after a struggle by Parliament, and which was the most immoral and audacious proposal ever brought before Parliament, it was sought to fasten on the citizens a lighting charge of 6d. per unit. But the Tramway Company now offered to supply electricity at 2¼d., 2d., and 1⅞d. The Corporation proposal was to supply the consumer for 1½d. To the Tramway Company's charge of 1⅞d., delivered at Ringsend, they had to add 10 per cent. of wastage from Ringsend to Fleet-street, and wages and salaries (put down at £2,700), so that the offer of the Tramway Company would mean a cost of 2½d. per unit to do the same service as the Corporation proposed to do for 1½d. The capital required would be very little reduced by accepting the Tramway Company's offer in bulk. The Tramway Company offered this at low tension at 500 volts at Ringsend. Their proposed system was the high-tension system; but if they put in low-tension mains to carry the electricity delivered at Ringsend it would cost £189,000. Add to that public lighting, £40,000, and meters and house connections, £15,000, and they got a total of £244,500. Now, on the other hand, the Corporation capital expenditure was £103,000 for mains; public lighting, £40,000; generating station, £96,000; and meter and house connections, £15,000; or, in fact, £254,000 of capital, as against the Tramway offer, which would involve a capital cost of £244,000. Adding a provision for interest and sinking fund, electricity delivered by the Tramway Company would cost 4·12d. per unit. If, on the other hand, the Corporation did it they found it would cost 3·37d. The company made an alternative offer; they said if they were given all the electric lighting of the city they would pay the loans due on their stations, take up all responsibility, and supply electricity at 4½d. per unit for the first million, 4d. for the second, and at 3d. for any further supply, and to give public lighting at 2¼d. The average worked out at 3·96d. per unit, while the Corporation scheme worked out at 3·42d. The Corporation would have to pay the Tramway Company £39,133 in perpetuity. All he had to say was, even if their electric lighting did cost more than the Tramway Company's—which he utterly disputed—the difference was this, that at the end of 25 years they would get their property into their own hands, and could reduce the price to consumers to 2d. a unit. There was an idea in the mind of some of the members that their own officials did not quite approve of the Corporation electricity scheme. Mr. Ruddle had some doubt about the scheme, but he said, with Mr. Ruddle's authority, that he was absolutely impressed with the magnificence of the scheme, and believed that it was the best that could be adopted for the city. He (the Lord Mayor) appealed to them to have confidence in themselves, and to believe they were capable of carrying out this great work. They talked of Home Rule, but if they were not capable of carrying out a 2¼d. job like this, they were not capable of governing Ireland.

Mr. Jones seconded the resolution, and said they had only to consider the tenders; that until the division list was issued he would not believe that there were enough men among their 60 members to write themselves down incompetent to carry out this work, which the Local Government Board had given them the money to carry out, and Parliament had given them the right and privilege to carry out.

Mr. Harrington, M.P., said he would not follow the Lord Mayor into the question of the evidence of experts, who were not, after all, independent men. No doubt Prof. Kennedy said the site of the Pigeon House could be worked successfully, but he did not say at what price. What they had to consider was the cheapest and best system, and they were not bound, for any question of sentiment, to expend one penny beyond that. In face of the future expenditure which the city had to face, it seemed to him that the proposal of the Tramway Company was infinitely cheaper than that of their own experts. Why should they ask for tenders for new machinery when not a brick had been laid of the structure in which it was proposed to place it? Unless some better reasons were given why the whole of the tenders were not laid before the Council together he held they should not adopt this report. He was not in favour of giving away the public rights of the city, but if they could get electric light cheaper, without imposing an enormous burden on the rates, he said the practical thing for the Corporation was to get it, and if a profit could be made out of it to endeavour to make it for the benefit of the citizens. He would move as an amendment—"That the consideration of the report of the Electric Lighting committee recommending the acceptance of tenders for machinery, amounting to £46,000 out of an estimated expenditure of £254,000, be postponed until tenders for the building and for the remainder of the machinery, cables, &c., are obtained, so that the amount of tenders for the whole work can be compared with Mr. Hammond's estimate."

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Mr. TALLON seconded. With regard to Mr. Hammond's figures, they must remember that when on a former occasion an estimate was made from the same source—a comparatively small estimate of £24,000 for a small job—it turned out to be erroneous to the extent of £10,000. When it came to be an estimate running into £254,000 of public money, he felt he must refer to it.

Mr. JONES said the statement was inaccurate. It was a charge against Mr. Hammond which was utterly wrong.

Mr. TALLON (continuing) said he thought they should be afforded time enough to invite and consider tenders from manufacturers in America. He was told that machinery of this kind could be manufactured in America and delivered here better than it could be made in England. There had been such mistakes made in the past that they should be very careful not to go rashly into such large expenditure.

Mr. BRADY said they must remember that they would become immediately responsible for the payment of this large sum of £46,000, the amount of the tenders they were now asked to accept. The loan they were told they had obtained sanction to borrow had been only provisionally granted subject to certain conditions and requirements being carried out by the Council. But those conditions had not been carried out. The plans of the Corporation scheme should be laid on the table. The Local Government Board had not had the terms of the conditional sanction carried out. They were asked to vote for a transaction which was not yet completed—to sanction tenders for machinery without having a place for it.

Mr. H. BROWN said they were told there would be a saving on these tenders of £5,000 on Mr. Hammond's estimate, and perhaps there might be a saving on the other tenders. He was in favour of waiting till the Local Government Board conditions had been fully complied with and the loan had been obtained.

Mr. IRWIN said if they accepted the tenders they would at once incur a liability to Mr. Hammond of £15,000. He asked that the contract should be produced, and having obtained it, read a clause providing that Mr. Hammond should be paid a commission of 5 per cent. on the amount of the contracts as carried out by the contractors. In face of the tremendous difference of opinion that existed in the city amongst experts, he thought it was very desirable and absolutely necessary that all the tenders should be brought before the Council at the same time, so that they might ascertain whether Mr. Hammond's estimate of £96,000 would not run into double that amount, and whether they would be able to produce the light at a profit.

Alderman IRELAND thought the Corporation should enter into a short contract with any company that could supply electricity cheaply, just as they would enter into a contract for coals.

Mr. BEATTIE asked if there was a wastage of 10 per cent. from Ringsend to Dublin, what would the wastage be from the Pigeon House Fort to Dublin? Having regard to the Tramway Company's great plant and convenience to the city, they should be in a position to generate electric current a great deal more cheaply than the Corporation could.

Ald. Sir ROBERT SEXTON said that, while in favour of the Corporation of Dublin having the power to light the city in their own hands, he thought they should endeavour to obtain every possible benefit they could for the ratepayers. He had nothing to do with the Tramway Company, but he thought their proposal should be considered.

The LORD MAYOR, in closing the debate, said their scheme had been approved by the most eminent engineers in England. He went into this scheme originally with a view to force the price of gas down in Dublin. As to the buildings not being ready for the machinery, the first thing was to get the dimensions of the machinery and then to put in the foundations, as it would take longer to complete the boilers and machinery than to build the foundations. Under the arrangement with Clontarf they were bound to supply it with electric current in three or four years. If the tenders now submitted were approved they would have machinery capable of supplying the whole municipal area.

A division was then taken, with the result that 14 voted for the amendment and 38 against, and the Committee's report was then carried by the same number (38 to 14).

Dumfries.—The Council have received several offers for a transfer of their provisional order, but the following terms, offered by one company, seems likely to form the basis of an agreement. All electric current required for public lighting to be supplied to the Council at 7d. per unit for the first hour, and 2d. after, which, for all-night street lighting would work out at 2½d. per unit. The charge to private consumers must not exceed 7d. per unit for the first hour and 4d. after. The Council would also have the option of purchasing the undertaking within twelve months after the expiration of 10 years.

Electric Tramways and Workmen's Tickets.—It is stated that parliamentary agents, who are about to enter upon preliminary work in connection with next year's private bills, have been notified that the revised clause securing better accommodation for workmen, which was inserted in the London United Tramways Bill at the instance of Mr. Lough last session, will be insisted upon in all future measures authorising the construction of tramways. This clause and the old model clause which it is to supersede are—(1) The substitution for the fixed minimum of two workmen's cars morning and evening of the more elastic requirement "a proper and sufficient service"; (2) the alteration of the time limits after which in the morning and before which in the evening workmen's cars will not be required to run from 7 a.m. to 8 a.m. and from 6 p.m. to 5 p.m.; (3) the reduction of the minimum fare from 1d. to ½d.; and (4) the introduction of new provisions compelling the companies to run workmen's cars between noon and 2 p.m. on Saturdays and making the companies liable to a fine of £5 for failure to comply with any order under the section.

Electrical Fire Risk Rules.—We have received from the Royal Insurance Co. a copy of a supplement to the rules for electrical installations issued by this office in which are described special safeguards to be observed with installations of electric light and power plant in factories and works premises, for overhead trolley, telephone and other wires, &c. The supplement is accompanied by a circular in which it is stated that "it does not appear to be sufficiently known to electrical engineers and to the users of electrical power installations that, in certain special risks, motors and other appurtenances must conform to the installation regulations of the associated fire offices in order to be allowed without an extra charge. It is important (continues the circular) to note that the only type of motor or dynamo which is allowed free when not situated in an engine room or in its own separate compartment is the fully enclosed type. A mere box turned over the motor is not accepted as a compartment, which must be of such size that a man can enter it to attend to the machine."

Fatal Accident.—At an inquest opened at Liverpool last week into the death of a labourer named M'Gurn, 22, employed by the Liverpool Corporation Tramways, it appeared that during the thunderstorm of Aug. 3 deceased was changing horses in Robson-street, when an electric trolley wire fell on his head. He was severely injured, and died the same night in Stanley Hospital. It was not known whether the wire was blown down, or had fallen through some defect of construction. The inquest was adjourned to 23rd inst. It was stated that that was the first accident of the kind that had occurred since the inauguration of electric traction, and the coroner thought that fact was sufficient to show that reasonable care had been exercised in connection with the construction and fitting up of the overhead equipment. A verdict of accidental death was returned, no blame attaching to anyone.

Gloucester.—The electricity undertaking is making excellent progress, and considerable extensions of the street arc lighting system are contemplated.

Goole.—"In order to keep out companies," the District Council will apply for electric lighting powers.

Haiti.—The Haitian Government announce that they are about to introduce electric lighting into the capital (Port au Prince). This Government have also decided to cancel all existing concessions for lighting cities of the State, paying the holders for their plant and other expenditure, in order that the lighting may be under Government control.

Halifax.—Three new electric tramway lines were officially inspected by the Board of Trade electrical inspector, Mr. A. P. Trotter, on Wednesday. About 15 miles of electric tramway owned by the Corporation are now open for traffic. The Booth Town route to Queensbury, and the continuation of the Cote Hill branch to Hebden Bridge will be the next tramways to be constructed.

Hanley.—On Tuesday tenders were accepted for the supply of additional plant for the electricity works, and it was decided to apply for sanction to borrow £7,000 to cover cost. The chairman (Ald. Hammersley) pointed out that from January to July the electricity department had generated 473,000 units of current, and had sold 311,000 units only. They were exceedingly anxious to find out where the leakage could be. With regard to domestic lighting, it was found that the consumption in many cases had been so small that the meters would not register the current, and that they hoped also to remedy shortly.

Hastings.—An inquiry was held here on Friday into the application of the Council to borrow £3,650 for electric lighting extensions. Technical particulars were supplied by the borough electrical engineer, Mr. Leonard Andrews. There was no opposition.

Hull.—A special meeting of the Parliamentary committee of the Hull and District Chamber of Trades was held last week to discuss the action of the electricity department of the Corporation in placing fuse-boxes in front of business premises. Messrs. Craft & Son complained that a fuse-box had been erected in front of their premises at the corner of Beverley and Fountain-roads at a distance of 5ft. 6in. from one of their principal windows. It had proved and was proving a great inconvenience to their trade. The attention of the Electric Light committee had been drawn to the matter, and the town clerk had informed them that they were prepared to remove the box to another site on condition that the cost of removing it (£10) was paid by the firm complaining. The meeting unanimously resolved that the erection of fuse-boxes in front of tradesmen's premises was a serious inconvenience, and a deputation was appointed to wait upon the committee in regard to the matter.

Ilford.—The foundation stone of the new electricity station building was laid by the chairman of the Council (Councillor H. Weeden, J.P.) on Saturday. Current is to be supplied for lighting and tramways. Councillor Weeden said the main thoroughfares were to be lighted electrically, and the Council were constructing an extensive system of electric tramways, which would, he said, be the

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most modern in existence. The lines would connect all the districts of the parish, and would provide ready and cheap means of transit. The Council were prepared to supply current at the lowest possible price, so that it should be to the interest of every householder to have the electric light in his house. Councillor Bailey afterwards laid the foundation stone of the chimney shaft. The consulting engineer of the scheme is Mr. W. C. C. Hawtayne.

Jungfrau Railway.—The *Schweizer Handels Zeitung* states that since last winter the Jungfrau Railway works have not advanced, have, in fact, been entirely suspended for the last few months. The published traffic returns are said to be inaccurate. The project (the cost of which is heavier than set out in the estimates) is in danger of being abandoned.

Leeds.—The Briggate, Hunslet and Thwaite Gate electric tramway route was opened for traffic on Friday last.

Light Railways.—The Board of Trade have confirmed the Gateshead and District Light Railway Order.

A comprehensive scheme for the construction of light (electric) railways in Surrey is being formulated, which includes a line from Chobham to Woking, Send, Ripley and West Horsley, and one from Walton-on-Thames to Weybridge and Addlestone.

Liverpool.—The wholesale fish market is now lighted by 20 arc lamps, current being supplied by the Corporation electricity department for the first time on Wednesday.

Llandudno.—The condenser at the electricity works is to be extended at an estimated cost of £1,500.

Manchester.—The negotiations for the purchase of the National Telephone Co.'s business in Manchester having fallen through, the special Telephone committee have entered into negotiations with the Mutual Telephone Co., who offer to provide, under certain conditions as to compulsory sale to the Corporation, a telephone service for £5 a year to shareholders and £6. 10s. a year to non-shareholders. The chairman of the company (Mr. W. Thompson) waited on the committee on Wednesday and gave an explanation of an agreement entered into by the Mutual Company with Salford Corporation, It is stated that the committee will next consult the Salford Corporation, and it is thought possible that eventually arrangements will be made which will enable the Mutual Company to obtain a licence to start a competitive system in the city. In the event of the failure of the negotiations the committee will consider the question of the establishment of a municipal service.

Newark.—The Council are considering the question of carrying out the terms of their provisional order, and the consulting engineer (Mr. C. S. Vesey-Brown) has been instructed to report on the cost, &c., of an electric lighting scheme.

Newcastle-on-Tyne.—The General Purposes sub-committee of the Council have already purchased 100 cars for the electric tramways and have decided to purchase 35 more, which will provide 20 spare cars for special occasions. The time-service of these cars has just been revised over all the principal routes, and the number of cars considerably increased.

Nottingham.—The Corporation have decided to light the electric tramway routes by arc lamps, and Mr. W. J. Furse has secured the contract. Arc lights are to be attached to every alternate tramway pole.

Nuneaton.—The Council have considered and approved the report of their consulting engineer (Mr. W. C. C. Hawtayne) on the present condition of the electricisy works and on the advisability of making extensions to the plant and mains. The report stated that the site of the station is good, being close to the business portion of the town, and feeders could be run economically to the outlying portion of the district. Mr. Hawtayne pronounces against the proposal to change the site of the works, and considers that the best course to be followed would be to erect entirely new buildings and to place new machinery in these buildings when completed. Of the present plant the steam dynamos are pronounced serviceable, but Mr. Hawtayne recommends that new boilers be substituted for the old ones, and that the storage batteries and such switchboard arrangements as cannot again be made use of should be scrapped. A new battery of accumulators will be required when the new works come into operation. The re-arrangement of the mains by the resident engineer (Mr. W. J. Proctor), the change over from overhead to underground cables, and the change in the system of distribution from two to three-wire, are favourably commented upon in the report. Mr. Hawtayne recommends the Council to erect 16 arc lamps for the eleetric lighting of the market place, the displacement of about 27 of the existing posts, and the provision of two incandescent lamps of, say, 32 c.p. each, to be switched on at midnight when the arcs are extinguished. Mr. Hawtayne's report has been accepted by the Council, and the amount for which borrowing powers are to be sought has been increased from £8,000 to £10,000.

Paraguay.—A company entitled the Paraguay Development Co. was recently formed in Philadelphia (U.S.A.) to exploit and develop "the natural resources of South American countries, and especially of the Republic of Paraguay," including the erection of electricity and other lighting plants, the construction of electric tramways, &c. It is stated that an American capitalist will shortly go to Paraguay to arrange for lighting Asuncion, the capital, and for building a trolley tramway line.

Party Line Telephones.—The following letter from A. R. Bennett, general manager of the Glasgow Municipal Telephone department, appeared in the *Glasgow Herald* of 23rd inst. :—

Referring to the description of the Party Line telephone apparatus which is proposed to be introduced in Glasgow by the National Telephone Co., which appeared in your issue of Aug. 21, I think it desirable in the public interest to point out that there is really nothing new about the system. The Party Call System is as old almost as telephones themselves, having been introduced under the name of the Individual Call System well back in the eighties. Under that name the National Telephone Co. themselves gave it an extensive trial, with results that did not justify its continuance. Making a call by lifting off the telephone was practised in London in 1880, and has always been a distinguishing feature of the Post Office telephones, which, nevertheless, have never enjoyed much public favour. Making signals by incandescent lamps is not a novelty, and possesses no practical advantage over a signal made by moving a disc or shutter. That it looks pretty may be admitted. Why the Individual Call System, or, to give it its new-fangled name, the Party Line System, was not a success, and never can be a success, is due to the fact that no two of the parties joined on the same line can use it at the same time. If A and B are on the same line, B cannot call the exchange if A is using it; and if any other subscriber calls for A while B is using the line, A loses his connection, which may mean much to him. When the complication is increased by the presence on the line of C, D, E, F, G, and H (I see that it is proposed to put as many as eight persons on one line), the confusion which results may be imagined. It must be borne in mind that telephone subscribers have a tendency to use their telephones at the same hours every day, the hours which correspond to the deliveries of letters and the closing of mails, so that attempts to use the line simultaneously are apt to be the rule rather than the exception. The National Telephone Co. state in their public advertisements that persons who take advantage of the Party Line rates must not join an opposition exchange; consequently those who sign such an agreement will be precluded, for one or two years at least, from taking advantage of the £5. 5s. telephone service offered by the Corporation, and at the same time may find that the disadvantages indicated above are very far from being imaginary.

Personal.—Mr. Andrew S. Dunn, who has been superintendent of telegraphs to the Caledonian Railway Co. for the past 33 years, has intimated his intention of retiring in October. Mr. Dunn is one of the oldest telegraph officers in the United Kingdom, and an original member of the Society of Telegraph Engineers. He was also president of the conference of railway telegraph superintendents and engineers in 1889. Mr. Dunn joined the Electric and International Telegraph Co. in 1853, and, after some time became assistant to the superintendent for Scotland in Edinburgh. In 1867 he was appointed superintendent of the northern section of the Caledonian Railway telegraph system at Aberdeen, and in 1869, on the State acquiring the telegraphs, was appointed to Glasgow as superintendent over the entire Caledonian Railway system. During his association with the Caledonian Company the telegraph department has expanded enormously, and from small beginnings in 1867, when the number of electrical instruments used in railway working were counted by hundreds, they are now counted by thousands. Electric lighting has also been introduced in the principal stations and hotels of the company. For 33 years Mr. Dunn has regularly accompanied the royal train conveying the Queen to and from her Balmoral residence.

Picketing.—In the Vacation Court, London, yesterday, Mr. Justice Farwell held a special sitting to hear an application on behalf of the Taff Vale Railway Co., to put a stop to the picketing prevailing on the Great Western railway at Cardiff, and after hearing the evidence produced his lordship granted an injunction against Mr. Richard Bell, general secretary of the Amalgamated Society of Railway Servants, and against Mr. James Holmes, organising secretary of the society for the West of England. The application for an injunction against the Amalgamated Society of Railway Servants was ordered to stand over for his lordship's reserved judgment on Wednesday next.

Preston.—The Council are recommended by the Streets and Buildings committee to introduce electric traction on the local tramways, the present lease of which expires in 1902. The Council obtained electric traction powers in their 1900 act.

Provisional Order Revocation.—The Board of Trade have revoked the Newbury Electric Lighting Order, 1892.

Rhyl.—The Council are anxious to raise a loan of £40,000 for electric lighting and other works, and a deputation has been sent to London to negotiate.

Rome.—The Anglo-Roman Gas Co., a British venture of old standing, owns the concession for lighting Rome and district by both gas and electricity. The amount of electric current supplied by the company for lighting during 1899 was 17,854,017 hectowatts, against 15,412,139 in 1898. The tramway company in Rome took from the

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Anglo-Roman Co. 24,174,933 hectowatts of current in 1899, compared with 11,263,309 in 1898. This large increase was due to the new lines opened during the year. The demand for current for lighting and traction necessitated a considerable extension of the works and plant at Tivoli, and an issue of 4½ per cent. debentures to the amount of £200,000 was authorised during the year, and a portion of the bonds issued.

Rothwell.—All applications by companies for a provisional order are to be opposed, and the Council will itself apply for electric lighting powers.

St. George's (London).—A special meeting of the Vestry was held on Friday to consider a proposal to rescind resolutions passed in favour of the electric lighting of the streets and authorising the Electric Lighting committee to enter into a contract with the Westminster Electric Supply Corporation. Mr. Burch, who moved the original resolution, now moved its rescission. The motion was seconded by Mr. P. T. Saunders, who thought the parish was sufficiently and adequately lighted, and he considered they had, so far as gas lighting was concerned, a perfect parish. He regarded the electric lighting scheme as a monstrous and mischievous one, and a wilful and scandalous waste of public money. After a discussion the rescinding resolution was adopted by 21 votes to 3, but a squabble appears to have occurred after this voting, and a further division resulted in 23 voting for the rescission and 13 against, and as a two-thirds majority is required to rescind a resolution of the Vestry the motion fell through. A resolution that the committee should submit a report to the Vestry before entering into an agreement with the Westminster Co. was subsequently carried.

St. John's (Newfoundland).—Electric tramways are now running through all the principal thoroughfares of this city, the length of line at present constructed being over 7 miles, and considerable extensions are already being considered. Power for these electric lines, as well as for lighting St. John's, is generated 9 miles from the city, the generating plant being of 1,600 H.P. capacity, with flume capacity for an additional plant of equal size. Westinghouse power-house equipment has been installed.

St. Michael's (Azores).—The advent of the submarine cable has undoubtedly called attention to the island of St. Michael's as a health resort, and the possibilities of the place as a competitor with Madeira are considerable. Only capital is required to develop Fournass, Sept Citades and other favoured spots on the island, and it is reported that the first step towards popularising St. Michael's will be the construction of an electric railway. Already it is announced that English capital is backing private enterprise in the building and maintenance of a line to run from Ponta Delgada, to be commenced at once and to be completed within four years. The introduction of an electric line would undoubtedly lead to the establishment of hotels, and, if only the pest of voracious flies in some districts can be combated, there is an excellent outlook for St. Michaels, where an extremely pleasant holiday can be spent. Fournass possesses many attractive features, amongst which may be reckoned some well-equipped iron and sulphur baths which at present are free.

Samara (Russia).—Electricity supply works have been started in this town.. The plant has been supplied by the Siemens and Halske Aktien Gesellschaft of St. Petersburg.

Sheffield.—The Electric Light committee have resolved to send a small deputation to Paris to collect information as to the progress made in electric lighting and traction plant as exemplified by the machinery on view at the Exhibition. The deputation will visit other cities on the Continent where electricity works have been established. The committee propose to erect a new power station in Sheffied, and information is being sought for the guidance of the Council.

Soothill Nether (Yorks.).—Owing to the increase in the price of gas the District Council are making enquiries into the cost of electric lighting.

Sunderland.—Since the recent opening of the electric tramways attempts have been made to wreck the cars. On two occasions iron slabs 1in. thick have, it is stated, been laid across the lines after dusk, but on each occasion the driver has detected the obstruction in time. The latest device has been to insert steel punchings within the groove of the rails. A reward of £20 has been offered by the Corporation, but notwithstanding constant vigilance so far no trace of the culprit has been discovered.

Tariff Changes.—The Russian Empire Customs tariff has been extended to the region of the Amur both at the ports at the mouth of that river and to the south of it, and also on the land frontier. Among the articles to be imported free of duty are dynamo electrical machinery, driving bands, &c.

Torquay.—An inquiry was held here last week into the application of the Council to borrow £15,000 for electric lighting extensions. The town clerk (Mr. F. S. Hex) explained that the Council's electricity undertaking had developed so rapidly that the additions to the plant made in 1899 were insufficient to meet the demand for current. At the end of March, 1898, there were 55 consumers, but on March 31 last the number was 221. The total equivalent number of 8 c.p. lamps connected in March, 1898, was 5,688, of which 3,310 were private lamps, and in March last there were 10,070 lamps. Several applications in hand could not be dealt with. The total revenue for the first year was £2,837, last year it was £3,699. There was a gross profit of £1,057 the first year, and of £1,256 the second year, but after allowing for interest and sinking fund (£1,188) there was a deficit of £138 on the first year, and a profit of £67 on the second. Technical details were given by the borough electrical engineer, Mr. P. Storey. There was no opposition.

Water Power Utilisation in Spain.—Electric traction is to be adopted on the Bilbao-Durange-Arratia Railway, the contract for the conversion having been secured by the French Thomson-Houston Co. The water power of the Falls of Maguras and Garay are to be utilised in the generation of electrical energy.

Workhouse Lighting.—The plans and specifications prepared by Mr. G. R. Peers for the electric lighting of the Christchurch workhouse and cottage homes have been approved by the Buildings committee of the guardians.

Wrexham.—The Council have fixed the charge for electric current at 6d. per unit for lighting and 3d. for power.

Yeadon.—A canvass of ratepayers on the electric lighting question has been made. Of 890 circulars distributed 510 were returned, 337 in blank. Of the remaining 173, 98 were in favour of electric lighting and 75 against. At a meeting of the Council on Friday the chairman proposed that the provisional order be transferred to a syndicate, but only the mover and seconder voted for it. There were also two against, and the chairman declined to give a casting vote. The Yeadon order was obtained in 1894, and some time ago the Board of Trade decided to defer the question of its revocation until the end of October.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"Secondary Batteries, their Design and Manufacture."—By E. J Wade.

"Primary Batteries: Their Construction and Use."—By W. R. Cooper.

"Practical Telephony."—By Dane Sinclair and F. C Raphael.

"'The Electrician' Wireman's Pocket-book."—Edited by F. C. Raphael. *Nearly ready.*

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TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]

TENDERS INVITED.

Whitby District Council invite tenders for the supply and erection of electricity generating plant, some particulars of which are set out in an advertisement. Specification may be obtained at the offices of the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster. Tenders, addressed to the clerk (Mr. Wm. Seaton Gray), Council offices, Whitby, must be in before noon of Sept. 3.

The Vestry of St. John, *Hampstead* (London) invite tenders for the supply and erection of (1) eight dry-back marine boilers, (2) steam and water pipes, feed pumps, &c., (3) feed-water heater, or (4) feed-water detartariser, (5) fuel economiser, (6) cast-iron water tank, and (7) two blow-off tanks. Conditions and specifications may be obtained at the offices of the vestry clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, N.W., to whom tenders must be delivered by 4 p.m. of Sept. 27. An advertisement contains further particulars.

Oldham Electric Light committee invite tenders for the supply and erection of dry-back marine boilers, with mountings, gangways, feed and drain pipes, &c., complete, and also for mechanical stokers with shaftingand gearing for driving; or water-tube boilers as an alternative to the dry-back marine boilers, including mountings, &c. Further particulars are given in an advertisement, and copies of specifications may be obtained from Mr. A. Andrew, Gas and Water offices, Oldham. Specification and drawings can also be seen at, but not obtained from, the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W., and tenders must be sent to the superintendent (Mr. A. Andrew) on or before Sept. 11.

London County Council invite tenders for the supply of mains required in connection with the scheme for the electric lighting of the Victoria Embankment and Westminster Bridge. Further particulars are given in an advertisement, and specifications, &c., may be obtained at the engineer's department, County Hall, Spring Gardens, S.W. Tenders must be addressed to the clerk (Mr. C. J. Stewart) before noon of Sept. 24.

London County Council Asylums committee invite tenders for boilers, engines, dynamos, &c., at Horton Estate, Epsom, Surrey. Tenders to committee, 6, Waterloo-place, S.W., by 10 a m. of Sept. 22.

Dundalk District Council invite offers for the transfer of their provisional electric lighting order. Some particulars are set out in an advertisement, and any further information can be obtained at the office of the borough surveyor. Tenders to the town clerk (Mr. Mathew Comerford), Town Hall, Dundalk, before 1 p.m. Sept. 18.

Mexborough District Council invite tenders for electricity generating plant, particulars of which are set out in an advertisement. Copies of the specification, &c., can be obtained from the electrical engineer to the Council (Mr. H. Waring), 18, Berkeley-road, Crouch End, London, N., and tenders must be delivered to the clerk (Mr. J. W. Hattersley), Mexborough, before Sept. 15.

Glasgow Corporation invite tenders for the supply and fitting-up of the power station piping required at Pinkston. An advertisement contains further particulars, and specifications, &c., can be obtained from the general manager (Mr. John Young), 88, Renfield-street. Tenders to the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by 5 p.m. Sept. 28.

Salford Corporatfon invite tenders for twelve months' supply of high and low-tension single and concentric cables, house fuse boxes, meters and meter boards. Particulars may be obtained from the borough electrical engineer (pro tem.), Mr. F. A. Wilkinson, Walness-road, and tenders must be delivered to the town clerk (Mr. L. C. Evans), Town Hall, Salford, before Sept. 10. See advertisement.

Walthamstow District Council invite tenders for the supply and erection of electric lighting plant and apparatus, including gas plant, gas engines, dynamos, switchboard, boosters, balancer and measuring instruments. Specifications may be obtained from the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., after Sept. 4. Further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m., Sept. 25.

Sunderland Corporation invite tenders for triple expansion high-speed direct-current steam dynamos, Lancashire boilers, and feed pumps. Specifications may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland, and tenders (addressed to the chairman of the Electric Lighting committee) must be sent to the town clerk (Mr. Francis M. Bowey) by noon of Sept. 21. An advertisement gives further particulars.

Dublin Electric Lighting committee invite tenders for the supply and laying of electricity supply mains and accessories. Specification may be inspected at the office of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and may be seen at and obtained from the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., after Sept. 3. Further particulars are given in an advertisement, and tenders, addressed to the town clerk (Mr. Henry Campbell), City Hall, Dublin, must be in by 4 p.m. of Oct. 4.

Tenders are invited for the electric lighting of the new drill hall, *Portsmouth*. Specifications can be seen on the works, and other information obtained from the architect, 148, High-street, Portsmouth, and tenders must be sent to the Col.-Commandant (A. R. Holbrook), Drill Hall, Alfred-road, Portsmouth, by 5 p.m. Sept. 10.

Hackney (London) Electric Lighting committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, arc lamps, meters, travelling crane, and workshop equipment. Tenders to vestry clerk by 4 p.m., Sept. 12.

Hammersmith (London) Vestry require tenders for the supply, delivery and erection of two single-phase alternate-current motors, coupled to two centrifugal pumps, with accessories. Tenders to clerk before 5 p.m., Sept. 12.

The managers of the *Poplar* and *Stepney* Sick Asylum District invite tenders for sundry work in connection with a telephonic installation at their sick asylum. Tender to clerk, Bromley, Middlesex, by 5 p.m., Sept. 17.

Hull Electric Lighting committee invite tenders for steam and water pipes, feed-pumps, water-softener, &c., for their Sculcoates-lane generating station. Tenders (addressed chairman of committee) to town clerk's office by noon, Sept. 27.

Aberdeen Electric Lighting committee invite tenders for two 200kw. direct-coupled continuous-current generators and one 120kw. balancing set; also for one 420kw. direct-coupled continuous generator. Willans engines are specified in both cases. Tenders to city electrical engineer by Sept 29.

Tunbridge Wells Corporation invite tenders for high and low-tension cables. Tenders to town clerk by Sept. 29.

Greenock Police Board invite tenders for water-tube boilers, two steam dynamos, boosters, switchboard, steam and exhaust pipes, &c. Tenders to town clerk (Mr. C. MacCulloch) by Sept. 10.

Nelson Corporation invite tenders for a 200kw. steam dynamo. Tenders to town clerk by Sept. 8.

Southampton Guardians invite tenders for electrical plant and an electric lighting installation for the new workhouse infirmary at Shirley Warren. Tenders to clerk St. Mary-street, Southampton, by Sept. 11.

Southampton Harbour Board invite tenders for a 30-cwt. portable electric wharf crane. Tenders by Sept 17.

Luton Town Council require tenders for watt and demand meters. Tenders to town clerk by Sept. 14.

Salford Cleansing committee invite tenders for a two or three cell and also a six cell refuse destructor. Tenders to town clerk by Oct. 2.

Tenders are invited for the electric lighting of the *Fife and Kinross* District Lunatic Asylum. Tenders to clerk, Cupar-Fife, by Sept. 3.

Tenders are invited until Nov. 4 by the municipal authorities of *Philippopolis* (Bulgaria) for the concession for electric lighting.

Up to Nov. 2 the Civic Administration of *Piatra Neamtz* (Roumania) is open to receive tenders for a concession for the lighting of the town by electricity for 30 years. The local administration will supply further particulars.

The "Madrid Gazette" of 20th inst. contains a notice calling for tenders for the electric lighting of Vélez Blanco up to March 1, 1920, on the basis of 110 incandescents (30 16 c.p., 60 10 c.p., and 20 5 c.p.). The upset payment to the Municipality is to be 3,000 pesetas (£92) per annum.

TENDERS RECEIVED AND ACCEPTED.

Barnes District Council received the following tenders for the supply of condensing plant, &c., and an overhead travelling crane, for their electricity works:—

Section E.—*Condensing plant, pumps, oil filters and separators, feed, steam, and exhaust pipes, &c.*

Babcock & Wilcox (*accepted*)	£2,239	Aiton & Co.	£2,596
Cole, Marchent and Morley..	2,860	Alley and MacLellan	2,480
Jas. Simpson & Co.	2,800		

Section F.—*Overhead travelling crane.*

Chatteris Engineering Works Co. (*accepted*)	£264	John Whitley & Co.	£400
		Jas. Carrick & Son	265

The tenders so marked have been accepted on the recommendation of the consulting engineer (Mr. Wm. Fairley).

Dudley Town Council have accepted the tender of the Worthington Pumping Engine Co. for the supply and erection of condensers, pumps, cooling tower, &c., for their electricity works.

The tender of Messrs. Crowther & Co. has been accepted by the Grimsby Corporation for wiring the electricity works.

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APPOINTMENTS VACANT AND FILLED.

Partick Commissioners require a resident engineer to take charge, under the superintendence of their consulting engineers (Messrs. Kincaid, Waller and Manville), of the erection of electric lighting plant and the laying of mains. An advertisement contains further particulars, and applications must be lodged with the town clerk (Mr. James Donaldson), Burgh-chambers, Partick, by Sept. 24.

A superintendent of mains is required by the Salford Electricity Department. Applications to be addressed to the borough electrical engineer (pro tem), Mr. F. A. Wilkinson, Electricity Works, Walness-road, Salford, by Sept. 5. See advertisement.

The Gas and Electric Committee of Belfast Corporation require an assistant electrical engineer to take charge of the meter, motor and testing department. Salary £120 per annum. Applications to the city electrical engineer (Mr. Victor A. H. M'Cowen) by noon of Monday, Sept. 10. See advertisement.

The Jandus Electric Co. (Ltd.), Hartham Works, Hartham-road, London, N., have a vacancy for an assistant electrician. See advertisement.

Sheffield Corporation require a meter superintendent, cable jointers, and an engine driver for their electricity department. Applications to the chief engineer and manager (Mr. S. E. Fedden) by Sept. 6. See advertisement.

Two shift engineers are required for the South Shields Corporation electricity works. Applications to borough electrical engineer (Mr. Jos. A. Jeckell) before Sept. 5. See advertisement.

Four telegraph linesmen are required for the Natal Government Railways. An advertisement contains further particulars, and applications should be addressed to the Agent-General for Natal, 26, Victoria-street, London, S.W.

A demonstrator and assistant lecturer in physics is required for the University College of South Wales and Monmouthshire, Cardiff. Applications to secretary by Sept. 9.

Mr. A. A. Day, chief assistant engineer of the Manchester Corporation electricity department, has been appointed borough electrical engineer of Bolton in succession to Mr. Arthur Ellis, who was recently appointed electric tramway engineer at Cardiff. The commencing salary is £500, advancing by yearly increments of £50 until the maximum of £750 is reached. There were 44 applications for the appointment, and these were first reduced to 12, and then to four, namely, Mr. A. A. Day; Mr. J. A. Jeckell, borough electrical engineer of South Shields; Mr. H. F. Street, borough electrical engineer of Halifax; and Mr. W. R. Wright, borough electrical engineer of Bootle. These appeared before the joint Tramways and Electricity committee on 17th inst., when Mr. Street was conditionally appointed. In this connection it is interesting to note that a special meeting of the Halifax Town Council in committee was held on Thursday last to consider a recommendation from the Gas Committee to increase the salary of Mr. H. F. Street from £400 to £500 per annum. This recommendation was due to the fact that Mr. Street had been offered the latter sum as a commencing salary by the Bolton Corporation. The Halifax Council, after a protracted discussion, however, declined by 18 votes to 17 to sanction the advance.

Bristol Electrical committee have appointed Mr. K. O. Hale clerk of works for the construction of the foundations of the new electricity station buildings at Avonbank.

BUSINESS NOTICES.

Messrs. T. Harrison and M. Brown (trading as Harrison and Brown), electrical engineers, &c., 79, High-bridge, Newcastle-on-Tyne, have dissolved partnership. Debts by Mr. Brown.

Messrs. H. Ambler and P. E. Caswell, electrical accessory factors, trading as Ambler and Caswell, 8 and 9, Lincoln's Inn, Birmingham, have dissolved partnership. Debts by Messrs. Abbott, Deeley, Hill & Co., Bennett's-hill, Birmingham.

Messrs. Holme, Ringer & Co., Chemulpo, Corea, are open to receive catalogues (preferably in duplicate) of electrical and telephonic machinery, overhead and underground telegraph and telephone wires, and general telegraphic, telephonic, and other electrical apparatus.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Wm. Dalzell (trading as Wm. Dalzell & Co.), electrical engineer, Newcastle-on-Tyne, the trustee (Mr. J. G. Gibson) has been released.

A receiving order has been made against F. L. L. Lindsay, electrical and mechanical engineer, Gorphwysfa, Llandegfan, Anglesey, and 216, High-street, Bangor.

In the Court of Session, Edinburgh, last week, a petition for a supervision order in connection with the liquidation of P. C. Middleton & Co. (Ltd.) was heard by Lord Low. The company was incorporated in December, 1898, with a capital of £50,000, in 14,000 ordinary and 36,000 5 per cent. preference shares of £1 each, and 6,153 preference shares and 10,381 ordinary shares were fully paid. The company was formed to carry on the business of electrical engineers, &c., but owing to the whole of its authorised capital not being subscribed, it did not possess sufficient ready money to enable it to carry on its business and to meet its present liabilities. Accordingly the company went into voluntary liquidation, and a liquidator was appointed by the shareholders. In terms of an arrangement, his lordship appointed Mr. R. Reid, advocate, 46A, Union-street, Aberdeen, and Mr. S. Easton Simmers, C.A., 58, Bath-street, Glasgow, joint liquidators, to whom claims against the company are to be sent within 14 days.

Meetings of the shareholders and creditors of the Gutta Percha Corporation (Ltd.) were held in London on Friday last. The chairman (Mr. Winearls, assistant receiver) stated that the company, which was to trade in and manufacture gutta-percha, was promoted by the Omnium Syndicate and the Globe Venture Syndicate. The purchase consideration was £150,000—£120,000 for patent rights, and £30,000 for the stock of gutta-percha leaves and other things sold to the company. The sale was conditional upon the company's proceeding to allotment before Oct. 14, 1897, on a subscription of £30,000, but only £25,280 was subscribed. In spite of favourable reports in the prospectus the company did not appear to have been able to manufacture gutta-percha of marketable value, and its total sales of stock amounted to £14. The action of the directors in proceeding to allotment upon insufficient subscription, contrary to the provisions of the purchase agreement, required further investigation. The statement of affairs disclosed total liabilities £20,303, of which £15,110 were stated to be unsecured, and no available assets, the whole of the amount (£5,195) being covered by debenture bonds. The total deficiencies as regarded creditors and shareholders was returned at £177,067. The official receiver continues to act as liquidator.

Creditors of Easton, Anderson and Goolden (Ltd.), in liquidation (which liquidation has, like many others in the electrical and engineering industries, dawdled on till creditors have become hopeless of any satisfactory outcome), have received a circular, dated Aug. 28, from Mr. W. B. Peat, the liquidator, notifying that the Court has sanctioned a contract for the sale of the business to a new company, to be called Easton & Co. (Ltd.), subject to the calling of meetings of the debenture stockholders and shareholders, and to a reservation as to certain cash assets available for distribution as a first dividend to creditors. A meeting of creditors is called for Wednesday, Sept. 12, at 12:30 p.m., at the Guildhall Tavern, Gresham-street, London, E.C., to consider the conditional agreement sanctioned by the Court. Under this agreement the new company pays interest to the debenture stockholders from July 1 last, and issues to them debenture stock of the new company, which pays as purchase consideration to the old company £252,000—£27,000 in cash, £150,000 in first mortgage debenture stock, £30,000 in preference shares, and £45,000 in ordinary shares. The cash portion of this purchase-money goes to liquidate the arrears of interest on debentures to June 30, 1900, advances made by the receiver, and other expenses. The ordinary shares (£45,000) will be held by the liquidator on account of creditors.

A creditor of the Fowler-Waring Cables Co. (in voluntary liquidation) desires to know the present position of this winding-up and whether the liquidators, who have had this matter in hand so long, will vouchsafe some public statement as to the progress made in the transfer of the business to the Western Electric Co. We ourselves think it due to creditors and others that some such public statement should be made. In the meantime we can only refer our correspondent to the liquidator, Mr. J. A. Blackwood.

While on the subject of these liquidations it would be interesting to have particulars of the final stage of the winding-up of Woodhouse and Rawson (Ltd.). What has become of Mr. Leslie!

Plant for Sale.—Messrs. Fuller, Horsey, Sons and Cassell will sell by auction at the Old Mill Works, Cowley Mill House, near West Drayton, Middlesex, on Thursday, Sept. 20, at 12 noon precisely, a quantity of engineering and electrical plant and machinery, some particulars of which are set out in an advertisement. Catalogues can be had of Messrs. Pond & Sons, 6, Butter Market, Ipswich, and of the auctioneers, 11, Billiter-street, London, E.C.

Water Power for Disposal.—Mr. Frederick Warman, surveyor, 66, Chancery-lane, W.C., is offering water power at Wandsworth, London, S.W. See advertisement.

"Simplex" Conduit.—The Simplex Steel Conduit Co. have issued a new supplementary list to their main catalogue in handy form, and amongst the latest improvements in this type of conduit we illustrate in Fig. 1 a "Simplex" split pendant box with internal dimensions of 2⅛in. by 1¼in. by 1in. This box is provided with bridge terminals and a connection box for connecting by branch circuits from a pair of bars fitted on to porcelain in the box. Fig. 2 shows a set of removable porcelain interiors and connection bars for use in "Simplex" standard junction boxes. This arrangement

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consists of a porcelain cradle which just fits inside the junction box and supports the two brass connecting bars, the latter being made in two parts. The bars are drilled between the supports along their length and terminal screws are fitted to clamp the branch circuit

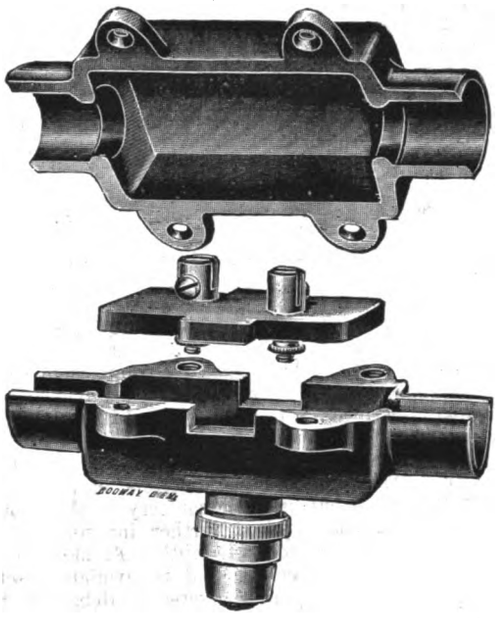

FIG. 1.

wires, a half-lap joint in the middle allowing the two ends to be easily sweated on to the main lead into the thimble-bored ends, which are provided to receive the cable. Amongst other improve-

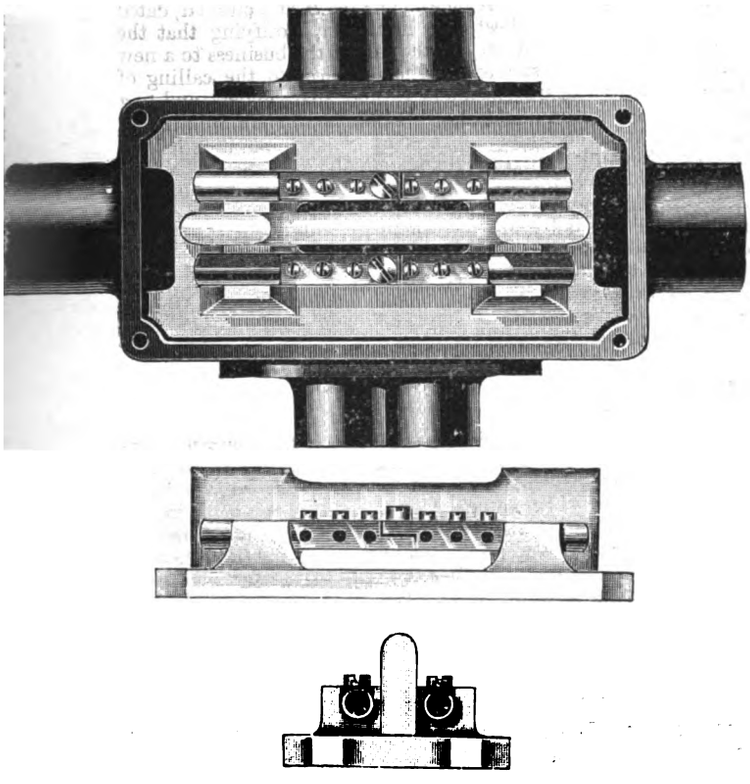

FIG. 2.

ments may be mentioned a screwed brazed conduit of heavy gauge and screwed fittings, for use where a water-tight system is imperative. The list also illustrates a new type of box enamelled iron-cased switch and fuse distributing board fitted with a deep cast-iron glass-fronted cover, which allows the box to be easily wired and the fuses to be readily replaced. Some very cheap "Simplex" brackets are also shown with terminal or through boxes having nipples to suit ⅜in. conduit.

Paris Exhibition Awards.—In extension of the list of awards which appeared on p. 679 of our last issue, we may mention that in Class 15 (scientific instruments) Mr. Mark Barr was awarded a gold medal for a three-dimensional engraving system, the most essential mechanism of which was a microphonic micrometer measuring a length of 4·5in. 10 times in succession within the $\frac{1}{50000}$ part of an inch. Mr. Barr thus secured one of the only four gold medals awarded to English exhibitors of mathematical and scientific instruments.

In connection with the award of a gold medal to the Electrical Power Storage Co., Mr. H. W. Butler, chief engineer to the company, was awarded a silver medal in recognition of the excellence of the manufactures of this exhibit.

In connection with the exhibit of the Simplex Steel Conduit Co., for which a gold medal was awarded, Messrs. L. H. Lander and L. M. Waterhouse were granted a silver medal as "collaborators."

Messrs. A. C. Wells & Co.'s awards included a silver medal for the "Wells' light," a silver medal for their "Lightning" painting machine, and a "mention honourable" for waste oil filters, "Unbreakable" lamps and oil feeders, and "Industrial" lamps.

Messrs. Salviati, Jesurum & Co. (Ltd.), of 14, St. Paul's Churchyard, London, E.C., were awarded a gold medal for electrical chandeliers and other fittings.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 22 to Aug. 28, with the ports of destination :—

Aden—£40 (telegraph apparatus). *Africa*—Alexandria, £83; Beira, £104 (including £44 telegraph material); Durban, £1,353; East London, £78; Port Elizabeth, £148. *Argentina*—Buenos Ayres, £1,112 (including £133 telegraph material). *Australasia*—Adelaide, £1,218 (including £700 telegraph wire); Fremantle, £60; Hobart, £53; Launceston, £214; Lyttleton, £697; Melbourne, £228; Sydney, £948; Wellington, £884 (including £387 telegraph cable). *Brazil*—Bahia, £32; Rio Janeiro, £188,592 (telegraph cable and material). *Ceylon*—Colombo, £81. *China*—Shanghai, £35. *Colombia*—Santos, £17. *Germany*—Hamburg, £1,050 (telegraph material). *Holland*—Amsterdam, £144; Flushing £16. *Hong Kong*—£320. *India*—Bombay, £407; Calcutta, £60; Karachi, £123. *Japan*—Kobe, £33; Nagasaki, £142. *Malta*—£29. *Mauritius*—£74. *Russia*—Libau, £330; St. Petersburg, £175. *Siam*—Bangkok, £110. *Straits Settlements*—Singapore, £166. Total £199,150, against £9,940 in the corresponding week last year (Aug. 23 to Aug. 29).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

June 21, 1900.

11,243. THE BRITISH ELECTRIC WORKS CO. (LTD.) and B. BRANDER. Birmingham. Improvements in polarised electric bells for alternating current.

11,255. A. W. B. PEARSON. London. A new or improved composition used for making electrical insulators and other articles.

11,260. A. TRIBELHORN. London. Improvements in electric accumulators and in electrodes therefor.

11,263. H. HIRST. London. Improvements in or relating to electric lamps and fittings therefor.

11,264. H. HIRST. London. Improvements in or relating to switchboards for electric distribution.

11,272. J. HOFBAUER. London. Improved means of and apparatus for preventing the premature starting of dynamos or the like used in connection with electric lifts.*

11,287. F. JONES. Liverpool. Improvements in or relating to conduits for electric conductors.

June 22, 1900.

11,340. M. FISCHER. Germany. Improvements in and connected with electric clock work.

11,344. W. L. VOELKER. London. Improvements in the manufacture of filaments for incandescing electric lamps.

11,358. H. N. WOLLASTON and J. V. SHERRIN. London. Improvements in or connected with secondary batteries.

11,361. J. G. S. LEE. London. Improvements in ceiling roses or attachments for pendant electric lamps.

June 23, 1900.

11,406. A. ZEHDEN. London. Improvements in the electrical equipment of railway vehicles for the purposes of lighting, skating, and ventilation.*

11,429. M. VOGELSANG and F. LINDENSTRUTH. Liverpool. An improved electromaguet of high attractive force.*

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11,437. E. Risler. London. Improvements in electric insulators.
11,438. Siemens Bros. & Co. (Ltd.), W. Dieselhorst and F. J. Budd. London. Improvements in casings for the jointings of underground electric cables.*

June 25, 1900.

11,471. H. E. Walter. London. Improvements in electro-magnetic brakes.
11,486. J. V. Sherrin. London. Improvements in means for preventing sparking in electric switches, commutators, current conductor contacts, contact breakers, and other electric devices.
11,500. P. H. F. Spies. London. Improvements in arc lamps.
11,519. H. G. Nicholson. London. Improvements in frogs to be used in connection with overhead conductors of electrical tramways and railways.

June 26, 1900.

11,547. G. Hill. Manchester. Improvements in fittings for overhead trolley systems of electric tramways.
11,555. W. L. Wise. London. Improvements in apparatus for driving phonograph cylinders. (The Germania Phonographen Compagnie (Ltd.), Germany.)
11,555. M. W. Hanks. London. Improvements in terminals and supports for Nernst lamp glowers.*
11,557. H. N. Potter. London. Improvements in ballast resistances and cutouts for Nernst lamps.*
11,558. A. J. Wurts. London. Improvements in systems for lighting by Nernst lamps.*
11,559. A. J. Wurts, H. N. Potter, and M. W. Hanks. London. Improvements in starting apparatus and cutouts for Nernst lamps.*
11,560. A. J. Wurts and M. W. Hanks. London. Improvements in terminal connections and supports for Nernst lamps.*
11,561. A. J. Wurts, H. N. Potter, E. Bennett, and M. C. Beebe. London. Improvements in Nernst lamps and heaters therefor.*
11,562. P. C. Hewitt. London. Improvements in electric lighting.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

13,996. Veritys Limited and Ridings. Electric arc lamps.
14,224. Alcock. Apparatus for electrically transmitting orders, signals, or indications from one place to another.
14,467. Pease and Burdon. Electric traction with overhead conductors.
14,568. Eggerding. Electrical alarm apparatus.
14,668. Farrell. Moveable electric lights.
14,906. Davis. Fuse blocks for electric circuits. (Date applied for under International Convention, Jan. 30, 1899.)
14,907. Davis and Wright. Electric circuit breakers. (Date applied for under International Convention, Mar. 23, 1899).
14,908. Mershon. Method of and apparatus for indicating potential in systems of electrical distribution. (Date applied for under International Convention, Feb. 1, 1899.)
14,909. Lamme. Dynamo-electric machines. (Date applied for under International Convention, April 14, 1899.)
15,128. Lucas. Plug contacts or contact plugs for electric circuits.
15,138. Lamme and Mallet. Electric generators and motors. (Date applied for under International Convention, Feb. 6, 1899.)
15,139. Wright and Aalborg. Automatic electric circuit breakers. (Date applied for under International Convention, March 23, 1899.)

1900.

7,567. Brown. Electric bonds for electrically connecting the meeting ends of two contiguous electric conductors.
7,594. Thompson (Hogan). Graphophones or phonographs.
7,606. Lindstrom, Hewitt and Hewitt. Electrical controlling switches.
7,695. Galsworthy. Wall plugs for electric lighting and heating.
7,851. Riebensahm. Electric incandescent lamps.
8,152. Wise (Actien-Gesellschaft Elektricitätswerke vorm. O. L. Kummer & Co.). Electric transformers.
8,160. Ely. Electric switches.
8,239. Siemens Bros. & Co. (Ltd.) (Siemens and Halske Aktien-Gesellschaft). Electricity meters constructed on the Ferraris principle.
8,299. Johnson (Dercum). Two-liquid primary batteries and regenerating the same.
8,300. Johnson (Dercum). Two-liquid primary batteries and regenerating same.
8,433. Dannert. Process for the production of electrically conductive illuminating bodies.
8,476. British Thomson-Houston Co. (Ltd.) and Hobart. Induction electric motors.
8,584. Tosi, De Felice and Parboni. System of electric traction by surface contact.
8,586. A. C. Martin. Galvanic battery.
8,682. Conant. Apparatus for measuring electrical resistances and chiefly intended for testing the electrical resistance of rail joints in the tracks of electric railways. (Date applied for under International Convention, Nov. 13, 1899.)
8,894. Koller. Electric smelting furnaces.
9,331. Haas. Electrolysing apparatus.
9,398. Doersch. Electric shampooing apparatus.
9,464. Husselman. Manufacture of filaments for incandescent electric lights.
9,503. Bergmann. Electric igniters for explosion engines.

NEW COMPANIES, STATUTORY RETURNS, &c.

ABERDARE ELECTRIC LIGHT CO. (LTD.)—This company was registered on Aug. 23, with a capital of £2,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for light, heat, motive power or other purposes.

FINCHLEY ELECTRIC LIGHT CO. (LTD.)—This company was registered on Aug. 22, with a capital of £3,000 in £1 shares, to acquire from Mr. M. W. Woods the concession for supplying electric light and power on the Finchley Manor estate, and to carry on the business of an electricity supply company in all its branches. The subscribers are C. H. Cribb, consulting chemist, L. Bradley, electrical engineer, M. W. Woods, electrical engineer, A. W. Marshall, electrical engineer, A. W. Sclater, electrical engineer, W. A. Hogarth, and W. R. Estall. Mr. M. W. Woods is a permanent director.

HUMPAGE, JACQUES AND PEDERSEN (LTD.)—This company was registered on Aug. 24, with a capital of £10,000 in £1 shares (3,500 preference), to carry on the business of electrical, mechanical, and general engineers, tool makers, &c. The first directors are M. Pedersen, J. Harrop, and T. Humpage.

UNION CABLE CO. (LTD.)—This company was registered on Aug. 24, with a capital of £25,000 in £1 shares, to manufacture and deal in submarine and other cables, telegraphs, telephones, and electrical appliances and apparatus, and to carry on the business of cable and rope manufacturers, mechanical and electrical engineers, &c. The subscribers (with one share each) are E. E. O Pelland (electrical engineer), A. J. Wilson, F. H. Miller, E. A. Rehder, J. V. Varela, G. Runge, and R. W. Cawse.

BRITISH THOMSON-HOUSTON CO. (LTD.)—According to the annual return to Aug. 6 the capital is £400,000, in £10 shares, all of which have been taken up. £10 has been called up on each of 16,531 and £3 10s. on each of 16,000 shares, and £221,310 has been received. 7,469 shares are considered as fully paid.

CALCUTTA TRAMWAYS CO. (LTD.)—In the annual return to July 31 the capital is given as £350,000, in 35,000 shares of £10 each, 34,440 of which have been taken up. £10 has been called up or credited as paid on each share, and £159,300 has been received. £185,100 is considered as paid on 29,090 shares.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The annual return to June 22 gives the capital as £120,000, in 60,000 ordinary and 60,000 preference shares of £1 each, all of which have been taken up.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The annual return to Aug. 14 has been filed. The capital is £1,000,000, in 150,000 "A" and 50,000 "B" shares of £5 each, of which 116,400 "A" and 23,564 "B" shares have been taken up. 10s. has been called up on each of 89,261 "A" and £44,630. 10s. has been received. £456,667. 10s. is considered as paid on 10,000 "A" (£3 credited), 89,261 "A" (£2 10s. credited), and 17,139 "A" and 23,564 "B" (credited as fully paid).

ELECTRIC CONSTRUCTION CO. (LTD.)—The annual return to July 26 gives the capital as £400,000, in 150,000 ordinary and 50,000 preference shares of £2 each, of which 112,100 ordinary and 25,000 preference have been taken up. £2 per share has been called up and paid on 2,100 ordinary and 11,855 preference shares. £246,290 is considered as paid on 110,000 ordinary and 13,145 preference shares.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—According to the annual return, to Aug. 10, the capital is £5,000,000, in 250,000 preference and 250,000 ordinary shares of £10 each, of which 180,042 preference and 180,227 ordinary shares have been taken up and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28⅜d. per oz. (Aug. 30). Consols (2¾ per cent.) 98¼—98⅜ for money, 98¼—99⅜ for account; 2½ per cent. 97½—97⅝ (Aug. 30). Stocks and Shares Continuation Day, Sep. 12; Ticket Day, Sep. 13; Pay Day, Sep. 14; Mining Share Carry-over Day, Sep. 11.

ALUMINIUM AND CASTNER-KELLNER ALKALI AMALGAMATION.—The necessary resolutions for the amalgamation of the Aluminium and the Castner-Kellner Alkali Companies have been passed at meetings of members of both companies.

BLACKPOOL AND FLEETWOOD TRAMROADS CO.—The half-yearly meeting was held on August 23. The chairman (Mr. G. Richardson) regretted the decrease in the receipts over the corresponding period last year. The weather had affected their tramway in a manner greater than most tramways, because they had more holiday and fine weather traffic than any other tramway in the kingdom. They had carried 660,006 passengers during the half-year, the gross receipts being £10,125. 17s. 2d. The cost of maintenance was £363. 19s. 1d., against £466. 17s. for the June half-year 1899. Generation expenses, in consequence of the price of coal, had shown an increased expenditure of about £200. The traffic expenses were £2,249. 19s. 3d., a slight increase; and the general expenses showed a decrease of about £20. The expense per mile was 7¾d., against 8¼d. for the corresponding half-year of 1899. In the December half of 1899 the expense per mile was only 7¼d. The receipts per mile were 11½d.

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MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—A meeting is to be held on the 5th prox. to consider and confirm a proposal to issue £25,000 additional capital in this company at £3 per share. The shares will be offered in the first place to shareholders.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—At an extraordinary meeting on Friday last, presided over by Mr. S. Gedge, M.P., the resolutions passed on 8th inst., increasing the ordinary capital from £150,000 to £200,000 (by the creation of 10,000 additional £5 ordinary shares), and the preference capital by the creation of 10,000 additional £5 preference shares were confirmed. The chairman announced that it had been decided to offer the new ordinary shares at £10 each, and shareholders would receive an allotment of one-sixth of their present holding.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Sept. 13 a special settling day in £125,000 4½ per cent. debenture stock of the *Potteries Electric Traction Co. (Ltd.)*, and has ordered the stock, as well as the further issue of 9,400 ordinary £5 fully-paid shares (Nos. 17,401 to 17,407 and 26,108 to 35,000) of *Edmundson's Electricity Corporation (Ltd.)*, to be quoted in the Official List.

WINDERMERE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The annual meeting was held on Monday. The chairman (Mr. W. Long) stated that the trading profit for the year was £1,112, and after payment of interest, &c., there was a balance of £970, and of this £949 had been applied to payment of dividend on the preference shares and the remainder carried forward. The company had acquired the undertaking of the Keswick Electric Lighting Co., and had come to an arrangement with the Ambleside Council to take over their provisional order on favourable terms. Mr. J. S. Raworth regretted the non-payment of a dividend on the ordinary shares. The directors had come to the conclusion to raise the price of current for lighting from 6d. to 7½d. per unit. In reply to a question, the managing director (Mr. F. Fowkes) said the company had no connection with the British Electric Traction Co. further than having entered into a contract to supply that company with electrical energy as soon as the Lake District tramway of that company was constructed.

WIRRAL RAILWAY CO.—At the half-yearly meeting the chairman (Mr. T. A. Jackson) stated that, having obtained powers to work the line by electricity, the change would be proceeded with when a favourable opportunity presented itself. The directors anticipated good results from the change in motive power.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Aug. 25	4,434	+ 11	7	31,903	+ 1,335
Blackpool Corporation...	„ 23	1,793	+ 487	21	17,681	+ 3,911
Blackpool and Fleetwood	„ 25	1,845	- 245	8	11,605	- 385
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 26	454	+ 64	21	10,473	+ 1,841
Brisbane Trams	July 11	1,669	+ 352	1	1,669	+ 352
*Bristol Trams & Carriage	Aug. 24	3,454	- 239	8	28,546	- 594
*Buenos Ayres & Belgrano	July 29	1,849	- 391	4	8,497	- 836
Central London Railway	Aug. 25	4,385	- 194	4	18,329	...
City & South London Ry.	„ 26	1,473	+ 578	8	12,008	+ 4,346
Cork Elec. Trams	„ 23	463	- 42	34	13,702	+ 1,199
Dover Corporation	„ 25	324	- 22	21	4,965	+ 323
Dublin & Lucan Rly. ...	...	...	...	...	...	...
Dublin United	„ 24	3,759	- 236	8	30,867	+ 2549
Dublin Southern Dist....	„ 24	1,049	- 591	8	9,002	
*Glasgow Corporation ...	„ 25	8,867	- 871	...	...	...
Hull Corporation	„ 25	1,296	+ 680	8	10,730	+ 6,086
*Liverpool Corporation...	„ 18	9,461	+1,812	33	250,616	+28,595
Liverpool Overhead Rly.	„ 26	1,767	- 132	8	13,960	+ 299
*Sheffield Tramways	„ 26	2,507	+1,045	34	73,211	+25,813

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 22.	Price Wednesday, Aug. 29.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 29. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£96,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	58 61	58 61	6 0 11	Feb., May, Aug., Nov.	60½	58
£2,088,640	Stock	20/0	Do. Preferred	110½ 111½	110½ 111½	5 7 7	„ „	111⅝	110½
£2,088,640	Stock	27/0	Do. Deferred	12⅜ 13	12⅛ 12⅜	10 11 8	„ „	12 1/16	12⅜
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	10 ½	10.½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,600	50	4½%	Do. 4½ per Cent. Debentures	100% 104%	100% 104%	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	11 11½	11 11½	6 1 9	Jan., Apr., July, Oct.	11½	11
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	145 150	145 150	4 13 4	Jan., Apr., July, Oct.	147½	145
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	96 99	97 100	3 10 2	„ „	...	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	111 116	3 9 0	May and November ...	...	...
250,000	10	2/6	Eastern Extension.....	14⅜ 15½	14⅜ 15½	4 11 10	Jan., Apr., July, Oct.	15 1/16	14⅜
£230,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110 115	110 115	3 9 7	February and August	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	99 102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) .	103% 103%	103% 103%	3 17 8	May and November ...	...	...
180,237	10	4/6	Globe Telegraph and Trust ..... x d	11 11½	11 11½	4 11 10	Jan., Apr., July, Oct.	11⅝	11½
180,042	10	3/0	Do. 6 per Cent. Preference..... x d	14⅜ 15½	14⅜ 15½	3 19 0	„ „	14⅝	...
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July.....	...	...
£24,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) ..	98 101	98 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	51 55	51 55	4 10 11	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	105 108	5 11 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 9	June and December ...	...	...
11,839	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October.....	...	...
3,331	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	93 101	98 101	5 0 4	March and September	...	...
20,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 18 7	January and July.....	...	...
22,321	10	1/0	West India and Panama	⅜ ⅝	⅜ ⅝	...	May and November ...	...	...
24,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	7	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference.....	6 7	5 6	10 0 0	„ „	...	...
£20,000	100	5%	* Do. 5 per Cent. Debentures	102 105	102 105	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ..	...	...	4 15 3	June and December ...	...	...
207,220	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜ 15½	14⅜ 15½	4 11 10	Mar., June, Oct., Dec.	15 1/16	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	... ...	... ...	...	July	...	...
272,680	1	2½%	Monte Video Telephone Ordinary	⅜ ½	⅜ ½	5 0 0	November	...	...
86,402	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
590,000	5	3/0	National	4⅜ 4⅞	4⅜ 4⅞	6 3 1	February and August	4 1/16	4 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	13 15	13 15	4 0 0	„ „	13⅜	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	12 14	13 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	4⅜ 5⅛	4⅜ 5⅛	4 17 7	„ „	5 1/16	5
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December ...	99⅛	99½
1171,50	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,00	5	4/6	United River Plate	4½ 5½	4½ 5½	6 13 4	July	...	...
16,62	5	2/6	Do. 5% Cumulative Preference.....	5 5½	4½ 5½	4 15 3	June and December ...	...	...
£179,94	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 22.	Price Wednesday, Aug. 29.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 29. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	El'ekh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞ ⅞	⅞ ⅞	...	...		
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref. x^	9½ 10½	9½ 10½	4 5 9	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord. xd	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference ..... xd	8½ 9½	8½ 9½	3 13 8	March and September	8½	8½
30,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6 6½	6 6½	...	...	6⅛	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp. xd	9 10	9 10	4 12 6	February and August	...	...
30,000	5	2/3	Do. 4½ per Cent. Preference ..... xd	5 7½	5½ 8½	3 19 3	" "	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7½	6½ 7½	4 0 0	March	6½	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	105 111	103 111	4 1 6	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	7½ 8½	7½ 8½	4 14 2	February and August	8½	8
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 16 0	January and July	12½	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 128	123 128	3 18 5	June and December	121½	...
40,000	10	4/0	County of London and Brush Prov. Ordinary ... xd	8½ 9½	8½ 9½	6 6 4	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference ..... xd	11 12	11 12	5 0 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1½	1 1½	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	3½ 4½	3½ 4½	6 13 4	...	4½	4
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	98 103	99 101	3 19 9	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord. ..... xd	14 15	14 15	3 13 4	April and October	14½	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December	...	...
£135,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 99	93 96	3 11 6	...	97½	96½
6,452	10	6/0	Notting Hill Electric Ordinary	14½ 15½	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5½ 6½	5½ 6½	3 16 11	"	...	...
300,000	1	8%	Rand Electric	⅞ 1	⅞ 1	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'st'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 16 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	" "	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14 15	14 15	4 16 8	February and August	14⅞	14½
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 3	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3 4	3 4	...	...	...	...
79,200	5	5/0	Westminster Electric Supply Ordinary ..... xd	12 13	12 13	5 0 0	March and September	13½	13½
29,437	5	...	Do. £1 10s. paid	8½ 9½	8½ 9½	...	...	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref. ..... xd	⅞ 1⅛	⅞ 1⅛	4 8 11	...	...	...
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞ 1	⅞ 1	6 17 2	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅝ ¾	⅝ ¾	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅞ 1	⅞ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½ 12½	11½ 12½	4 0 0	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5½ 6½	5½ 6½	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4½ 5½	4½ 5½	...	...	...	...
90,060	2	1/2½	Brush Electrical Engineering	1⅜ 1⅝	1⅜ 1⅝	4 5 4	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	2½ 3⅛	2½ 3⅛	5 1 1	"	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103 113	108 113	4 1 1	February and August	...	...
£106,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 103	101 103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13 14	13 14	5 7 2	" "	13⅛	13
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6½	5½ 6½	4 6 11	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	6 8 0	...	1⅛	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾ 1	¾ 1	5 6 8	...	...	...
32,098	3	2/-⅜	Crompton and Co. (Nos. 1 to 24,065)	3½ 4½	3½ 4½	5 5 10	January and July	4⅛	4
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 101	4 18 0	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,361	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	1½ 2⅛	1½ 2⅛	3 0 0	February and August	...	...
17,139	5	2/9½	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	" "	...	...
£344,028	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91 93	89 91	4 8 2	June and December	92½	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	63 73	63 73	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4½ 5	4½ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 103	4 8 3	...	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	1⅞ 2⅛	1⅞ 2⅛	5 13 11	January and July	1⅞	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½ 3½	2½ 3½	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 103	102 103	3 16 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary	13 14	13½ 13⅝	7 0 9	February and August	12⅞	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5 5½	5 5½	4 1 10	" "	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	" "	2⅛	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 104	101 104	3 17 10	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	85 89	85 89	4 12 4	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1900	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6½	5½ 5½	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½ 11½	10½ 11¢	5 4 4	April and October	11½	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7	6½ 7	4 5 9	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	106½	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	14 16	5 6 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103 105	103 105	4 17 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21½ 23½	21½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd.)	10½ 11½	10½ 11½	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 123	118 123	3 6 1	February and August	...	...
13,000	10	5/0	British Columbia Electric Railway 5% Pref.	10 10½	10 10½	4 15 3	May and November	...	...
46,000	10	11/0	British Elec. Trac. Ord.	14 15	14½ 15½	6 9 0	...	15½	14½
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12⅝	12½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123 123	123 123	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	121 124	121 124	...	...	123½	123
40,000	5	2/8 3/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 105	103 103	4 15 0	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	93 99	96 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10 10½	9½ 10½	2 18 6	June and December	10½	9½
£955,000	Stock	1½%	City and South London Railway Con. Ordinary	55 58	57 60	2 6 0	February and August	...	...
37,500	10	1/3 1/10	Do. (Nos. 22,501 to 60,000)	5 6	5 6	2 9 4	" "	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	133 143	139 143	3 9 11	" "	...	...
£300,000	Stock	5%	Do. (1898)	130 135	130 135	3 14 1	...	133	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	21 23	21 21	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15	14½ 15	3 19 8	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	... ...	... ...	...	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	⅞ 1	⅞ 1	4 17 7	" "	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'st'n 5% Pref.	9⅛ 10⅛	... ...	4 8 11	May and November	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary	8⅛ 9⅛	8⅛ 9	4 15 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13½	3 15 6	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	103 105	102 105	3 16 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 3⅝	3½ 3⅝	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	... ...	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½ 10¾	... ...	4 15 3	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12⅜	11½ 12⅜	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	90 93	91 94	3 3 10	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,164. [No. Vol. 20. XLV.] FRIDAY, SEPTEMBER 7, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30c., or 70pf.

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NOTES.

THE annual meeting of the British Association for the Advancement of Science was inaugurated at Bradford on Wednesday. The public proceedings commenced with the presidential address of Sir WILLIAM TURNER, the eminent Professor of Anatomy at Edinburgh University. The PRESIDENT took for his subject the cell theory of life, and sketched in an interesting and instructive manner the progress of knowledge of living tissue. The subject has just this much in common with electrical science, and indeed with all scientific inquiry, that it admirably illustrates how advance has always been made by the unfolding or evolution of previous discoveries. Thus, from a knowledge of the essential relation of tissue to life, biologists passed to the establishment of the essentially cellular nature of all tissue, and at the present stage the internal structure of the cell itself is being gradually unfolded. Prior to the inaugural address, at a meeting of the General Committee, the question was raised as to the admission of women as members of the General and Sectional Committees. A motion, advocating their admission, was brought forward by Prof. HARTOG and seconded by Prof. SILVANUS P. THOMPSON, and after some debate was carried by a substantial majority. Before, however, this proposal can be practically adopted, it must go before the Committee of Recommendations, and be subsequently reported by this committee to another meeting of the General Committee. It is to be hoped this routine can be gone through before the Bradford meeting is concluded. The meetings of the various sections began yesterday with the delivery of the presidential addresses. We commence this week a full report of Dr. LARMOR's address to Section A, the subject of which will be found of extreme interest to students of the dynamics of the ether in relation to electrical and magnetic phenomena.

THE inquiry of the Board of Trade Commissioners on the boiler explosion which took place on July 25 last at the Crystal Palace District Electric Supply Co's. works at Sydenham practically attributes the disaster to a boiler badly made in the first instance, and badly looked after during its use. Although constructed only nine years ago, and apparently built for a working pressure of 140lbs.—at about which pressure it has been in actual use—the boiler-makers had employed cast-iron, in place of a more reliable metal, for such important details as some of the stays supporting the crown of the firebox. Messrs. HORNSBY & SONS freely admitted at the inquiry that the boiler was defective, but pleaded that at the time the boiler was made they had in their employ an engineer who subsequently had been dismissed for passing bad work! The Engine, Boiler and Employers' Liability Insurance Co.'s inspector appears also to have been at fault, the Commissioners stating that he had not, in their opinion, made adequate examination of the boiler. Moreover, the Commissioners appear to have thought that, besides his electrical and other qualifications, the resident chief engineer and manager, Mr. A. L. PHILLIPS, ought to be a boiler expert. The Crystal Palace District Supply Co. were ordered to pay £150 towards the costs of the inquiry, and the above-named insurance company £50; but the boiler makers were let off because the boiler was made so long ago! Surely this last was a curious reading of the Statute of Limitations, when it is remembered that the makers admit having built the boiler with inherently defective parts, the failure of which was the immediate cause of the explosion. If, as we understand, Messrs. HORNSBY are cautioning users of this type of boiler against their continued use, and undertake to overhaul these boilers free of charge, some good may come from the inquiry, which does not seem to have altogether placed the burden of guilt, if we may so term it, upon the right shoulders. A feature of the case was a singularly inconsequent report upon the boiler by another insurance office expert.

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THE correspondence columns of *The Times* recently have given expression to a not altogether unnatural anxiety on the part of the general public to know what may be expected to happen when a train of the Central London Railway type of underground railway is brought to a standstill midway between two stations through temporary stoppage of electric power. Suffocation in Egyptian darkness seems to be the fate most feared. We hasten to say that no fate is more improbable. The deserved popularity of the "Twopenny Tube" need suffer no detraction on account of such fears, which are utterly baseless. Even the discomfort of being plunged into darkness need not occur, for lights other than the electric lamps are provided on every train. As to suffocation, the numerous shafts at the stations along the line, to say nothing of trains moving in other parts of the tunnels, must maintain a continual circulation of fresh air. On this subject Sir BENJAMIN BAKER has sent an authoritative —if in some parts gruesome—letter to *The Times*, which we reprint below :—

In reply to the inquiry of "A. F. B.," as to what would happen in the event of a train filled with passengers being stopped for half-an-hour in the middle of a tunnel on the Central London Railway or other of similar construction, will you permit me to say that the purity of the air breathed by the passengers would be practically unaffected, but that the temperature might appear somewhat high in contrast to the cold tunnel unless the end doors and side ventilators were all kept open? Numerous experiments on a scientific basis have proved that the oppressive condition of air sometimes complained of in railway carriages above or below ground is related to the temperature and not to the purity of the air; so that, whilst in summer people may complain of being suffocated though all the carriage windows are open, in winter they feel no such oppression though they remain all night in a well-filled carriage with every window and ventilator studiously closed. It has been practically demonstrated by physiological and chemical experiments that a live man might be sealed up in a lead coffin for half-an-hour without any resultant feeling of oppression—I say nothing of depression—provided he were treated as frozen mutton in a cold store, so that the air he breathed, though astoundingly foul from repeated breathing, might still remain cold. The worst that could happen from a stoppage of many hours in a small tunnel would be that some of the passengers might get as warm as if they were in the cheap seats of a theatre, assuming they remained in the carriages, which is not at all likely, as convenient gangways are provided along which passengers could walk to the nearest station, and supplementary lights are available in the event of a breakdown of the ordinary system.

AN important change in the system of electric supply at Sheffield has been proposed by the City electrical engineer, Mr. S. E. FEDDEN, in a report dated 24th August, reprinted on another page. From the outset Sheffield has been under the disadvantage of having a high-frequency alternate-current system of supply. This, combined with various troubles from time to time in the working of the plant, has tended to hinder the natural growth of the load. It will readily be seen that as regards motor load this high frequency is practically fatal. It is not at Sheffield only that supply station engineers have had to grapple with this same difficulty. In some places it has been solved by conversion from the alternating to the continuous-current system, in others by the introduction of supplementary continuous-current plant for a separate motor load, and in still other places polyphase machinery has been introduced. There have been alternate-current systems, however, which, owing to being planned at the start to work on a low frequency, have been able to develop a considerable motor load: the municipal station at Derby is a notable instance. The problem presented to Mr. FEDDEN, therefore, has been to select the best of several practicable solutions; and he has recommended his Electric Light Committee to adopt that one which certainly would involve the least possible change in the existing works, viz., to adhere to the single-phase alternate system, but to reduce the frequency from 100 ∿ to 50 ∿. Evidently Mr. FEDDEN has become a disciple of Mr. FERRANTI, who, on several occasions recently, has preached the efficacy of the low-frequency single-phase current for general supply to lamps and motors. Mr. FEDDEN's report has been referred to Mr. R. HAMMOND, and we understand that Mr. HAMMOND's report on it is about to be forwarded to the Committee. Meanwhile, Mr. FEDDEN is accompanying a deputation, consisting of the Chairman and Vice-Chairman of the Committee, to the Paris Exhibition, where the latest electrical machinery is to be inspected, and from thence to Frankfort, where there is a magnificent object lesson in single-phase electrical distribution for lighting and power.

ON February 11, 1898, we announced than an ingenious telegraphic instrument, invented by Messrs. CREHORE and SQUIER, and called by them a synchronograph, had been tested on the British Post Office land lines, the longest loop tried being 1,097 miles in length—viz., from London to Glasgow and back by different routes. Considerable development in this instrument, we believe, has taken place since that date, and at the International Electrical Congress at Paris, in the Telegraphy and Telephony Section, on the 23rd ult., a Paper was communicated by the joint inventors, giving a description of their latest practice with this instrument. An abstract of the Paper appears in our issue this week. In the discussion which followed the reading of the Paper, Mr. GAVEY, of the General Post Office, commented on the claims made by the authors as to the relative increase in transmitting speed, and described some of the experience on British lines. He stated that as they could always get full speed out of the ordinary Wheatstone system anywhere within the limits of the British Isles, by the use of repeating instruments, the Crehore and Squier system of sinusoidal transmission had not been adopted. He further considered that the results obtained by the inventors compared none too favourably with the British Wheatstone practice, because it was necessary for the inventors to experiment with their system at night or at other times when the neighbouring wires were quiet, and he believed that in the busy hours with other land lines at work, the inductive disturbances would greatly reduce the apparent advantage. We hope at an early date to give some further particulars of the sinusoidal system of operating the Wheatstone receiver.

Cable Interruptions :—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

University College, Nottingham.—The next session commences on Oct. 8th, and courses of instruction in mechanical, electrical and civil engineering extending over two and three years are given at this college. Prospectuses can be obtained from the secretary.

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A False Alarm.—The rumour having been circulated that the fire in the subway at Charing Cross *originated* with the telephone wires, we may assure our readers that such was not the case. Telephone wires, our non-electrical readers may care to know, are not a source of fire risk.

Northampton Institute (Clerkenwell, London).—In addition to the engineering day courses at this Institute, evening technical courses have been added in all branches of electrical and mechanical engineering. These classes will commence on Monday, Sept. 24. Particulars can be obtained at the Institute or of the principal, Dr. R. Mullineux Walmsley.

Iron and Steel Institute.—Arrangements have been made for holding a meeting of the above Institute in Paris from Sept. 17 to Sept. 20. On the 18th inst. the President will deliver an address in the Hall of the Société d' Encouragement, and a number of Papers will be read and discussed, while on the following day the remainder of the Papers will be disposed of. The rest of the visit will be occupied in paying visits, attending receptions, &c. A detailed programme may be obtained of the secretary, at 28, Victoria-street, S.W.

Paris Exhibition Literature.—The second part of "L'Electricité à l'Exposition, de 1900," which is being edited by MM. Hospitalier and Montpellier and published by Vve. Charles Dunod (Paris) has just appeared. It is from the pen of M. Montpellier himself, and deals with the continuous-current dynamos generating current for the light and power supply of the exhibition. The machines are taken *seriatim* and a condensed description of each is given, the two German continuous-current machines being omitted however. There appears to be no attempt at literary style, the particulars of the machinery being simply written down in short sentences, most of which commence with "le," "la," or "les." Some good drawings illustrate the text, however, but the photographic views of the various units are for the most part badly executed. The volume should be useful as a record, and we look forward to reading the next number, already due, on the alternating-current sets.

The German-American Cable.—A Reuter's telegram, dated the 31st ult., announces that Herr von Podbielski, the German Secretary of State, has received the following telegram from the German Emperor:—

I am much pleased at the successful completion of the laying of the cable between Emden and New York. I give you my best thanks for the intelligence, and congratulate you on the speedy execution of this work, which is of such importance for our Fatherland, and which, as I confidently expect, will contribute to strengthen and increase the relations between two friendly peoples. As an expression of my satisfaction with your successful efforts, I appoint you *à la suite* of the Third Regiment of Ziethen Hussars. WILHELM, I.R.

His Majesty also sent the following telegram to President McKinley:—

On the opening day of the new cable, which brings Germany into the closest telegraphic communication with the United States, it gives me pleasure to express to your Excellency my satisfaction at the completion of this important work of peace. I am sure that I am at one with your Excellency in wishing and hoping that this cable communication will further the well-being, and will contribute to the maintenance of the friendly relations existing between our two countries. WILHELM, I.R.

President McKinley replied as follows:—

To his Majesty Emperor and King William II., Berlin.

I have received with great pleasure your Majesty's telegram of congratulation on the occasion of the inauguration of the cable, which completes the net of closer communication between this country and the German Empire. In this age of progress every tie which draws nations nearer together in their commercial and friendly relations and in their general well-being cannot fail to strengthen their cordial relations, and speed them on their mutual advance along the path of peace.

Traction Electrolysis at Providence, R.I.—Investigations have recently been carried out at Providence, R.I., to determine the danger from electrolysis due to traction earth currents, and a report has been drawn up by Mr. A. A. Knudson, of New York. Most of the electrolytic troubles are accounted for by bad bonding or broken bonds. In some cases the voltage between the tracks was as high as 5 volts. The following extract from the report gives a description of the condition of the pipes after excavation:—

At the 11 excavations made the water mains were carefully examined for evidence of electrolysis, and tests for current flow through them were made at each place. Most of them were in soil which was sandy, and in some cases hardly damp, although there had been recent rain; this condition of soil is not such as to favour the flow of current from the mains owing to its high electrical resistance, and thereby to cause electrolytic action at such points. In some cases, however, where the soil was more favourable, and the current flow in the main excessive, electrolysis pittings have been found, but not of an immediately serious nature so far as could be seen, as in all except one case the action was found on the bell end of the joint, where the metal is heavier than at other portions. The exception mentioned was at the excavation on Hartford-avenue, near the junction of Plainfield-street and Manton-avenue, where the effects of electrolysis were found at the spigot side of a joint, the current of the pipe flowing in the reverse direction in relation to the joint. This is a condition which should cause concern and warrant early attention, for although the damage is not serious, as found at this point, there may be many other joints in this main located where more favourable conditions prevail to cause electrolysis to be more active and damaging.

A Selector System of Typewriting Telegraphy.—A typewriting telegraph embodying several novel features has recently been brought out in America by Messrs. Z. G. Sholes and A. C. Gilmore of Chicago. One of the principal features of this instrument is that the signals are transmitted over an ordinary telegraph line by Morse dots and dashes. The transmitting instrument consists of a typewriter resembling an ordinary Remington-Sholes machine with an electric sending apparatus attached. This sending attachment consists of a contact drum which is driven one revolution, by a tiny electric motor, every time that a typewriter key is depressed. When a key is depressed and while the contact cylinder is making its one revolution, a contact finger corresponding to the letter struck is brought down against the cylinder. Upon the cylinder are contact strips corresponding to each letter as arranged on the Morse alphabet. The revolution of the cylinder therefore transmits the Morse signal for that letter. At the receiving end a relay is operated which works the receiving apparatus in the following manner. The impulses from the line are received by means of an electromagnetic selector apparatus which separates the several batches of signals. By means of a contact arm moving over contacts, the different combinations of dots and dashes that form each separate letter are made to operate the keys of the receiving typewriter through the agency of a number of electromagnets placed underneath the instrument. We understand that messages have been transmitted with this instrument over 265 miles of the Central Union Telephone Co.'s lines in Illinois. The speed at present attained is said to be about the same as that of an average telegraph operator. A recent issue of the *Western Electrician* of Chicago gives an illustration of this instrument together with further particulars of its construction.

Gas Polarisation in Lead Accumulators.—Messrs. Nernst & Dolezalek, commenting on this subject in the *Zeitschrift für Elektrochemie*, say that, according to the theory of the liberation of hydrogen on metals which Caspari has been recently seeking to verify experimentally (*Zeitschr. Physikal. Chem.*, 1899, Vol. XXX., p. 89), there is a term to be taken into account in addition to that which represents the energy requisite for the decomposition of the electrolyte, and this term depends on a specific property of the electrodes themselves, and is probably greater the smaller the amount of hydrogen which has to be abstracted by them. As lead has this property in a very small degree the work which is necessary for the formation of hydrogen bubbles in the electrolysis of dilute sulphuric acid is considerably greater on a lead surface than on one of platinum. Therefore, in the electrolysis of dilute sulphuric acid containing lead sulphate in solution, not hydrogen, but lead is formed. Lead sulphate immersed in dilute sulphuric acid in a platinum vessel was not reduced by a current of 0·02 ampere with a current density per square centimetre of 0·0004 ampere acting on it for a week, but it was reduced in a lead vessel. According to this the potential difference between platinum and lead peroxide is 1·60 volt, and between lead and lead peroxide is 1·92 volt. If the current density is 0·01 ampere per square centimetre, then the hydrogen is formed under such high pressure on the platinum surface that a reduction of lead sulphate takes place, and the same reasoning can be applied to the case of the separation of oxygen. This abnormal behaviour of lead also explains the sharp rise in E.M.F. which takes

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place at the end of charge. During the greater part of charge the acid is saturated with lead sulphate owing to the presence of dense sulphate on the electrodes, but at the end nearly all the sulphate is used up, and what is present in solution is therefore quickly electrolysed out of it, which results in the concentration of the lead ions rapidly decreasing, with a consequent rise of E.M.F. Very soon therefore the lead solution becomes so dilute that the work requisite to separate lead from it becomes as great as that which is requisite for the separation of hydrogen from a lead surface. After this the separation of lead ceases and that of hydrogen begins, and analagous changes occur at the lead peroxide electrode. If an accumulator which has been overcharged is left at rest on open circuit the ever-present lead sulphate diffuses out of the pores of the plate, quickly reducing the E.M.F. to the normal. The high potential which is noticed at the end of charge is therefore due, according to this hypothesis, to the formation of a lead sulphate concentration couple in the accumulator. In the case of mercury the evolution of hydrogen is more difficult than in that of lead, and when a lead plate is amalgamated the evolution of hydrogen does not start till a higher potential difference is reached, and in consequence a larger part of the active material takes part in the reaction. This explains the well-known effect of the mercury salts in increasing the capacity of the cell.

An American Report on Steel Rails.—The American delegates to the International Railway Congress at Paris appointed to report for all countries, except the United States, as to the nature of rail steel, have prepared their report. Our readers are aware that America has taken the lead in the matter of using high grade steel for tramway and railway rails, and that only recently has this country begun to follow the practice. The report states that on the Continent hard steel is now universally acknowledged to be superior to soft steel for rails, as it resists better the crushing action of heavy locomotive wheel loads, and improvements in metallurgical processes now enable hard steel rails to be rolled without danger of brittleness. Both acid and basic steel are used, the latter on a large number of lines. The report refers to a remarkable case of rail wear on the Western Railway of France, where some 89lb. basic steel rails which had been in service seven years at stations, where they were subject to the braking action of the wheels, were worn down 1·06in. on the head, after carrying a traffic of 450,000 trains, without producing an uneven surface. When it is considered that the wear which rails will ordinarily stand is $\frac{1}{4}$in. to $\frac{1}{2}$in., in most cases $\frac{3}{8}$in., this record speaks well for basic steel. The report produces some evidence to show that the hardness (percentage of carbon) should be increased with increase in weight of rail, one reason stated specifically being that in light and heavy rails, made by the same process from steel showing the same tensile strength in both, the metal in the heavier rails appeared to be less homogenous and offered less resistance to wear. On the wear of rails the information produced by the report was gathered from widely varying results. For instance, on the Kaiser Ferdinand's road in Austria the average wear per 100,000 trains amounted to 0·039in., while on the Northern Railway of France the wear was 0·078in. per 100,000 trains, under similar conditions. The report as to wear on the railways of Great Britain and colonies states that information received on this subject is vague and indefinite in regard to such particulars as grades, tonnage, number of trains, &c. On the London and South-Western Railway, bull-headed rails weighing 82lb. per yard lost 15 per cent. of their weight in 15 years, while 88lb. T-rails laid in a tunnel lost 10 per cent. of their weight in nine years; the same rails under heavy traffic on open track lost 15 per cent. of their weight in five years, while rails of the same weight in a different track lost only 6 per cent. during the same time. In the practice with the railways of Great Britain and colonies most companies specify metal having an ultimate tensile strength of 40 tons to 50 tons per square inch, and in addition to this some companies specify that metal of this strength must show an elongation of 15 per cent. to 20 per cent. Acid steel is used in all cases and is made by both the open hearth and Bessemer processes, more generally by the latter. The percentages of carbon runs pretty generally from 0·35 per cent. to 0·50 per cent. Some of the companies leave the technical conditions of manufacture to the discretion of the manufacturer, stipulating that certain tests shall be made, while others exercise a considerable amount of precaution as to the handling of the metal during manufacture, specifying the minimum size of ingot, hammered and reheated ingots and the cropping of all doubtful metal from the ends of rails. On the whole the report shows some differences between European and American practice and many points of similarity. An important difference is in the use of basic steel and steel made by the open-hearth process, neither practice having as yet gained a foothold in America. On proportioning the metal between head and base and as to the preference for the use of hard steel the practice in Europe is similar to their own. Hammered ingots were once the rule in America, but the practice was abandoned many years ago.

Railways and Moving Platforms.—We reprint below a remarkable letter from Prof. John Perry which appeared in *Nature* last week. Prof. Perry claims to have invented, about 20 years ago, a method of entering and leaving moving trains, which may be regarded as containing the germ of the idea of moving platforms and stairways so recently grown popular. Although the subject is not directly electrical, our readers will readily perceive that if the scheme is to be put into practice it can only be by the application of electric power:—

About 20 years ago I was in the habit of speaking with Prof. Ayrton and other friends about a scheme which might increase ten-fold the carrying capacity of the Underground Railway. I prepared a letter for *The Times* newspaper about two years ago, but at the earnest entreaty of a friend I applied for patent protection for the scheme, and did not publish the letter. I have not proceeded with the patent, and wish now that I had published the letter. Indeed, I wish that, instead of merely talking the matter over with friends 20 years ago, I had published what I had to say. Travelling now on the new Central London Railway, one feels that there is enormous waste of energy and of time in starting and stopping the trains. Again, a train must not be longer than the platform. On my scheme the train does not stop, and the longer it is the better. Indeed, I can imagine an endless train keeping a perfectly constant speed all the time. My scheme is easy enough to understand now that moving platforms are common. After passengers enter a station I get them gradually into a state of motion, so that moving alongside the train, and at the same speed, they may enter and other passengers may leave. There are many ways in which the scheme may be carried out. From a wayside station passengers may enter an express train which does not stop in the following way: They enter a small train at the station; this train gradually gets up a speed equal to that of the express; it runs alongside the express at a particularly well-laid part of the line; there is an exchange of passengers, and the local train gradually comes to rest again at the station. For the Underground Railway the method which most commended itself to Prof. Ayrton and me long ago was this: At a station, say St. James's Park, the platform was a carefully contructed turntable, 500ft. in diameter, the rim of which travelled at 8 miles per hour. The whole area was not really a floor; it was only a skeleton of a turntable, being an outer rim 8ft. broad and many radial passages. The very long train to Mansion House, travelling at 8 miles per hour, was close to the rim of the turntable; indeed geared with it in a rough, simple manner for less than half its circumference; the train from Mansion House did the same on the other side. I need not speak of the automatic opening and closing of the doors of the train. A passenger—let us say second class for Mansion House, takes his ticket and descends a spiral staircase, which revolves so slowly that even the frailest and most timid of old ladies is not frightened; in fact, it revolves on its own axis once in 134 seconds. At the bottom the passenger sees a few notices; one of them saying second class, Mansion House, has a hand pointing along a radial passage, and this is followed. As the passenger moves radially, he does not notice that he is gradually getting up speed circumferentially. He does not notice that the floor gets slightly inclined as he moves out, to counteract the small effect of centrifugal force. When he reaches the outside of the platform he probably finds a train there, seemingly at rest, with the doors open, and he enters it, moving perhaps along the platform, choosing one compartment rather than another. If he is lucky he has about one minute in which to make his choice. But he will notice near him on the platform an altering time signal which tells him how much more time he has to waste: 50sec., 40sec. or 30sec., or 20sec., or 10sec. If he delays after the signal says 0, an iron railing will come between him and the train; he will see the train moving laterally away from the platform, and he must wait 74sec. before he sees a train coming laterally towards him; the railing goes away, and he has again 60sec. in which to enter. If he had a third-class to South Kensington, he would have proceeded in exactly the same way. Also every passenger wanting to leave the train at St. James's Park had 60sec. in which to do it. Trains at 16 miles an hour would give only half these times. A platform of only 250ft. diameter would give only half the time if the train speed was 8 miles an hour. I need not dwell upon the details of this and other methods which suggest themselves. It may be soon or syne, but I feel sure—I have felt sure for many years—that my method will have to be adopted.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Spectrum of Radium.—Demarçay has given a list of 15 spectrum lines due to "radium." C. Runge points out, however, that the accuracy of Demarçay's determinations is not very great, the error being about 0·7 of an Angström unit. Hence Demarçay's line 4,688·0 might be anywhere between 4,682·3 and 4,688·7. But in this interval there are no less than six Fraunhofer lines, according to Rowland, and that makes the evidence for the separate identity of radium very much feebler than it was. Runge has therefore re-determined the spectrum of radio-active barium chloride with a greater dispersive power than that employed by Demarçay, and has been able to definitely locate three of Demarçay's lines. These are situated at 4,826·14, 4,682·346, and 3,814·591 respectively. The remainder were either invisible, or were found in the spectrum of barium chloride when free from radium. An economical method of spectroscopy was that of dipping a thin platinum wire into the powdered preparation and heating the wire by means of an electric current until a bead was formed, which was then made an anode in a spark-gap. But it is possible that the luminous intensity attained was not great enough to reveal some of the feebler lines described by Demarçay. In any case, the existence of at least three characteristic lines may be taken as definitely proved. They are not contained in the solar spectrum.

[C. Runge, *Ann. der Physik*, No. 8, 1900.]

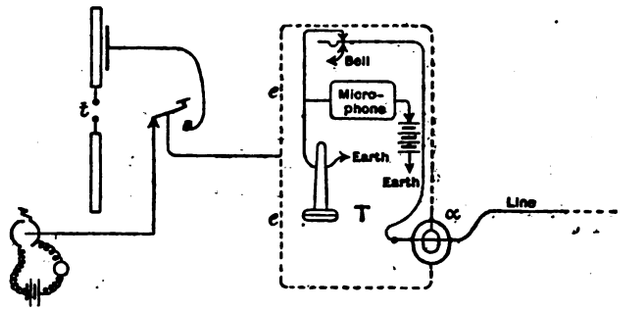
Atomic Weight of Radium.—Madame Curie has made considerable progress lately towards the eventual isolation of pure radium. The latest product only contains traces of barium, and may be regarded as practically pure radium chloride. But the quantity of the salt so far available is too small to determine the atomic weight of radium from it, and the authoress has had to content herself with a determination of the atomic weight of the mixed metallic base contained in a product rich in radium. The atomic weight of pure barium is 137·5. The value for the mixed product found last November was 146, and the latest value is 174. The two last figures mark the very considerable advance made in the last half-year towards the purification of the radium salt. How high the atomic weight of radium is cannot at present be even guessed at, since there is no means of determining the proportion of radium in the salt, and the spectroscope only yields very rough quantitative indications. But it is safe to say that it is very high. Radio-activity seems, in fact, to be conditioned by a high atomic weight, just as if the heavier atoms had more negative electrons to spare. It is to be hoped that, in spite of the difficulty and costliness of the work involved, the atomic weight of radium will soon be obtained from the pure chloride.

[Madame Curie, *Comptes Rendus*, August 6, 1900.]

Circuit of Electrolytes.—Electrolysis without electrodes has already been satisfactorily carried out by means of liquid electrolytes moving in a magnetic field. Camichel and Swyngedauw now describe some new arrangements, one of which proves that an electrolyte can be traversed by a current without any electrolysis taking place, or at least none which involves the evolution of gas. The authors induced an alternating current in an electrolytic circuit (acidulated water of density 1·25) contained in a glass tube, under conditions in which a voltameter should have given several cubic centimetres of gas, but none was produced. In another experiment, a spiral tube of ebonite was wound about the primary coil of a transformer and inside the secondary coil, and the circuit was completed by means of a glass tube, the whole having a resistance of some 70 ohms. A constantan-iron thermo-couple indicated a rise of temperature of the order which could be expected in consideration of the experimental data. The authors also formed an electrolytic chain consisting of sulphuric acid, sodium chloride, and potash, separated presumably by porous partitions. The contact surfaces were renewed by continuous circulation. But the sensitiveness of the galvanometer employed was not sufficient to place in evidence the current probably generated.

[Camichel and Swyngedauw, *Comptes Rendus*, August 6, 1900.]

Simultaneous Telegraphy and Telephony.—A. Turpain has devised a means of utilising a telephone circuit for the transmission of simultaneous telegraphic messages by employing wire waves generated by a Lecher oscillator. The main difficulty employed lies in protecting the telephone circuit from the effect of the waves. This is done by enclosing the telephone apparatus T (see diagram) in a cabin papered with



tinfoil *e*. The line wire traverses a vacuum tube inserted in the wall. It is surrounded by a wire ring not in contact with it, but in touch with the tinfoil. This tinfoil is connected with the resonator *t*. It captures the waves and thus leaves the telephone undisturbed.

[A. Turpain, *Journ. de Physique*, August, 1900.]

Measurement of Electric Absorption.—Rowland has described an arrangement for measuring the residual charge of a condenser, or what is now generally termed electric absorption, consisting essentially of a Wheatstone bridge, in which the fixed coils of an electrodynamometer are placed in one arm of the bridge and the hanging-coil in the cross-connection, where the galvanometer is ordinarily inserted. The adjustment of the bridge thus used depends upon the fact that there will be no deflection of the electrodynamometer if the phase-difference of the current in the fixed coils and those in the hanging-coil is 90deg. L. M. Potts has tested this method and found it very satisfactory. The electric absorption always acts as a resistance in series with a capacity. This resistance is independent of the current. The temperature has a decided effect, the absorption increasing very rapidly with rising temperature. Both the capacity and the resistance depend upon the period of the current. The method is very useful for determining the capacity of a condenser showing electric absorption. The method given by Rowland for the detection of short circuits in coils proves to be an exceedingly sensitive one, and his method for the measurement of losses due to hysteresis and Foucault currents gives very good results, its chief advantage lying in the fact that only small quantities—say a few hundred grammes—of the substance are necessary.

[L. M. Potts, *Am. Journ. of Science*, August, 1900.]

Electrification by Ice.—In the course of some experiments on liquid air, H. Ebert and B. A. Hoffmann noticed that a body suspended above the surface of the liquid acquired a strong negative charge. A series of test experiments revealed the fact that this charge is not due to the liquid air itself, but to the friction of minute particles of very cold ice suspended in it. The authors even succeeded in constructing a kind of electrifying machine by means of a tube containing a piece of wire gauze through which the vapour of liquid air was driven. This phenomenon of electrification should be allowed for in all experiments with liquid air, as it may account for many errors and anomalies. Ice acquires a positive charge by friction with any metal, and imparts to the metal, and other bodies also, a negative charge. It appears to be the more active in this respect, the colder and the drier it is. This may account for the strong electric effects of polar snowstorms. Even in our latitudes, ascending currents of air soon reach elevations at which all their water freezes, and the friction of the ice crystals against suspended dust particles would account for part of the atmospheric electrification. In the highest regions, a friction between atmospheric ice and cosmic dust, together with solar ionisation and the consequent conductivity of the atmosphere, might account for the luminescence often observed, and even for the aurora.

[Ebert and Hoffmann, *Ann. der Physik*, No. 8, 1900.]

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THE CENTRAL LONDON RAILWAY.

(*Continued from page 557.*)

In our last article we brought to a conclusion our description of the power station and its equipment. We have now to consider the means for the transmission of power to the various sub-stations, and afterwards its distribution along the line.

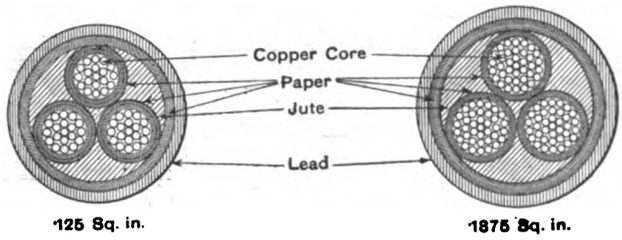

FIG. 35.—SECTION OF HIGH-PRESSURE CABLES.

Three-phase Feeders.—The 5,000-volt three-phase current is conducted from the power station through four independent

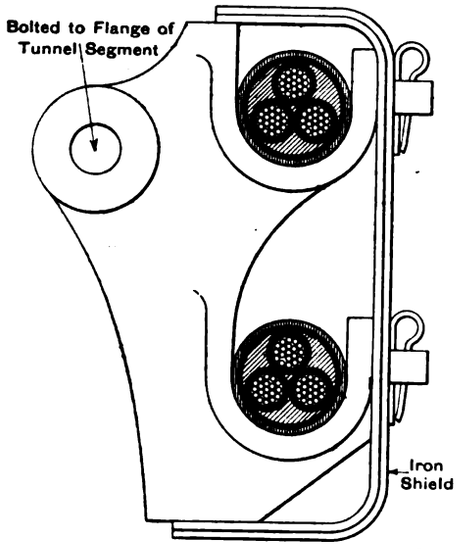

FIG. 36.—SECTION OF CABLE SUPPORT AND SHIELD.

feeders. These are three-core, paper insulated, lead-covered cables (Fig. 35), tested to 15,000 volts, and also to one hour's

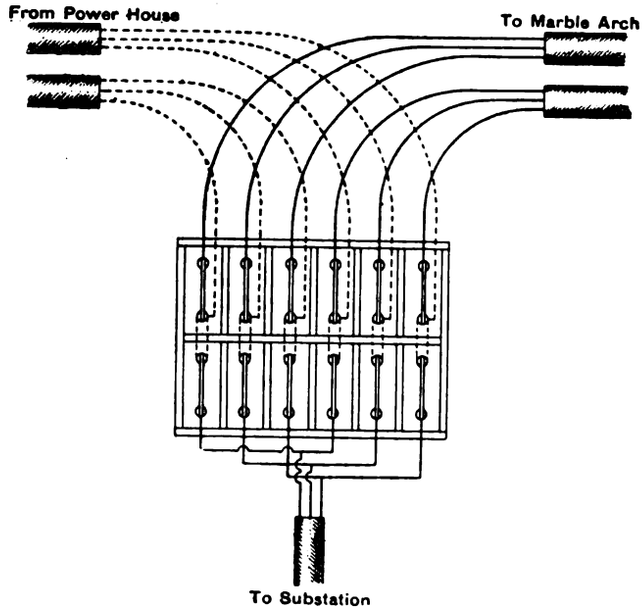

FIG. 37.—ONE OF THE HIGH-PRESSURE CONNECTION BOXES AT NOTTING HILL GATE STATION.

10,000 volts test—firstly, between the different cores, and subsequently from the cores to earth. Capacity tests have been made as follows, the figures giving the capacity per mile: Between one core and the other two cores and the sheathing, 0·88 microfarads; between one core and the other two cores alone, 0·82 microfarads; and between one core and one other core, 0·23 microfarads. The cables are conveyed in a special tunnel together with the test cables, &c., to the

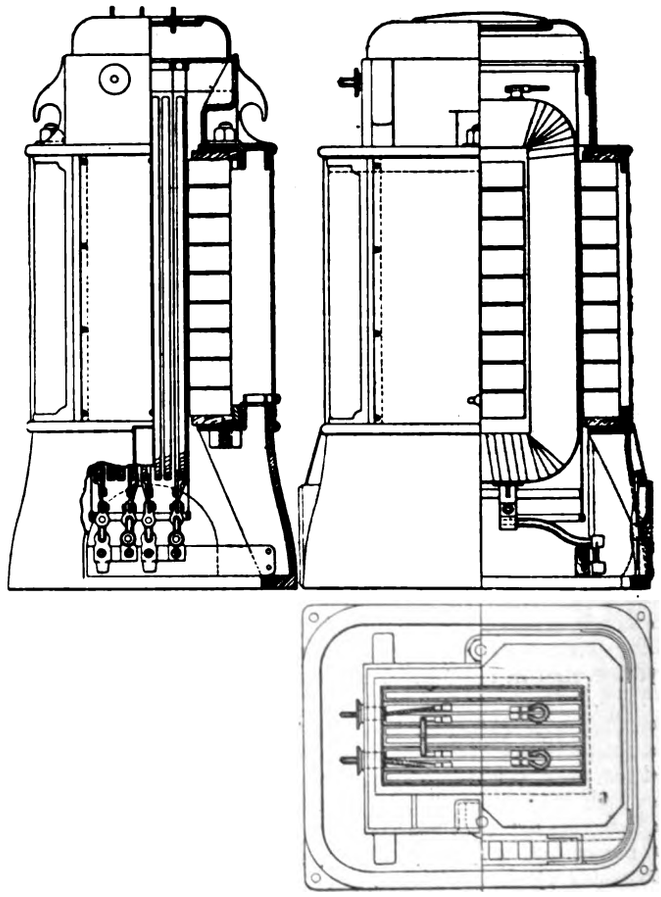

FIG. 38.—ONE OF THE 300KW. TRANSFORMERS.

entrance of the railway tunnel, where they are brought down to the side of the tunnel and carried on brackets protected by sheet-iron shields, as shown in Fig. 36. Two cables are in the down tunnel and two in the up tunnel. At Notting Hill Gate station, where the first sub-station is erected, there is a small brick chamber in each tunnel within which is mounted

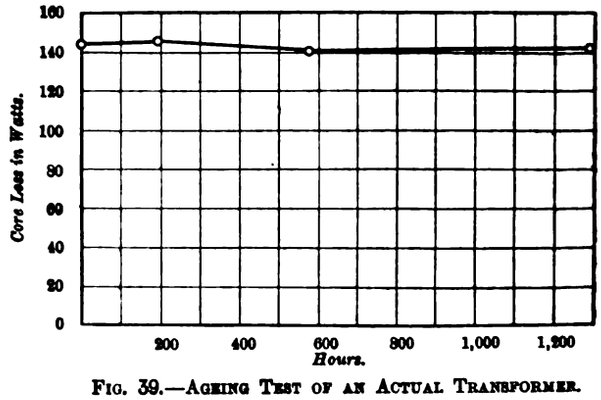

FIG. 39.—AGEING TEST OF AN ACTUAL TRANSFORMER.
The temperature of the core was maintained at 80° C. during the test.

a marble connection box, shown in Fig. 37. Here three 37/16 cables are carried from the three cores of each of the four cables to the sub-station. By means of this small switchboard one or more of the four cables can be cut out of service, or

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an entire sub-station can be completely cut off from the three-phase system. From the power-house to the Notting Hill Gate station each three-phase feeder has a total copper section of

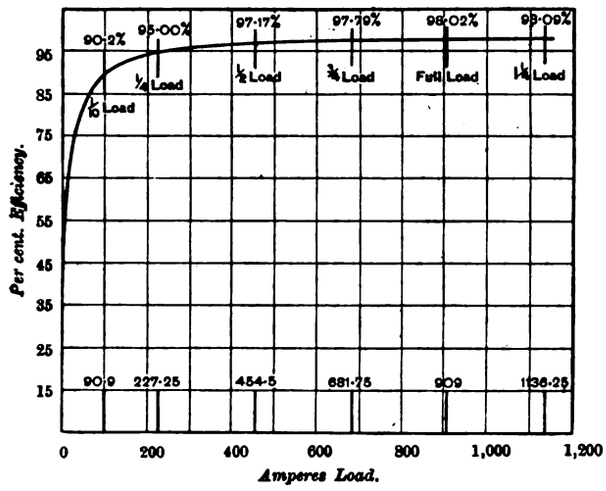

FIG. 40.—EFFICIENCY CURVE OF TRANSFORMER.

0·1875 sq. in., but from the Notting Hill Gate station to the Marble Arch sub-station the cross section is reduced to 0·125 sq. in. Only two cables—viz., one in each tunnel, is

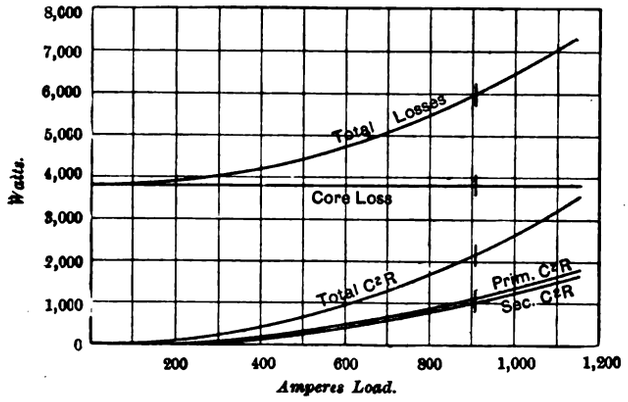

FIG. 41.—LOSS CURVES OF TRANSFORMER.

brought into the sub-station at Marble Arch the other two proceeding direct with undiminished copper section to the Post Office sub-station where they are carried direct to the

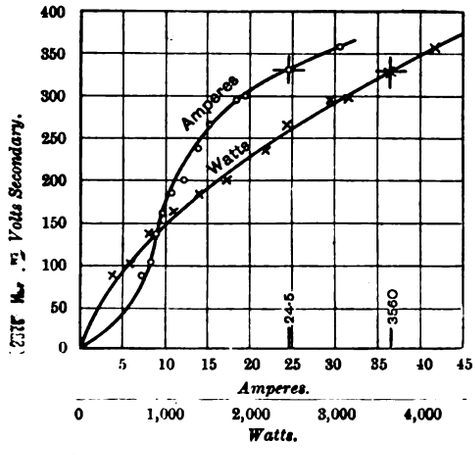

FIG. 42.—AIR BLAST TRANSFORMER CORE LOSS CURVES.

feeder panels without an intermediate connection box. The high-pressure supply is not carried beyond this point at present. The following table gives some additional data relating to the three-phase cables.

	0·1875 sq. in. cores.		0·125 sq. in. cores.
Lbs. copper per cable per 1,000ft. length	2,140	...	1,425
Lbs. insulation per cable per 1,000ft. length	1,090	...	995
Lbs. lead per cable per 1,000ft. length	3,870	...	3,480
Lbs. weight complete cable per 1,000ft. length	7,100	...	5,900
Lbs. weight complete cable per cubic inch	0·166	...	0·165
Average specific gravity complete cable	4·6	...	4·6
Total weight of copper in all high-pressure cables	78·4 tons.		
Total length of all high-pressure cables	19·6 miles.		
Outside diameter	2⅛in.	...	1 1/16in.

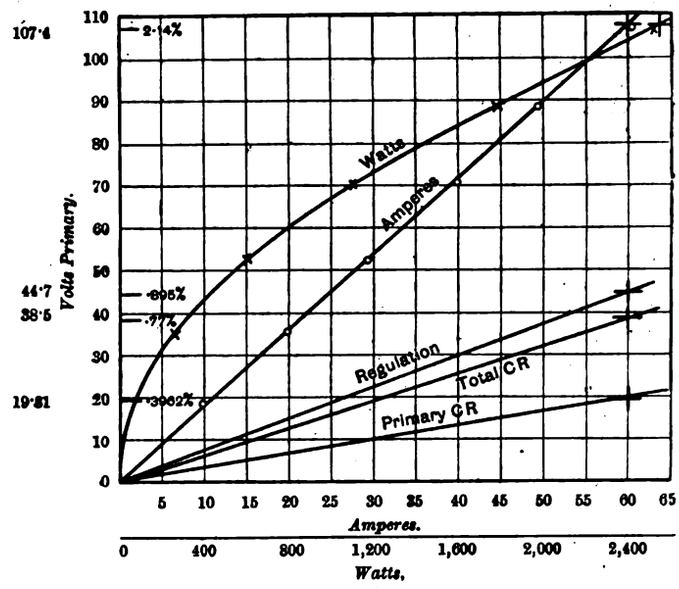

FIG. 43.—AIR BLAST TRANSFORMER IMPEDANCE CURVES.

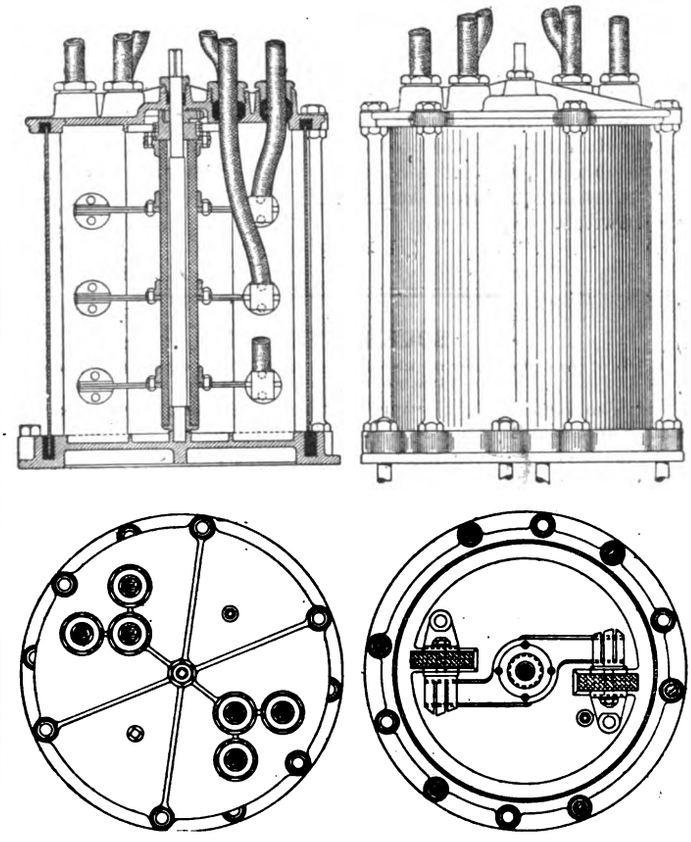

FIG. 44.—THREE-PHASE OIL SWITCH. STEEL CYLINDER PATTERN.
5,000 volts, 400 amperes. Scale: One-twelfth full size.

Equipment of the Sub-stations.—Although the actual arrangement of the plant differs at the various sub-stations to suit the local circumstances, the equipment of each sub-station is the same. It will be unnecessary, therefore, to describe

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more than one of these stations. Our illustrations, where they differ from the general arrangements, relate to the Notting Hill Gate station. Each station is provided with seven stationary transformers each of 800kw. capacity, two rotatory converters each of 900kw. capacity and two blower sets. There is also, of course, a switchboard for controlling the three-phase and continuous-current connections.

The static transformers, one of which is shown in Fig. 38, have their primaries wound for 5,000 volts and their secondary coils for 330 volts. By means of the blowers, to be described presently, a forced circulation of air is maintained around and through the coils, vertically through the cells and horizontally through the armature laminations. The primaries of the transformers are connected in delta arrangement to the three-phase circuit. The core is built up of laminated iron 0·014in. thick, arranged horizontally, and forming a double magnetic circuit round the coils; each sheet is japanned separately to reduce the eddy current losses to a minimum. The iron used is of a special quality, having high permeability and low hysteresis loss, and is not subject to deterioration due to ageing. A curve showing the actual ageing is given in Fig. 39. Ventilating ducts are left between the laminations at intervals of a few inches. The coils, which are form-wound, are arranged vertically, there being four primary and four secondary sections. Earth shields are placed between the primary and secondary sections, and ventilating ducts are left to admit of the maximum cooling surface for the coils. The method of cooling by forced ventilation consists in drawing air through the transformer by means of blowers. The ventilation can be regulated by means of adjustable dampers situated at the top and side of the transformer case. The case of each transformer is connected through the base to an air chamber running under the bank of transformers, and the air from this is exhausted by means of two blowers furnished by the Buffalo Forge Co., and driven by three-phase 6 H.P. induction motors having squirrel cage armatures. Either or both blower sets can be used, but one is sufficient for ordinary need, the other being held in reserve. Figs. 40 to 43 give characteristic curves for the transformers, showing efficiency, losses, impedance, and core loss, &c. Both primary and secondary coils of the transformers are connected to double pole switches on the switchboard, so that any or all of the transformers may be used as circumstances require. Fig. 44 shows the three-phase oil switch.

(To be continued.)

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"The Rubber Industry in the British South Africa Company's Territories." By P. Lyttelton Gell. (London: British South Africa Co.).

"The Inventor's Adviser, or Every Man's Own Patent Agent," by R. Haddan. Fifth edition. (London: Harrison & Sons.) 5s.

"L'Electricité à l'Exposition de 1900." Edited by MM. E. Hospitalier and J. A. Montpellier. Part 2. (Paris: Vve. Ch. Dunod.)

"Die Finanzielle Zukunft der Bau-und Betriebsgesellschaft für Stadtische Strassenbahnen in Wien." By Fritz Golwig. (Vienna: F. Deuticke.) 4.20 marks.

The Electric Equipment of the New York Elevated Railways.—Mr. W. E. Baker, the superintendent of the electric construction of the Manhattan Railway of New York has announced that the first electrically-equipped train may be expected to run on this railway about the 15th inst. The first section to be completely equipped is the Second Avenue line, on account of its proximity to the power station. The total capacity of the new power station will be 64,000 H.P., and the maximum horse-power, exclusive of storage plant, which will be erected at the sub-stations, will aggregate 100,000 H.P. Each train will be equipped with four 100 H.P. motors.

DR. JOSEPH LARMOR'S PRESIDENTIAL ADDRESS TO A SECTION OF THE BRITISH ASSOCIATION AT BRADFORD.*

It is fitting that before entering upon the business of the Section we should pause to take note of the losses which our department of science has recently sustained. The fame of Bertrand, apart from his official position as secretary of the French Academy of Sciences, was long ago universally established by his classical treatise on the "Infiniteaimal Calculus": it has been of late years sustained by the luminous exposition and searching criticism of his books on the "Theory of Probability and Thermodynamics and Electricity." The debt which we owe to that other veteran, G. Wiedemann, both on account of his own researches, which take us back to the modern revival of experimental physics, and for his great and indispensable thesaurus of the science of electricity, cannot easily be overstated. By the death of Sophus Lie, following soon after his return to a chair in his native country Norway, we have lost one of the great constructive mathematicians of the century, who has in various directions fundamentally expanded the methods and conceptions of analysis by reverting to the fountain of direct geometrical intuition. In Italy the death of Beltrami has removed an investigator whose influence has been equally marked on the theories of transcendental geometry and on the progress of mathematical physics. In our own country we have lost in D. E. Hughes one of the great scientific inventors of the age; while we specially deplore the removal, in his early prime, of one who has recently been well known at these meetings, Thomas Preston, whose experimental investigations on the relations between magnetism and light, combined with his great powers of lucid exposition, marked out for him a brilliant future.

Perhaps the most important event of general scientific interest during the past year has been the definite undertaking of the great task of the international co-ordination of scientific literature, and it may be in some measure in the prolonged conferences that were necessitated by that object that the recently announced international federation of scientific academies has had its origin. In the important task of rendering accessible the stores of scientific knowledge the British Association, and in particular this section of it, has played the part of pioneer. Our annual volumes have long been classical, through the splendid reports of the progress of the different branches of knowledge that have been from time to time contributed to them by the foremost British men of science, and our work in this direction has received the compliment of successful imitation by the sister associations on the Continent. The usual conferences connected with our department of scientific activity have been this year notably augmented by the very successful international congresses of mathematicians and of physicists which met a few weeks ago in Paris. The three volumes of reports on the progress of physical science during the last 10 years, for which we are indebted to the initiative of the French Physical Society, will provide an admirable conspectus of the present trend of activity, and form a permanent record for the history of our subject. Another very powerful auxiliary to progress is now being rapidly provided by the republication, in suitable form and within reasonable time, of the collected works of the masters of our science. We have quite recently received, in a large quarto volume, the mass of most important unpublished work that was left behind him by the late Prof. J. C. Adams; the zealous care of Prof. Sampson has worked up into order the more pure astronomical part of the volume; while the great undertaking, spread over many years, of the complete determination of the secular change of the magnetic condition of the earth, for which the practical preparations had been set on foot by Gauss himself, has been prepared for the press by Prof. W. G. Adams. By the publication of the first volume of Lord Rayleigh's papers a series of memoirs which have formed a main stimulus to the progress of mathematical physics in this country during the past 20 years has become generally accessible. The completed series will form a landmark for the end of the century that may be compared with Young's "Lectures on Natural Philosophy" for its beginning.

The recent reconstruction of the University of London, and the foundation of the University of Birmingham, will, it is to be hoped, give greater freedom to the work of our University Colleges. The system of examinations has formed an admirable stimulus to the effective acquisition of that general knowledge which is a necessary part of all education. So long as the examiner recognises that his function is a responsible and influential one, which is to be taken seriously from the point of view of moulding the teaching in places where external guidance is helpful, test by examination will remain a most valuable means of extending the area of higher education. Except for workers in rapidly progressive branches of technical science, a broad education seems better adapted to the purposes of life than special training over a narrow range; and it is difficult to see how a reasonably elastic examination test can be considered

* Delivered Sept. 6, 1900.

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as a hardship. But the case is changed when preparation for a specialised scientific profession, or mastery of the lines of attack in an unsolved problem, is the object. The general education has then been presumably finished; in expanding departments of knowledge, variety rather than uniformity of training should be the aim, and the genius of a great teacher should be allowed free play without external trammels. It would appear that in this country we have recently been liable to unduly mix up two methods. We have been starting students on the special and lengthy, though very instructive, processes which are known as original research at an age when their time would be more profitably employed in rapidly acquiring a broad basis of knowledge. As a result we have been extending the examination test from the general knowledge to which it is admirably suited into the specialised activity which is best left to the stimulus of personal interest. Informal contact with competent advisers, themselves imbued with the scientific spirit, who can point the way towards direct appreciation of the works of the masters of the science, is far more effective than detailed instruction at second hand as regards growing subjects that have not yet taken on an authoritative form of exposition. Fortunately there seems to be now no lack of such teachers to meet the requirements of the technical colleges that are being established throughout the country.

The famous treatise which opened the modern era by treating magnetism and electricity on a scientific basis appeared just 300 years ago. The author (William Gilbert, M.D., of Colchester) passed from the Grammar School of his native town to St. John's College, Cambridge; soon after taking his first degree, in 1560, he became a Fellow of the College, and seems to have remained in residence, and taken part in its affairs for about 10 years. All through his subsequent career, both at Colchester and afterwards at London, where he attained the highest position in his profession, he was an exact and diligent explorer, first of chemical and then of magnetic and electric phenomena. In the words of the historian Hallam, writing in 1839, "in his Latin treatise on the Magnet he not only collected all the knowledge which others had possessed, but he became at once the father of experimental philosophy in this island"; and no demur would be raised if Hallam's restriction to this country were removed. Working nearly a century before the time when the astronomical discoveries of Newton had originated the idea of attraction at a distance, he established a complete formulation of the interaction of magnets by what we now call the exploration of their fields of force. His analysis of the facts of magnetic influence, and incidentally of the points in which it differs from electric influence, is virtually the one which Faraday re-introduced. A cardinal advance was achieved, at a time when the Copernican Astronomy had still largely to make its way, by assigning the behaviour of the compass and the dip needle to the fact that the earth itself is a great magnet, by whose field of influence they are controlled. His book passed through many editions on the Continent within 40 years: it won the high praise of Galileo. Gilbert has been called "the father of modern electricity" by Priestley, and "the Galileo of magnetism" by Poggendorff.

When the British Association last met at Bradford in 1873 the modern theory which largely reverts to Gilbert's way of formulation, and refers electric and magnetic phenomena to the activity of the æther instead of attractions at a distance, was of recent growth: it had received its classical exposition only two years before by the publication of Clerk Maxwell's treatise. The new doctrine was already widely received in England on its own independent merits. On the Continent it was engaging the strenuous attention of Helmholtz, whose series of memoirs, deeply probing the new ideas in their relation to the prevalent and fairly successful theories of direct action across space, had begun to appear in 1870. During many years the search for crucial experiments that would go beyond the results equally explained by both views met with small success; it was not until 1887 that Hertz, by the discovery of the æthereal radiation of long wave-length emitted from electric oscillators, verified the hypothesis of Faraday and Maxwell and initiated a new era in the practical development of physical science. The experimental field thus opened up was soon fully occupied both in this country and abroad; and the borderland between the sciences of optics and electricity is now being rapidly explored. The extension of experimental knowledge was simultaneous with increased attention to directness of explanation; the expositions of Heaviside and Hertz and other writers fixed attention, in a manner already briefly exemplified by Maxwell himself, on the inherent simplicity of the completed æthereal scheme, when once the theoretical scaffolding employed in its construction and dynamical consolidation is removed; while Poynting's beautiful corollary specifying the path of the transmission of energy through the æther has brought the theory into simple relations with the applications of electrodynamics. Equally striking has been the great mastery obtained during the last 20 years over the practical manipulation of electric power. The installation of electric wires as the nerves connecting different regions of the earth had attained the rank of accomplised fact so long ago as 1857, when the first Atlantic cable was laid. It was largely the theoretical and practical difficulties, many of them unforeseen, encountered in carrying that great undertaking to a successful issue, that necessitated the elaboration by Lord Kelvin and his coadjutors of convenient methods and instruments for the exact measurement of electric quantities, and thus prepared the foundation for the more recent practical developments in other directions. On the other hand, the methods of theoretical explanation have been in turn improved and simplified through the new ways of considering the phenomena which have been evolved in the course of practical advances on a large scale, such as the improvement of dynamo armatures, the conception and utilisation of magnetic circuits, and the transmission of power by alternating currents. In our time the relations of civilised life have been already perhaps more profoundly altered than ever before, owing to the establishment of practically instantaneous electric communication between all parts of the world. The employment of the same subtle agency is now rapidly superseding the artificial reciprocating engines and other contrivances for the manipulation of mechanical power that were introduced with the employment of steam. The possibilities of transmitting power to great distances at enormous tension, and therefore with very slight waste, along lines merely suspended in the air, are being practically realised; and the advantages thence derived are increased manifold by the almost automatic manner in which the electric power can be transformed into mechanical rotation at the very point where it is desired to apply it. The energy is transmitted at such lightning speed that at a given instant only an exceedingly minute portion of it is in actual transit. When the tension of the alternations is high, the amount of electricity that has to oscillate backwards and forwards on the guiding wires is proportionately diminished, and the frictional waste reduced. At the terminals the direct transmission from one armature of the motor to the other, across the intervening empty space, at once takes us beyond the province of the pushing and rubbing contacts that are unavoidable in mechanical transmission; while the perfect symmetry and reversibility of the arrangement by which power is delivered from a rotatory alternator at one end, guided by the wires to another place many miles away, where it is absorbed by another alternator with precise reversal of the initial stages, make this process of distribution of energy resemble the automatic operations of nature rather than the imperfect material connections previously in use. We are here dealing primarily with the flawless continuous medium which is the transmitter of radiant energy across the celestial spaces; the part played by the coarsely-constituted material conductor is only that of a more or less imperfect guide which directs the current of æthereal energy. The wonderful nature of this theoretically perfect, though of course practically only approximate, method of abolishing limitations of locality with regard to mechanical power is not diminished by the circumstance that its principle must have been in some manner present to the mind of the first person who fully realised the character of the reversibility of a gramme armature.

In theoretical knowledge a new domain, to which the theory as expounded 20 years ago had little to say, has recently been acquired through the experimental scrutiny of the electric discharge in rarefied gaseous media. The very varied electric phenomena of vacuum tubes, whose electrolytic character was first practically established by Schuster, have been largely reduced to order through the employment of the high exhaustions introduced and first utilised by Crookes. Their study under these circumstances, in which the material molecules are so sparsely distributed as but rarely to interfere with each other, has conduced to enlarged knowledge and verification of the fundamental relations in which the individual molecules stand to all electric phenomena, culminating recently in the actually determination, by J. J. Thomson and others following in his track, of the masses and velocities of the particles that carry the electric discharge across the exhausted space. The recent investigations of the circumstances of the electric dissociation produced in the atmosphere and in other gases by ultra-violet light, the Röntgen radiation, and other agencies, constitute one of the most striking developments in experimental molecular physics since Graham determined the molecular relations of gaseous diffusion and transpiration more than half a century ago. This advance in experimental knowledge of molecular phenomena, assisted by the discovery of the precise and rational effect of magnetism on the spectrum, has brought into prominence a modification or rather development of Maxwell's exposition of electric theory, which was dictated primarily by the requirements of the abstract theory itself; the atoms or ions are now definitely introduced as the carriers of those electric charges which interact across the æther, and so produce the electric fields whose transformations were the main subject of the original theory. We are thus inevitably led, in electric and æthereal theory, as in the chemistry and dynamics of the gaseous state, which is the department of abstract physics next in order of simplicity, to the consideration of the individual molecules of matter. The theoretical problems which had come clearly into view a quarter of a century ago, under Maxwell's lead, whether in the exact dynamical relations of æthereal transmission or in the more fortuitous domain of the statistics of

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interacting molecules, are those around which attention is still mainly concentrated; but as the result of the progress in each, they are now tending towards consolidation into one subject. I propose—leaving further review of the scientific aspect of the recent enormous development of the applications of physical science for hands more competent to deal with the practical side of that subject—to offer some remarks on the scope and validity of this molecular order of ideas, to which the trend of physical explanation and development is now setting in so pronounced a manner.

If it is necessary to offer an apology for detaining the attention of the section on so abstract a topic, I can plead its intrinsic philsophical importance. The hesitation so long felt on the Continent in regard to discarding the highly developed theories which analysed all physical actions into direct attractions between the separate elements of the bodies concerned, in favour of a new method in which our ideas are carried into regions deeper than the phenomena, has no given place to eager discussion of the potentialities of the new standpoint. There has even appeared a disposition to consider that the Newtonian dynamical principles, which have formed the basis of physical explanation for nearly two centuries, must be replaced in these deeper subjects by a method of direct description of the mere course of phenomena, apart from any attempt to establish casual relations, the initiation of this method being traced, like that of the Newtonian dynamics itself, to this country. The question has as to how far the new methods of æthereal physics are to be considered as an independent departure, how far they form the natural development of existing dynamical science. In England, whence the innovation came, it is the more conservative position that has all along been occupied. Maxwell was himself trained in the school of physics established in this country by Sir George Stokes and Lord Kelvin, in which the dominating idea has been that of the strictly dynamical foundation of all physical action. Although the pupil's imagination bridged over dynamical chasms, across which the master was not always able to follow, yet the most striking feature of Maxwell's scheme was still the dynamical framework into which it was built. The more advanced reformers have now thrown overboard the apparatus of potential functions which Maxwell found necessary for the dynamical consolidation of his theory, retaining only the final result as a verified descriptive basis for the phenomena. In this way all difficulties relating to dynamical development and, indeed, consistency are avoided, but the question remains as to how much is thereby lost. In practical electromagnetics the transmission of power is now the most prominent phenomenon. If formal dynamics is put aside in the general theory its guidance must here be replaced by some more empirical and tentative method of describing the course of the transmission and transformation of mechanical energy in the system.

The direct recognition in some form, either explicitly or tacitly, of the part played by the æther has become indispensable to the development and exposition of general physics ever since the discoveries of Hertz left no further room for doubt that this physical scheme of Maxwell was not merely a brilliant speculation, but constituted, in spite of outstanding gaps and difficulties, a real formulation of the underlying unity in physical dynamics. The domain of abstract physics is in fact roughly divisible into two regions. In one of them we are mainly concerned with interactions between one portion of matter and another portion occupying a different position in space; such interactions have very uniform and comparatively simple relations; and the reason is traceable to the simple and uniform constitution of the intervening medium in which they have their seat. The other province is that in which the distribution of the material molecules comes into account. Setting aside the ordinary dynamics of matter in bulk, which is founded on the uniformity of the properties of the bodies concerned and their experimental determination, we must assign to this region all phenomena which are concerned with the uncoordinated motions of the molecules, including the range of thermal and in part of radiant actions; the only possible basis for detailed theory is the statistical dynamics of the distribution of the molecules. The far more deep-seated and mysterious processes which are involved in changes in the constitution of the individual molecules themselves are mainly outside the province of physics, which is competent to reason only about permanent material systems; they must be left to the sciences of chemistry and physiology. Yet the chemist proclaims that he can determine only the results of his reactions and the physical conditions under which they occur; the character of the bonds which hold atoms in their chemical combinations is at present unknown, although a large domain of very precise knowlege relating, in some diagrammatic manner, to the topography of the more complex molecules has been attained. The vast structure which chemical science has in this way raised on the narrow foundation of the atomic theory is perhaps the most wonderful existing illustration both of the rationality of natural processes and of the analytical powers of the human mind. In a word, the complication of the material world is referable to the vast range of structure and of states of aggregation in the material atoms; while the possibility of a science of physics is largely due to the simplicity of constitution of the universal medium through which the individual atoms interact on each other.

The reference of the uniformity in the interactions at a distance between material bodies to the part played by the æther is a step towards the elimination of extraneous and random hypotheses about laws of attraction between atoms. It also places that medium on a different basis from matter, in that its mode of activity is simple and regular, whereas intimate material interactions must be of illimitable complexity. This gives strong ground for the view that we should not be tempted towards explaining the simple group of relations which have been found to define the activity of the æther, by treating them as mechanical consequences of concealed structure in that medium; we should rather rest satisfied with having attained to their exact dynamical correlation, just as geometry explores or correlates, without explaining, the descriptive and metric properties of space. On the other hand, a view is upheld which considers the pressures and thrusts of the engineer, and the strains and stresses in the material structures by which he transmits them from one place to another, to be the archetype of the processes by which all mechanical effect is transmitted in nature. This doctrine implies an expectation that we may ultimately discover something analogous to structure in the celestial spaces, by means of which the transmission of physical effect will be brought into line with the transmission of mechanical effect by material framework.

At a time when the only definitively ascertained function of the æther was the undulatory propagation of radiant energy across space Lord Kelvin pointed out that, by reason of the very great velocity of propagation, the density of the radiant energy in the medium at any place must be extremely small in comparion with the amount of energy that is transmitted in a second of time. This easily led him to the very striking conclusion that, on the hypothesis that the æther is like material elastic media, it is not necessary to assume its density to be more than 10^{-18} of that of water, or its optical rigidity to be more than ten 10^{-8} of that of steel or glass. Thus far the æther would be merely an impalpable material atmosphere for the transference of energy by radiation, at extremely small densities but with very great speed, while ordinary matter would be the seat of practically all this energy. But this way of explaining the absence of sensible influence of the æther on the phenomena of material dynamics lost much of its basis as soon as it was recognised that the same medium must be the receptacle of very high densities of energy in the electric fields around currents and magnets.* The other mode of explanation is to consider the æther to be of the very essence of all physical actions, and to correlate the absence of obvious mechanical evidence of its intervention with its regularity and universality.

On this plan of making the æther the essential factor in the transformation of energy as well as its transmission across space, the material atom must be some kind of permanent nucleus that retains around itself an æthereal field of physical influence, such as, for example, a field of strain. We can recognise the atom only through its interactions with other atoms that are so far away from it as to be practically independent systems; thus our direct knowledge of the atom will be confined to this field of force which belongs to it. Just as the exploration of the distant field of magnetic influence of a steel magnet, itself concealed from view, cannot tell us anything about the magnet except the amount and direction of its moment, so a practically complete knowledge of the field of physical influence of an atom might be expressible in terms of the numerical values of a limited number of physical moments associated with it, without any revelation as to its essential structure or constitution being involved. This will, at any rate, be the case for ultimate atoms if, as is most likely, the distances at which they are kept apart are large compared with the diameters of the atomic nuclei; it, in fact, forms our only chance for penetrating to definite dynamical views of molecular structure. So long as we cannot isolate a single molecule, but must deal observationally with an innumerable distribution of them even this kind of knowledge will be largely confined to average values. But the last half-century has witnessed the successful application of a new instrument of research, which has removed in various directions the limitations that had previously been placed on the knowledge to which it was possible for human effort to look forward. The spectroscope has created a new astronomy by revealing the constitutions and the unseen internal motions of the stars. Its power lies in the fact that it does take hold of the internal relations of the individual molecule of matter, and provide a very definite and detailed, though far from complete, analysis of the vibratory motions that are going on in it; these vibrations being in

* We can here only allude to Lord Kelvin's recent most interesting mechanical illustrations of a solid æther interacting with material molecules and with itself by attraction at a distance; unlike the generalised dynamical method expounded in the text, which can leave the intimate structure of the material molecule outside the problem, a definite working constitution is there assigned to the molecular nucleus. It is pointed out in a continuation that is to appear in the *Phil. Mag.* for September, that a density of æther of the order of only 10^{-9}, which would not appreciably affect the inertia of matter, would involve rigidity comparable with that of steel, and thus permit transmission of magnetic forces by stress; this solid æther is, however, as usual, taken to be freely permeable to the molecules of matter.

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their normal state characteristic of its dynamical constitution, and in their deviations from the normal giving indications of the velocity of its movement and the physical state of its environment. Maxwell long ago laid emphasis on the fact that a physical atomic theory is not competent even to contemplate the vast mass of potentialities and correlations of the past and the future, that biological theory has to consider as latent in a single organic germ containing at most only a few million molecules. On our present view we can accept his position that the properties of such a body cannot be those of a "purely material system," provided, however, we restrict this phrase to apply to physical properties as here defined. But an exhaustive discovery of the intimate nature of the atom is beyond the scope of physics; questions as to whether it must not necessarily involve in itself some image of the complexity of the organic structures of which it can form a correlated part must remain a subject of speculation outside the domain of that science. It might be held that this conception of discrete atoms and continuous æther really stands, like those of space and time, in intimate relation with our modes of mental apprehension, into which any consistent picture of the external world must of necessity be fitted. In any case it would involve abandonment of all the successful traditions of our subject if we ceased to hold that our analysis can be formulated in a consistent and complete manner, so far as it goes, without being necessarily an exhaustive account of phenomena that are beyond our range of experiment. Such phenomena may be more closely defined as those connected with the processes of intimate combination of the molecules: they include the activities of organic beings, which all seem to depend on change of molecular structure.

If, then, we have so small a hold on the intimate nature of matter, it will appear all the more striking that physicists have been able precisely to divine the mode of operation of the intangible æther, and to some extent explore in it the fields of physical influence of the molecules. On consideration we recognise that this knowledge of fundamental physical interaction has been reached by a comparative process. The mechanism of the propagation of light could never have been studied in the free æther of space alone. It was possible, however, to determine the way in which the characteristics of optical propagation are modified, but not wholly transformed, when it takes place in a transparent material body instead of empty space. The change, in fact, arises on account of the æther being entangled with the network of material molecules; but inasmuch as the length of a single wave of radiation covers thousands of these molecules the wave-motion still remains uniform and does not lose its general type. A wider variation of the experimental conditions has been provided for our examination in the case of those substances in which the phenomenon of double refraction pointed to a change of the æthereal properties which varied in different directions; and minute study of this modification has proved sufficient to guide to a consistent appreciation of the nature of this change, and therefore of the mode of æthereal propagation that is thus altered. In the same way, it was the study and development of the manner in which the laws of electric phenomena in material bodies had been unravelled by Ampère and Faraday, that guided Faraday himself and Maxwell—who were impressed with the view that the æther was at the bottom of it all—in their progress towards an application of similar laws to æther devoid of matter, such as would complete a scheme of continuous action by consistently interconnecting the material bodies and banishing all untraced interaction across empty space. Maxwell, in fact, chose to finally expound the theory by ascribing to the æther of free space a dielectric constant and a magnetic constant of the same types as had been found to express the properties of material media, thus extending the seat of the phenomena to all space on the plan of describing the activity of the æther in terms of the ordinary electric ideas. The converse mode of development, starting with the free æther under the directly dynamical form which has been used in physical optics, and introducing the influence of the material atoms through the electric charges which are involved in their constitution,* was hardly employed by him; in part, perhaps, because, owing to the necessity of correlating his theory with existing electric knowledge and the mode of its expression, he seems never to have reached the stage of moulding it into a completely deductive form.

The dynamics of the æther, in fact the recognition of the existence of an æther, has thus, as a matter of history, been reached through study of the dynamical phenomena of matter. When the dynamics of a material system is worked up to its purest and most general form, it becomes a formulation of the relations between the succession of the configurations and states of motion of the system, the assistance of an independent idea of force not being usually required. We can, however, only attain to such a compact statement when the system is self-contained, when its motion is not being dissipated by agencies of frictional type, and when its connections can be directly specified by purely geometrical relations between the coordinates, thus excluding such mechanisms as rolling contacts. The course of the system is then in all cases determined by some form or other of a single fundamental property, that any alteration in any small portion of its actual course must produce an increase in the total "action" of the motion. It is to be observed that in employing this law of minimum as regards the action expressed as an integral over the whole time of the motion, we no more introduce the future course as a determining influence on the present state of motion than we do in drawing a straight line from any point in any direction, although the length of the line is the minimum distance between its ends. In drawing the line piece by piece we have to make tentative excursions into the immediate future in order to adjust each element into straightness with the previous element; so in tracing the next stage of the motion of a material system we have similarly to secure that it is not given any such directions as would unduly increase the action. But whatever views may be held as to the ultimate significance of this principle of action, its importance, not only for mathematical analysis, but as a guide to physical exploration, remains fundamental. When the principles of the dynamics of material systems are refined down to their ultimate common basis, this principle of minimum is what remains. Hertz preferred to express its contents in the form of a principle of straightness of course or path. It will be recognised, on the lines already indicated, that this is another mode of statement of the same fundamental idea; and the general equivalence is worked out by Hertz on the basis of Hamilton's development of the principles of dynamics. The latter mode of statement may be adaptable so as to avoid the limitations which restrict the connections of the system, at the expense, however, of introducing new variables; if, indeed, it does not introduce gratuitous complexity for purposes of physics to attempt to do this. However these questions may stand, this principle of straightness or directness of path forms, wherever it applies, the most general and comprehensive formulation of purely dynamical action: it involves in itself the complete course of events. In so far as we are given the algebraic formula for the time integral which constitutes the action, expressed in terms of any suitable co-ordinates, we know implicitly the whole dynamical constitution and history of the system to which it applies. Two systems in which the action is expressed by the same formula are mathematically identical, are physically precisely correlated, so that they have all dynamical properties in common. When the structure of a dynamical system is largely concealed from view, the safest and most direct way towards an exploration of its essential relations and connections, and in fact towards answering the prior question as to whether it is a purely dynamical system at all, is through this order of ideas. The ultimate test that a system is a dynamical one is not that we shall be able to trace mechanical stresses throughout it, but that its relations can be in some way or other consolidated into accordance with this principle of minimum action. This definition of a dynamical system in terms of the simple principle of directness of path may conceivably be subject to objection as too wide; it is certainly not too narrow; and it is the conception which has naturally been evolved from two centuries of study of the dynamics of material bodies. Its very great generality may lead to the objection that we might completely formulate the future course of a system in its terms, without having obtained a working familiarity with its details, of the kind to which we have become accustomed in the analysis of simple material systems; but our choice is at present between this kind of formulation, which is a real and essential one, and an empirical description of the course of phenomena combined with explanations relating to more or less isolated groups. The list of great names, including Kelvin, Maxwell, Helmholtz, that have been associated with the employment of the principle for the elucidation of the relations of deep-seated dynamical phenomena, is a strong guarantee that we shall do well by making the most of this clue.

Are we then justified in treating the material molecule, so far as revealed by the spectroscope, as a dynamical system coming under this specification? Its intrinsic energy is certainly permanent and not subject to dissipation; otherwise the molecule would gradually fade out of existence. The extreme precision and regularity of detail in the spectrum shows that the vibrations which produce it are exactly synchronous, whatever be their amplitude, and in so far resemble the vibrations of small amplitude in material systems. As all indications point to the molecule being a system in a state of intrinsic motion, like a vortex ring, or a stellar system in astronomy, we must consider these radiating vibrations to take place around a steady state of motion which does not itself radiate, not around a state of rest. Now, not the least of the advantages possessed by the action principle, as a foundation for theoretical physics, is the fact that its statement can be adapted to systems involving in their constitution permanent steady motions of this kind, in such a way that only the variable motions superposed on them come into consideration. The possibilities as regards physical correlation of thus introducing permanent motional states as well as permanent structure into the constitution of our dynamical systems

* In 1870 Maxwell, while admiring the breadth of the theory of Weber, which is virtually based on atomic charges combined with action at a distance, still regarded it as irreconcilable with his own theory, and left to the future the question as to why "theories apparently so fundamentally opposed should have so large a field of truth common to both."—"Scientific Papers," II., p. 228.

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have long been emphasised by Lord Kelvin ;* the effective adaptation of abstract dynamics to such systems was made independently by Kelvin and Routh about 1877 ; the more recent exposition of the theory by Helmholtz has directed general attention to what is undoubtedly the most significant extension of dynamical analysis which has taken place since the time of Lagrange.

Returning to the molecules, it is now verified that the action principle forms a valid foundation throughout electrodynamics and optics ; the introduction of the æther into the system has not affected its application. It is therefore a reasonable hypothesis that the principle forms an allowable foundation for the dynamical analysis of the radiant vibrations in the system formed by a single molecule and surrounding æther ; and the knowledge which is now accumulating, both of the orderly grouping of the lines of the spectrum and of the modifications impressed on these lines by a magnetic field or by the density of the matter immediately surrounding the vibrating molecule, can hardly fail to be fruitful for the dynamical analysis of its constitution. But let it be repeated that this analysis would be complete when a formula for the dynamical energy of the molecule is obtained, and would go no deeper. Starting from our definitely limited definition of the nature of a dynamical system, the problem is merely to correlate the observed relations of the periods of vibration in a molecule, when it has come into a steady state as regards constitution and is not under the influence of intimate encounter with other molecules. It may be recalled incidentally that the generalised Maxwell-Boltzmann principle of the equable distribution of the acquired store of kinetic energy of the molecule, among its various possible independent types of motion, is based irectly on the validity of the action principle for its dynamics. In the demonstrations usually offered the molecule is considered to have no permanent or constitutive energy of internal motion. It can, however, be shown, by use of the generalisation aforesaid of the action principle, that no discrepancy will arise on that account. Such intrinsic kinetic energy virtually adds on to the potential energy of the system ; and the remaining or acquired part of the kinetic energy of the molecule may be made the subject of the same train of reasoning as before.

(To be concluded.)

THE GENESIS OF THE IONS IN THE DISCHARGE OF ELECTRICITY THROUGH GASES.†

BY PROF. J. J. THOMSON, M.A., F.R.S.

In many cases of discharge through gases, the ions have not to be supplied by the action of the electric field itself, but are produced by external agents such as Röntgen rays, radiation from uranium and other radio-active substances, the action of ultra-violet light on metals, incandescent filaments, &c. In addition, however, to such cases as these we have the very important series of phenomena which includes the spark-discharge and the ordinary discharge through vacuum tubes in which there are no external sources available for the production of ions, so that these must in some way or another arise from the action of the field itself. There are many difficulties in the way of supposing that single molecules are torn asunder by the electric force in the field pulling the positive ion one way and the negative ion in the opposite way. To mention only one of these difficulties, the electric force necessary to produce discharge is almost vanishingly small compared with the force due to an atomic charge acting at an atomic distance. In my "Recent Researches" I suggested that under the action of the electric field some of the molecules formed long narrow aggregations, just as smoke and dust do under similar circumstances: these aggregations, being bodies of higher specific inductive capacity than their surroundings, will act on the lines of force like long and pointed conductors, and will therefore produce a great concentration of the lines of force on the ends of the aggregation, so that the maximum electric force in the field will be enormously greater than the average force, which is all we can measure. Since that was written, many investigations have been made which have proved that where electrified particles move through a gas ions are produced under certain circumstances, at any rate if the particle is negatively electrified. Thus Lenard showed that his rays make a gas through which they pass a conductor of electricity. Lenard rays are negatively electrified particles, and on our theory the conductivity of the gas is due to the production of ions. Again, I showed (*Phil. Mag.*, Oct., 1897) that the passage of cathode rays through a gas ionised it. Thus we have evidence that in some cases at any rate the motion of the corpuscles through a gas can ionise it. The view that the motion of the ions through a gas can ionise a gas is supported by the observation of Stoletow (*Journal de Physique*, IX. p. 468) that under the same electric force the current between two plates, one of which is illuminated by ultra-violet light, increases with the distance between the plates, the increase being most marked when the pressure is low. This is what we should expect if the negative ions, starting from the illuminated plate, produced in the passage through the gas fresh ions. The view which I wish to bring forward in this Paper is that the ionisation in the ordinary cases of discharge through gases is produced by the motion through the gas of ions or corpuscles already present in the gas. These ions or corpuscles under the action of the electric field acquire velocity and kinetic energy ; and when this velocity or energy reaches a definite value, which need not be the same for the positive as the negative ion, these ions or corpuscles are able, by their collision with the surrounding molecules, to produce other ions and corpuscles. This dissociation may be directly due to the collision, or indirectly to rays like Röntgen rays produced by the collision. Let us take the case of a gas through which a few ions are distributed: then, if the energy or velocity communicated by the electric field to these ions exceeds a certain critical value, each of the original ions will produce other ions, and these new ions will give rise to fresh ions, so that the number of ions and the conductivity of the gas will rapidly increase ; it will go on increasing until the conductivity of the gas reaches such a value that the strength of the electric field is reduced so that the work done by it on an ion is equal to the critical value ; when this stage is reached each ion produces one and only one successor, so that the number of ions remains constant, and the gas, with the discharge passing through it, attains a steady state.

If the strength of the field had been so small that the work done on an ion was not equal to the critical value, the number of ions would not increase, and there would be no discharge through the gas beyond the very slight leak due to the ions originally present in the gas. Thus this view explains why a field of finite strength is required to send the discharge through a gas.

The maximum kinetic energy given by the field to an ion will be measured by the work done on the ion during its free path, for after a collision the disturbance in the energy and direction of motion is so great that the work has, as it were, to be begun over again ; while if the direction of the motion is reversed, the field, if it increased the kinetic energy of the ion before the collision, will diminish it afterwards. Thus, if λ is the mean free path, the kinetic energy given by the field to the ion will be measured by $F\epsilon\lambda$, where ϵ is the charge on the ion and F the electric force. The condition that discharge should take place is that the maximum kinetic energy should equal q, where q is a quantity depending on the nature of the gas. Thus the condition for discharge is $F\epsilon\lambda = q$, so that F, the electric force required to produce discharge, varies inversely as the mean free path of the ions or corpuscles. Now λ is inversely proportional to the density of the gas, so that on this theory the electric force required to produce discharge should in the same gas be directly proportional to the density of the gas, a result which is approximately true over a wide range of pressures. Thus the theory we are describing gives a very simple explanation of the fact that it is easier to produce a discharge through a gas at a low pressure than through one at a high.

The theory readily explains why it requires a greater electric force to send a spark through a thin layer of gas than through a thicker one, provided the thickness of the thin layer is less than a certain value which is inversely proportional to the pressure. For in order that the ions should produce dissociation it is necessary that they should strike against the molecules of the gas, or if the dissociation is due to rays produced by the collision, that the layer should be thick enough to absorb the radiation ; but as soon as the thickness of the layer becomes comparable with the mean free path of an iron the chance of their striking against a molecule before reaching the electrode begins rapidly to diminish, so that the ability of the moving ions to produce dissociation will rapidly diminish when the thickness of the layer falls below a certain value. And although the thickness of the layer when the electric force begins to increase is large compared with the free path of a molecule moving through the gas, it is not so compared with the free path of a corpuscle ; *i.e.*, one of the small ions which are found in the cathode rays, and which we have reason to believe play an important part in all cases of electric discharge.

On this view of the electric discharge, the presence of a small number of ions is required to start the discharge. The experiments of Linss,* and the recent ones of Elster and Geitel†, seem to show that such ions are present in gases under ordinary conditions ; the first spark, too, is much more irregular in its behaviour than subsequent ones, and this is in accordance with the view that the conditions attending its formation are capricious and almost accidental.

*For a classical exposition see his British Association Address of 1884 on "Steps towards a Kinetic Theory of Matter," reprinted in "Popular Lectures and Addresses," Vol. I.

†Paper read before the Cambridge Philosophical Society and communicated to the *Philosophical Magazine*, September, 1900.

* W. Linss, *Meteor. Zeits.*, IV., p. 352 (1887).

† "Terrestrial Magnetism and Atmospheric Electricity," IV., p. 213 (1899).

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Let us now consider the more complicated phenomena attending the passage of the discharge through a gas at low pressure. The production of ions may take place throughout the tube, or it may be localised in certain places. There must, however, be at least two places where ionisation takes place. For on this theory the ionisation at a place A is produced by ions brought into A by the electric field, so that there must be some other centre or centres of ionisation to produce the ions which are brought into A by the electric field. In the *Philosophical Magazine* for March, 1899, I showed how, from the study of the distribution of electric force in a discharge-tube, we could determine the places of maximum ionisation; the result of an investigation leads to the conclusion that there is one centre of ionisation close to the cathode, and another in the negative glow.

According to the view taken in this Paper these centres form mutually dependent and, as it were, regenerative systems, the ionisation in the negative glow being due to the corpuscles coming from the centre close to the cathode, while the ionisation close to the cathode is due to the positive ions which come from the centre in the negative glow. This view seems in accordance with the experiments of Villard,* in which a screen placed between the negative glow and the cathode stopped the emission of cathode rays from the portion of the cathode shielded by the screen. The negative corpuscles starting from the cathode ionise the gas in the neighbourhood of the magnetic glow, producing in this region a large number of ions; this makes the region one of great electrical conductivity, and the electric force consequently falls to a very small value. Let us now trace what would happen if there were no centre of ionisation between the negative glow and the anode; the current in this part of the tube would be carried by the negative ions produced in the negative glow, such a distribution of ions in the tube would cause the electric force to increase as we approach the anode, and, if this increase did not cause the kinetic energy of the ions to exceed the value at which they begin to produce other ions, the electric force would increase uninterruptedly up to the anode. If, however, the electric force increases to such an extent that the energy the field communicates to the ions is greater than that required for the dissociation of the surrounding molecules into other ions, then in the region where the electric force reaches this value fresh ions will be produced. This will increase the conductivity of the gas, and therefore cause the electric force to diminish; thus, after reaching a certain value, the electric force will fall off, and then begin to increase again after it has sunk below the value at which ionisation takes place. If this were repeated several times before the anode was reached, we should get the electric force waxing and waning, as it does in the striated discharge. The view that the striations consist of alternations of layers of high conductivity due to the ionisation of the gas by an electric force exceeding a certain critical value, with layers of gas through which the electric force is too low to produce ionisation, accounts for the distance between the striations diminishing as the density of the gas increases, and also for the distance between the striations in a tube of unequal bore being less in the narrow than in the broad parts of the tube. The electric force in the striated part of the discharge is much less than that close to the cathode; and it might be urged that if such an intense field were required to ionise the gas close to the cathode, the smaller field in the striated discharge would not produce ionisation. It must, however, be remembered that the ionisation at the cathode has to be produced by *positive* ions, while that in the rest of the field may be due to negative corpuscles; and it may very well be the case that the large positive ions are less efficient as ionisers than the negative corpuscles.

THE RUBBER INDUSTRY OF THE AMAZON VALLEY.*

Of late years the enormous consumption of rubber in the manufacture of bicycle tyres has created a very great demand. The supply not being able to cope with this demand the price has steadily increased, and considerable attention is now being paid to the production of rubber all over the world. So great is the demand at present that, although the supply from the Amazon Valley alone has increased from 8,635 tons in 1880 to 25,370 tons in 1899, the approximate price of 2s. 6d. per pound in 1889 increased to 4s. 6d. per pound in 1899. The British Vice-Consul at Manàos states that the total world's supply to-day is about 120,000,000lb. to 130,000,000lb., valued at about £15,000,000. At the present time laticiferous plants yielding "caoutchouc" or "rubber" are being worked for commercial purposes in Brazil, Bolivia, Central America, East and West Africa, whence come the chief supplies, while Guiana, the Eastern Archipelago, Madagascar, India, and Ceylon contribute a small quantity to the general stock. More than half the total supply is exported from the Amazon district. In Brazil several kinds of lactiiferous trees exist from which rubber is manufactured. In the State of Ceará, the *Manihot Glaziovii*, locally known as the maniçoba, is fairly extensively worked, and considerable attention is being paid to its cultivation. In the State of Maranhao the *Hancornia speciosa* or mangabeira is beginning to give results. These trees, however, are unimportant compared to the *Hevea Braziliensis* or seringueira, to which the Amazon Valley owes its present prosperity. The *Hevea Braziliensis* is found scattered through the forests that clothe the banks of the Amazon River and its tributaries. It does not strike the eye among the innumerable varieties of trees to be met with in the Amazonian forests, and is often difficult to detect. A peculiar glistening of the trifoliate leaves and the whiteness of the bark serves as a guide to the practised eye. The tree grows to the height of 70ft. to 100ft., and has, as a rule, when full grown, a girth of from 5ft. to 7ft. at a height of 1yd. from the ground. The tree flowers in January; the seeds are ripe and begin to fall in March in the case of old trees, and in May in the case of young trees. The seeds are contained in a hard shell, three or four in each shell, which hang by a short stalk from the upper and outer branches. When ripe the shell explodes, often with a loud report, scattering the seeds to a considerable distance. For this reason it is difficult to procure seeds. There are for practical purposes three distinct varieties of the "seringueira" to be met with in the forest. These are locally known as the seringueiras "casca vermelha" (red bark), "barriguda" (bellied), and "casca preta" (black bark). The first of these, the "casca vermelha," grows in the higher parts of the forest which are seldom or never flooded. The latex which it yields is scanty, thick, and will not run. Is is therefore of little value. The second of these, the "barriguda," so named because the trunk increases very rapidly in thickness towards the base, grows in those parts which are almost constantly flooded, named "igapós." It yields plentifully a thin, watery latex, which is of little value. The third variety, the "casca preta," grows in those parts where a certain amount of drainage exists, and which form an intermediary zone between the permanently flooded parts and the high lands. It is this variety which yields the latex from which the rubber of commerce is manufactured. The "latex," or as it is commonly known, the "milk" of the tree, is a milky juice contained in special tubes running amongst the other tissues of the plant. These tubes, in the case of the hevea, are connected, forming what is known as the "laticiferous system." The latex is quite different from what is called the "sap," and probably does not play any part in the nutrition of the tree. According to some authorities it forms a reserve of water to be drawn upon in cases of drought. The actual extraction of latex cannot kill the tree, and the common statement that the trees are "bled" to death is a mistake. As a matter of fact, though trees, exhausted, inasmuch as they will not yield any more latex are common—actually dead trees, killed by overtapping, are rarely met with. The latex as it exudes from the bark is of a dazzling whiteness, resembling milk, which it also resembles in composition, inasmuch as it consists of an emulsion in which "caoutchouc" takes the place of the butter in the ordinary milk. The fluid part of the latex consists of water with very small quantities of albuminous matter, organic acids and phosphates in solution. The extraction of the latex, or as it is usually called the "tapping" of the tree is effected by making an incision in the bark of the tree. From this incision the latex flows for about three or four hours, after that it stops flowing of its own accord. The incision should not penetrate beyond the bark, which is generally about ⅛in. thick, into the wood of the tree, and for this reason a very small axe, which rapidly thickens wedge like from the cutting edge is used, the shape of the instrument preventing its entering too deep. The axe is generally about ¾in. wide. The custom is to strike with it a backhanded blow upwards, thus making an oblique cut in the bark. It is probable that a better method would be to use a chisel and mallet and make a V-shaped incision. Recent experiments at Henaratgoda have shown the advantage of this shaped incision. The incision having been made, a small tin cup, of a capacity of about 4oz., is affixed just below it to receive the latex as it flows. This is effected by pressing the edge of the cup—which is sharp—into the bark, until it gets a sufficient hold to remain firm. By this method, however, a second wound is made in the bark, which is injurious. No better method has yet been suggested. In some places a winding groove is cut in the bark of the tree, and by means of a clay breastwork the milk is conducted into a vessel placed at the foot to receive it. This method is found, however, to be very exhausting to the tree, and is falling into disuse. The usual mode of tapping is to make an incision with the axe at the height of some 6ft. or 7ft. from the ground; on a level with that incision and at a distance of some 8in. a second cut is made, and so on round the tree. On the next day incisions are made just below these, and so on day by day, until they reach the ground. Incisions are then made on the same plan, beginning, as before, from the top, and working downwards between the former rows. A tree that will carry seven cups 8in. apart is

* From the *Journal* of the Society of Arts.

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considered a large one, and although trees that will carry eight or nine cups are to be met with, the average do not carry more than four or five. The latex having been obtained and collected, the caoutchouc, or rubber known to commerce, may be obtained from it in various ways. The only method, however, that has met with practical success is that of evaporation, by which the watery portion of the latex is driven off, and solid caoutchouc remains. The object to be secured is that as little water as possible shall remain in the caoutchouc, the putrefaction of the caoutchouc owing to the presence of these matters being extremely detrimental to its elastic properties, and therefore to its market value. In the Amazon district the method followed is to light a fire upon the ground, and to invert over it a specially-constructed, funnel-shaped chimney. From the narrow end of this funnel, which is open, the smoke and heated gases pour out in concentrated form. The fuel used for the fire consists, as a rule, of chips from any hardwood tree that grows handy to the labourer's hut. The nuts of the "Urucury palm" (*Attalea excelsa*) are sometimes used, their smoke containing a trace of acetic acid, and creosote being found particularly effective in curing the rubber and preventing putrefaction. It is, however, a mistake to suppose that all or even a large proportion of the rubber coming from the Amazon district is cured in this way. It is, on the contrary, very rarely that the rubber cutter will be at the trouble to collect these nuts, he nearly always prefers to use wood chips, which give him less trouble to procure. The fire having been made, and a large stream of hot smoke pouring out of the chimney, the operator seats himself on a small stool by the side of it. The latex is contained in a basin placed at hand. In his right hand he holds a paddle-shaped piece of wood, in his left hand a small calabash. Dipping the calabash into the basin of latex he pours a small quantity over the paddle, which he then revolves in the smoke issuing from the chimney. That having dried in a layer over the paddle he repeats the operation. In the course of time a "ball" or "biscuit" of solid rubber is thus formed. In some parts where it is the custom to manufacture very large balls or pellets, an arrangement is made by means of a pivot to rotate the ball over the chimney. The wooden core is withdrawn through a slit made in the "biscuit," or simply drawn out in the case of the pellet. The latex of a tree named "macaranduba" (*Mimusops elata*), and more often that of a tree named locally "amapa" is sometimes used to adulterate that of the *hevea*. In both cases the adulteration is extremely prejudicial to the quality of the rubber produced. Three distinct qualities of rubber are manufactured in the Amazon district, namely, "fine," "entrefine" and "sernamby" respectively. "Fine" rubber has been well smoked, and is free from putrefaction. "Entrefine" rubber has been either burnt while being smoked, or has been insufficiently smoked, and has, therefore, putrified. It is due to carelessness on the part of workmen, which it should be possible to avoid. "Sernamby" is the "negro-head" of commerce, and consists of scraps mixed with dirt, or strips peeled off the bark of the tree and mixed with impurities of all sorts.

* Villard, *Journal de Physique*, January, 1900.

ELECTRICITY WORKS ACCOUNTS.

The Bournemouth and Poole Electricity Supply Co. (Ltd.).

Under this new title the Bournemouth Company present their accounts for 1899, the undertaking of the Bournemouth and District Electric Supply Co. having been vested in the new company.

Owing partly to directors' fees, which apparently were not incurred during the period, and to other unusual charges appearing in the accounts, the management costs show somewhat of an increase on those of 1898, and now stand at a figure distinctly above the average under similar conditions. On the other hand all the items of generating costs, although they also show a slight increase, are under the average, and present excellent figures.

The resulting works costs at 1·96d. per unit are quite a farthing under what they might have been expected to stand at.

The increases in the output and lamp connections indicate healthy progress; the former advanced 27·4 per cent., and the latter by 30·7 per cent. on the 1898 figures.

We are glad to see that the low load factor of only 8·16 per cent. in 1898 has improved to 8 49 per cent. In view of the company's intention to supply power to the tramways connecting Bournemouth and Poole, it is not too much to expect that the character of the load will be still further improved to the great advantage of the undertaking.

Hastings and St. Leonards Municipal Electric Supply Works.

Although our analysis of the accounts of this undertaking for 1899 shows that, as compared with 1898, a decided improvement in the various items of works costs has been effected, yet we must say that the results are disappointing.

In a comparison of the generating costs with those at other stations the fuel item is at a disadvantage owing to the existence of heavy town dues on coal. In the fuel item in our table these dues amount to £279, being a charge of 2s. 4d. per ton of coal.

The Corporation electrical engineer having been unsuccessful in inducing the committee to waive this charge, as being only a matter of accounts between departments, recommended, as we understand, that the public lighting department be surcharged to meet the dues, thus relieving the price to private consumers. As he points out, under this arrangement the fuel item and the public lighting charges appear high in comparison with other towns.

Unfortunately, after making due allowance for this charge the fuel item and, indeed, all the generating, as well as the management and property charges are still to such an extent above the average as to result in a total costs figure quite 1·5d. above what it should stand at under similar conditions of output and load factor.

As compared with 1898 the output shows but the small advance of 11·8 per cent. The additional lamp connections indicate, however, much better progress, having advanced the total by 31·1 per cent.

The following table gives an idea of the progress of the undertaking. Last year was the first under municipal administration:—

Year.	Output units sold.	Equiv. lamp c'nnections.	Load factor.	Rev. per unit sold.	Total costs per unit sold.	Working profit.	Dividend (under c'mp'ny).
1895	265,846	9,667	...	5·76d.	4·64d.	£1,246	nil
1896	283,100	10,064	12·6%	5·92d.	4·37d.	1,894	nil
1897	338,705	13,418	12·5%	6·30d.	3·86d.	3,426	6%
1898	363,678	14,817	12·7%	6·76d.	4·58d.	3,302	7¼%
1899	404,866	19,423	12·8%	6·94d.	3·95d.	5,046	...

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	July 20, 1900
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, ,,
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	Aug. 3, ,,	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	July 6, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, 1899	Liverpool (Municipal)	June 23, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	April 28, ,,	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.)(Municipal)	Dec. 15, ,,
Bristol (Municipal)	Aug. 24, ,,	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, ,,	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	Aug. 24, 1900
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, 1899
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	Aug. 3, 1900	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, ,,	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	July 13, ,,
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, 1899
Croydon (Municipal)	July 20, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Aug. 17, 1900
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, 1899
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 18, 1900
Hanley (Municipal)	July 27, 1900	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, 1899	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	July 6, ,,	Wolverhampton (Municipal)	July 27, 1900
Huddersfield (Municipal)	Aug. 17, ,,	Woolwich (Company)	Jan. 18, 1899
Islington (Vestry)	Oct. 27, 1899	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 8, 1899
Kingston-upon-Hull (Mun.)	July 13, ,,		

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	BOURNEMOUTH.		HASTINGS & ST. LEONARDS.	
Undertaking Worked by	The Bournemouth and Poole Electricity [Supply Co. (Ltd.)		Hastings Corporation.	
Date of Commencement of Supply	1891.		1893.	
System of Supply	Alternate-current transformer sub-stations.		Alternate-current transformers.	
Chief Engineer	E. Ll. Ingram.		L. Andrews.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	620,001	836,914	521,000	542,619
„ SOLD (TOTAL)	414,662	528,039	363.678	404,866
„ sold to consumers	414,662	528,039	239,580	281,866
„ sold for public lighting, &c.	nil	nil	124,098	123,000
„ used on works	28,893	64,697	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	21·1	16·9	31·0	19·8
Maximum supply demanded	581 kilowatts	710 kilowatts	326 kilowatts	360 kilowatts
Number of public lamps	nil	nil	53 arc	53 (15 ampere) arc
Number of consumers	456	616	294	378
Connections to mains in 8-c.p. lamps	33,732	44,096	14,817*	19,423
CAPACITY OF PLANT IN 8-C.P. LAMPS	19,680	31,250	11,700	20,450
CAPACITY OF PLANT IN KILOWATTS	630	1,000	375	655 kilowatts
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —	— / —	— / —
Share	£50,000 / £79·4	£150,000 / £150	— / —	— / —
Loan (including Debenture charges)	— / —	— / —	— / —	— / —
RECEIVED (TOTAL)	92,516 / 147	143,230 / 143	£6,871 / £18·3	£64,871 / £99·1
Share	28,625 / 45·5	— / —	— / —	— / —
Loan (including Debenture charges)	63,891 / 101	— / —	6,871 / 18·3	64,871 / 99·1
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	— / —	— / —
Share (unissued)	21,375 / 33·9	6,770 / 6·77	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	2,174 / 3·45	2,205 / 2·21	— / —	— / —
EXPENDED (TOTAL)	103,966 / 165	143,230 / 143	—[a] / —	78,916[h] / 120
Lands and buildings	18,548 / 29·4	19,145[f] / 19·1	— / —	— / —
Plant	48,288 / 76·7	56,799 / 56·8	— / —	— / —
Mains	35,119 / 55·8	42,992 / 43·0	— / —	— / —
Miscellaneous	2,011 / 3·19	24,294[g] / 42·3	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	−11,450[a] / −18·2	nil / —	— / —	−14,045[b] / −21·4
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£11,917 / 6·900d.	£14,457 / 6·575d.	£10,247 / 6·764d.	£11,703 / 6·940d.
Revenue from supply	11,108 / 5·430d.	13,289 / 6·042d.	7,643 / 5·040d.	8,673 / 5·142d.
„ meters, &c.	537 / 0·311d.	803 / 0·365d.	— / —	130 / 0·077d.
„ public lighting	— / —	— / —	2,476[c] / 1·633d.	2,650 / 1·572d.
„ sale of lamps, &c.	— / —	— / —	— / —	130 / 0·077d.
„ miscellaneous sources	272 / 0·157d.	365 / 0·166d.	128 / 0·085d.	120 / 0·071d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,837 / 2·798d.	£6,807 / 3·094d.	£6,948 / 4·580d.	£6,657 / 3·945d.
WORKS COSTS	3,231 / 1·869d.	4,318 / 1·964d.	5,539 / 3·653d.	5,027 / 2·980d.
Generation of electricity	*2,899 / 1·677d.*	*3,945[h] / 1·793d.*	*4,905 / 3·235d.*	*4,597 / 2·724d.*
Fuel (including cartage, &c.)	1,344 / 0·778d.	1,939 / 0·882d.	2,899 / 1·912d.	2,662[i] / 1·578d.
Oil, waste, water, stores	339 / 0·196d.	346 / 0·157d.	402 / 0·265d.	459 / 0·272d.
Wages at station	906 / 0·524d.	1,256 / 0·571d.	967 / 0·638d.	983 / 0·583d.
Repairs and maintenance at station	310 / 0·179d.	326 / 0·148d.	637 / 0·420d.	492 / 0·292d.
Distribution of electricity	*332 / 0·192d.*	*373 / 0·170d.*	*188 / 0·124d.*	*157 / 0·093d.*
Wages, &c.	247 / 0·143d.	266 / 0·121d.	106 / 0·070d.	21 / 0·012d.
Repairs, renewals of mains, &c.	86 / 0·050d.	107 / 0·049d.	82 / 0·054d.	136 / 0·081d.
Public lighting	— / —	— / —	*446 / 0·294d.*	*273 / 0·162d.*
Attendance	— / —	— / —	} 446 / 0·294d.	273 / 0·162d.
Renewals	— / —	— / —		
MANAGEMENT AND PROPERTY CHARGES	1,606 / 0·929d.	2,499 / 1·132d.	1,407 / 0·929d.	1,630 / 0·967d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*644 / 0·373d.*	*750 / 0·341d.*	*491 / 0·324d.*	*450 / 0·267d.*
Management	*963 / 0·557d.*	*1,739 / 0·791d.*	*916 / 0·604d.*	*1,180 / 0·700d.*
Salaries	463[b] / 0·268d.	1,100[j] / 0·500d.	598 / 0·394d.	577 / 0·342d.
Stationery, &c.	65 / 0·038d. }	472 / 0·215d.	69 / 0·046d.	64 / 0·038d.
Establishment charges	198 / 0·115d. }		77 / 0·051d.	54 / 0·032d.
Law charges, &c.	236[c] / 0·137d.	167[i] / 0·076d.	172[d] / 0·113d.	485[j] / 0·288d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£7,080 / 7·44%	£7,650 / 6·19%	£3,302 / 6·03%	£5,046 / 6·40%[k]
Sum carried to Depreciation Fund	1,000 / 1·05%	1,518 / 1·23%	— / —	— / —
Sum carried to Reserve or Sinking Fund	10 / 0·01%	372 / 0·301%	— / —	2,336 / 2·96%[k]
Net interest on loans (incl. Debenture charges)	4,568 / 4·80%	236 / 0·191%	1,309 / 2·39%	2,446 / 3·10%[k]
BALANCE FROM LAST ACCOUNT	nil / —	1,276 / 1·03%	58 / 0·106%	−10 / 0·013%[k]
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,501 / 1·58%	6,800 / 5·50%	2,051[c] / 3·75%	253 / 0·321%[k]
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	5% / —	5% / —	—[e] / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	40·6%	47·1%	67·8%	56·9%
Expenditure per kilowatt capacity	£7. 13s. 7d.	£6. 16s. 2d.	£18. 10s. 0d.	£10. 3s. 2d.
REVENUE PER KILOWATT CAPACITY	£18. 18s. 7d.	£14. 9s. 2d.	£27. 6s. 0d.	£17. 17s. 2d.
Expenditure per 8-c.p. lamp capacity	4s. 11d.	4s. 4½d.	11s. 10½d.	6s. 6d.
REVENUE PER 8-C.P. LAMP CAPACITY	12s. 1½d.	9s. 3d.	17s. 5½d.	11s. 5½d.
REVENUE PER 8-C.P. LAMP CONNECTED	7s. 1d.	6s. 6½d.	13s. 9½d.	12s. 0½d.
Price charged for lighting, per unit	7d. to 3½d.[d]	7d. to 3½d.[e]	} 6d.[f]	{ 1½d. per unit plus 10s. per 8 c.p. lamp demanded per ann.[g]
Price charged for power, per unit	4d.	4d.		
Price charged for public lighting	—	—	—[e]	

BOURNEMOUTH.—REMARKS—*a* Over-expended. *b* Includes directors' remuneration £200. *c* Includes £95 to insurance, £80 to "Stores and works expenses," and £37 to auditing. *d* On Wright system (1½-hour scale). *e* On Wright system (1-hour scale). *f* Includes £3,885 on transformer sub-stations. *g* Includes £22,601 (expended during 1899) "Special items." *h* Includes £78 "Stores and works expenses." *i* Inclusive of £47 to auditing and £101 to insurance. *j* Inclusive of £800 directors' remuneration for two years.

HASTINGS AND ST. LEONARDS.—REMARKS—* Inclusive of 830 as the assumed equivalent in 8 c.p. lamps of the 53 arc lamps. *a* The total purchase price of the undertaking, including £3,200 paid for the "Front" lighting installation, was £61,200. *b* Over-expended. *c* Includes £1,743 in respect of current consumed and £733 actual cost of repairs and attendance to lamps, and interest and sinking fund on capital expended on public lighting plant. *d* Includes £38 to auditing and £134 to insurance. *e* This profit, sufficient for a dividend of 7½ per cent. on the ordinary share capital of £27,220, was disposed of by being added to the profit on the sale of the undertaking, thus realising to the ordinary shareholders of the late Company a total dividend of £2. 3s. per £10 share. *f* Plus a charge of 1s. per quarter per 8 c.p. lamp. *g* Or 6d. per unit, and 5s. meter rent per quarter. *h* Includes £54,800 consideration money for purchase of undertaking under contract of July 23, 1897, and £6,548, amount paid to the company in respect of new and improved machinery and plant, alterations to buildings, extension of mains, transformers, &c., carried out by company subsequent to date of above contract. *i* Includes £279 coal dues. *j* Inclusive of £185 to insurance and £274 expenses of executing the order. *k* Per cent to capital at end of year (£78,916).

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial Publishing and Printing Offices,

2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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AN INDUSTRIAL OBJECT LESSON.

The introduction of electric power supply on an extensive scale and at a cheap rate is a change in the conditions of material civilisation which cannot fail to exert a deep and widespread influence on industrial and social life. Electrical engineers, political economists and even leading statesmen, such as Lord SALISBURY, have studied this subject in its various aspects. One aspect of the subject, viz., its relation to land development, was considered in our leading article last week. There has recently been placed before us a number of particulars relating to an example of industrial power supply that constitute an instructive object lesson, from which it appears feasible to derive a number of useful inferences. Our readers will remember that a short time ago electric power supply works, deriving water power from the river Isar, were started at the then insignificant village of Höllriegelsgerent, a few miles above Münich. The works were driven by four turbines and had an aggregate rating of 2,000 H.P., exclusive of some 1,000 H.P. in reserve steam plant. It was the object of the promoters of these works to supply electric power over an extensive rural area for agricultural and other industrial purposes. So successfully were the requirements of the neighbourhood divined and its industrial possibilities perceived, that already no less than 25 farms and in all 90 premises of various kinds are supplied with light and power, the area covered including as many as 21 villages and rural districts near Münich. The load is composed of 151 motors—to which 21 new motors are being added—besides 13,500 glow lamps and 329 arc lamps. Mains for the supply to these items aggregate 56 miles of feeders and 30 miles of secondary distributors. It is none too early therefore that the decision has been made to provide additional 4,000 H.P. at the power station.

But it is not merely to call attention to the rapid success of these works that we have cited them. An entirely new industrial district has been created before now by the establishment of cheap electric power supply: there is nothing novel, however satisfactory, in that; numberless instances might be mentioned, were the entire civilised world to be scanned, though, by-the-way, not an instance of this type occurs in this country. But the most striking feature in the experiment on the Isar is the creation of a vigorous competition between the electrical area

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and the town of Münich, in regard to the location of factory sites; for not only have new works sprung up within the electrical area, but established works in Münich have been abandoned, their industries being transferred from town to country. The official report from H.M. Legation at Münich, from which we derive the facts about this interesting experiment, states that "many of these works previously sold their valuable buildings and sites in the centre of the town, bought far cheaper sites with siding connections with the railway, and built workmen's dwellings adjoining at great profit and economy in working expenses."

Now we will grant that at first glance these results appear to justify the view which is sometimes advanced—and it is a view that has captured the popular fancy—that cheap and abundant electric power supply has a tendency to decentralise industrial life, breaking up the closely-populated manufacturing city and scattering its factories in a deliciously healthy uniformity over an unsmirched country. In the same manner, this experiment might at first sight be supposed to show how electric power supply develops the value of land—not heeding, for the moment, any depreciation in value of the forsaken factories in Münich. But we think that on closer inspection neither of these inferences will be found to be justified. In the first place, it is important to bear in mind that the electric power is merely an intermediary agent; the real source of power is in the river Isar, at a particular spot. Prior to the commencement of electric supply this power could not attract industry on any extensive scale, because factories would be unable to crowd sufficiently close to the water power. Electric power has enabled many more factories to crowd round the water power by giving this latter a larger and more practicable radius of action; but the tendency is still to crowd round. There is no inducement to select a site as remote from the river as electric power can be conveyed; but, on the contrary, to get as near to the power-house as rents and other considerations will allow, because in that case electric power will be the more cheaply obtained. It will be seen then that this type of electric power scheme is just as centralising in its tendency as is steam power; perhaps even more so, since coal can be distributed without additional net cost over so much larger an area. Bearing in mind also that the real explanation of the industrial phenomena exhibited in this experiment is the existence of a large source of water power, it will be seen that there can be no parallel between this experiment and the large electric power schemes promoted in the United Kingdom, in regard to the appreciation in land and property values. As, however, we have already dealt with this matter so recently, we shall not proceed further with it now.

While dealing with the effect of electric power in reforming town and city life, we cannot fail to notice an important influence, quite apart from the effect on the so-called factory system. Although, as we have said, we fail to discover that electric power supply tends to break up the individual factory into a number of home-workshops, or to scatter factories broadcast throughout rural districts, there is no difficulty in perceiving one direction at any rate in which electricity is doing much towards the amelioration of city life. We refer to electric traction—the influence of cheap and rapid transit, on electric tramways and suburban railways, in providing ready means for the city toiler to have his home in the neighbouring country. Some time ago we directed the attention of the authorities responsible for a satisfactory solution of the problem of "the housing of the poor," to this very effective and practicable solution. We have been glad to observe from time to time that local authorities throughout the country have been strongly disposed to accept this solution, which we have frequently pressed upon their attention, and that the great social value of electric tramways is being more and more recognised by them.

THE USE OF ALUMINIUM FOR ELECTRICAL CONDUCTORS.

BY JOHN B. C. KERSHAW, F.I.C.

(*Concluded from page 671.*)

PART II.—PRACTICAL APPLICATIONS.

Electric Power Transmission.—Details of the more important power transmission schemes in which aluminium has been used, or is about to be used for the overhead work, are given below in tabular form:—

Aluminium Transmission Lines in America.

Name of company.	Locality supplied.	Power transmitted.	Length of line in miles.	Voltage used.
Snoqualmie Falls Power Co.	Tacoma-Seattle	10,000	34	29,000
Blue Lakes Power Co.	Stockton	1,000	46	25,000
North Yuba Power Co.	Sacramento ...	1,000	63	?
Hartford Electric Light Co.	Hartford	2,000	11	10,000
Municipal Supply Co., Orillia, Ontario	Ragged Rapids and Orillia	2,000	13	?
Big Cottonwood Power Co.	Utah	500	?	12,000
Telluride Power Co.	Provo, Utah...	2,000	80	?
Standard Electric Co.....	San Francisco	?	150	60,000
Niagara Falls Hydraulic Power Co.	Niagara Falls	3,000 1,000	1½th	?

One or two of the above schemes are not yet completed, but all are expected to be in operation before the close of the present year.

The following are additional details concerning some of the lines:—

Niagara Falls Lines.—Both these lines are short, and convey current from the generating station to works in the neighbourhood only. According to Dunlap the cable supplying current to the National Electrolytic Co.'s factory for chlorate production, consists of 12 separate cables of No. 10 wire, and where it runs down the Penstock, bars of aluminium 6in. wide by ¼in. thick have been used. The metal from which the wire was drawn tested 99·5 per cent. aluminium. Molten tin was used to make all the joints on both bars and cable.*

The second aluminium conductor conveys current to the No. 2 works of the Pittsburg Reduction Co., but no details concerning this conductor have come under the writer's notice. Both conductors are stated to be working satisfactorily.

Snoqualmie Falls (Washington) Line.—In connection with this power scheme, 150,000lbs. aluminium have been used, but the full 12,000 H.P. has not yet been transmitted. The line runs between Tacoma and Seattle, and is constructed of wire drawn from an alloy containing 1½ per cent. copper. Spans of 120ft. are safely used with this wire. The Seattle branch of this line has now been in operation over twelve months, and in February of this year it was stated to be working satisfactorily.† The line is constructed of No. 1 and 2 B. and S. gauge wire. The MacIntyre mechanical joint is used, the sleeves being 9in. long by $\frac{1}{16}$in. thick. The Seattle line has required 67,000lbs. aluminium and the Tacoma line 72,000lbs. Triple petticoat porcelain insulators, 4¼in. high by 6½in. diameter, are used, each of which weighs 4lbs. The average span on the Seattle line is 110ft. and on the Tacoma line 150ft.‡

Blue Lakes and Stockton Line.—Three-phase current was used on this line, and it was operated for 10 months with success, but in January, 1900, the power-house was destroyed

* *Western Electrician*, July 30, 1898.
† *Aluminium World*, February, 1900.
‡ *Electrical Review* (New York), September, 1899.

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by fire, and the opportunity was seized to replace the whole line by a heavier wire. The new line is not yet carrying current. The former line possessed a conductivity of 59·9—(copper 100). The tensile strength was 14·6 tons per square inch, and spans of 120ft. were used. 1,000,000lbs. of aluminium are to be used in constructing the new line. At 29 cents. per pound, this represents an outlay of £60,400 for the metal alone. Very full details regarding this line will be found in a Paper read by Messrs. Perrine and Baum before the American Institute of Electrical Engineers in May, 1900, and reprinted in full in the journal named below.*

Tariffville and Hartford Line.—The three-phase system of transmission is used on this line. The cable consists of seven strands, each strand made up of seven No. 11 B. and S. gauge wires. The diameter of the cable is $\frac{3}{4}$in., and it weighs about 1,500lbs. per mile. 20,160lb. of aluminium has been used for the scheme.†

Telluride Power Co.'s Line, Utah.—The line used to distribute electric power over this 80-mile circuit and to supply the mines at Mercur and Tintic is of $\frac{3}{8}$in. wire. The amount of power transmitted is to be increased as soon as the requisite machinery can be installed.

Sierra Nevada and San Francisco Line.—The scheme of the Standard Electric Co. of San Francisco for transmitting electric power from the foot of the Sierra Nevada Mountains to the city of 'Frisco, a distance of 150 miles, at 60,000 volts pressure, is likely to be fully completed in the course of the next few months. Aluminium cables, each consisting of 37 strands, are to be used for the overhead line, and the main trunk line will be 150 miles in length. The total capital outlay upon the scheme is estimated at £415,000.

Electric Tramways and Light Railways Transmission.—Although the use of aluminium in connection with traction developments is not proceeding so rapidly as in connection with industrial and mining undertakings, there are nevertheless instances in which it is receiving trial on an extensive scale for tramway or railway work. Thus the North-Western Elevated Railway Co. of Chicago have used 150,000lbs. aluminium to equip their overhead track in Chicago, and the line was started with the new power in the spring of this year. Very full details of the size of cable used and of the method of laying it alongside the track have been published in the American papers,‡ and some notes upon this cable have already appeared in the issue of *The Electrician* for June 2, 1899. Each cable contains 47 strands aluminium wire, grouped in sevens, and measures 1½in. in diameter. Vitrified clay blocks are used to insulate the cable, which is laid in wooden troughs. The inter-urban electric railway between Kansas City and Leavenworth has also been equipped with aluminium, and 70 miles of cable is stated to have been used for this line. The cable is $\frac{3}{4}$in. diameter, but no other details concerning it have been published. The Manhattan Elevated Railroad Co. of New York have also decided to use aluminium as conducting material on their line, and the transformation from steam to electric traction is now in progress. It is also reported that aluminium is being used experimentally upon a trolley line of electric tramways in this country, but the writer has been unable to obtain any details concerning these trials of the new metal for electric tramway work. Whether the skin of oxide which forms on all aluminium surfaces will render the metal unsuited for traction purposes, as suggested in *The Electrician* note of September 8, 1899, remains to be seen. Evidently in the States they do not consider this objection to aluminium of any importance.

Electric Light Cables.—Since aluminium cables for equal conductive capacity possess 1·68 times the sectional area of copper, it is evident that when insulated cables are necessary the latter metal has a decided advantage. On this account aluminium has never been used as a conductor excepting for overhead work, and for one or two of the schemes in which bare cables are laid along the surface of the ground, as for example, in electric railroad work.

As distributing systems for lighting purposes are practically always underground, insulated cables are used, and the writer has only record of two instances in which aluminium has been used for electric lighting schemes. One of these is in this country at Northallerton, where a small electricity supply company has made use of 4 miles of the light metal. Three sizes of wire were used, namely, 0·662in., 0·465in., and 0·380in., and screwed sockets were used for jointing purposes.* The writer has been in direct communication with this company with regard to their experiences with aluminium for distributing purposes, but so far the information promised has not come to hand.

The other instance in which the new metal has been used on a lighting system is in the United States of America, the Waxahachie Electric Light Co. of Texas having made use of aluminium in their distributing network about the year 1898. Their use of aluminium has, however, been restricted to short sections of their line, and only 2,700lbs. has yet been used.

The British Aluminium Co. informed the writer last November that aluminium had been supplied by the Foyers Company to various places in the North of England during 1899 for conducting purposes—in one case 1½ tons being supplied—but it was not stated whether the wire and cable supplied were to be used for traction or lighting systems.

Telegraph and Telephone Lines.—The use of aluminium for telegraphic and telephonic lines is making some progress. The Pennsylvania Railroad Co. is stated to have 16 miles of aluminium line in operation, wire of 0·144in. diameter being used.† The new telegraph line between Manilla and Cavite in the Philippines, 40 km. in length, is also of the new metal, and a wire 0·130in. in diameter has been employed. The Pacific States Telegraph and Telephone Co. are stated to have 200 miles of aluminium wire in use. Annoying breaks occurred at first, but these are now attributed to bad lots of wire having been used in the first installation.§

As regards the use of aluminium for similar work in this country and its dependencies, Sir William Preece has stated that it is now on trial in certain districts for long distance telephonic communication, and that he has recommended its use for telegraphic purposes in Africa.‖ The only unsatisfactory reports concerning this use of aluminium come from Messrs. Perrine and Baum, who state that in Washington and Oregon the telephone companies have experienced so much trouble with breaks in their aluminium wires, that they are replacing them.¶

On the other hand H. D. Fitch, a manager of the New York Telephone Exchange, has stated that in New York the new metal has answered well for telephonic communications, and that spans of 450ft. and 600ft. had survived two winter's exposure without mishap.** In view of this conflicting testimony, one can only conclude that the early breaks in aluminium overhead wires were due to defects either in the original wire, or to careless erection, and insufficient allowance for its high coefficient of expansion.

Conclusions.—The facts given above prove that aluminium has already made considerable progress as a substitute for other metals in overhead line construction for both telegraphic and power purposes. It has been stated that 500 tons of aluminium were used for these purposes alone in the United States of America in 1899. Whether this progress will continue, however, depends largely upon the further experience gained with the installations already in operation.

Prof. Forbes, in his Paper upon "Power Transmission," read before the Electrical Engineers in London on April 26th of this year, stated that the Westinghouse Company of the United States of America, which had recommended the light metal for use on the Tacoma and Seattle line, when asked to specify for its use on the proposed power transmission scheme in

* *Electricity* (New York), May 30, 1900.
† *Electrical Review* (New York), August, 1899.
‡ *American Electrician*, January, 1900.

* *Electro-Chemical Review*, June, 1900.
† *Aluminium World*, March, 1899.
‡ *El. Chem. Zeitschrift*, July, 1899.
§ *Aluminium World*, Jan., 1900.
‖ *Electrical Review*, April 27, 1900.
¶ *Electricity* (New York), May 30, 1900.
** *Western Electrician*, March 25, 1899.

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Mysore, India, had replied that its use was "too experimental" to permit of this.

For an American firm to make such an admission after trial of the new material for conductors is startling, and proves that even in that land of progress mistakes are sometimes acknowledged. That there is need for further investigation of the whole subject is certainly proved by this decision of the Westinghouse Company *not to advise* the use of aluminium for the Mysore scheme. The latest reports of Messrs. Perrine and Baum concerning the Californian transmission lines are also not reassuring, although these investigators consider that the breaks are due to causes which may be avoided or overcome, and as the following extracts show, they are willing to pin their faith to the future of aluminium as a conducting medium:—

In all of these cases it seemed almost impossible in certain sections to keep the wire on the poles, and in these portions the lines have been finally taken down and replaced by other wire of either copper or aluminium. The writers have examined many breaks from these lines, and would judge from the appearance of the fracture that the cause, whatever it may be, was similar. In those breaks there are many small flaws, but by far the greatest majority are clear, sharp fractures, with but a slight reduction of area, and that entirely on one side—a break very characteristic of improperly mixed and brittle alloys. Partially from the appearance of the fracture, and partially from the fact that the breaks appear only in certain sections of the line, the writers are of opinion that this trouble is due to the presence of impurities in the material. This view is strengthened by the fact that when measurements were made on the line of the Yuba Power Company, the resistance of the whole line was found to be 10 per cent. greater than it should have been if it were made of the quality of material described in the earlier part of this Paper.

As a general conclusion, it is the opinion of the writers that aluminium can be safely used in place of copper where the proper precautions are taken in inspecting the wire before it is erected, and in erecting it with due consideration of its peculiar properties—of low and indefinite elastic limit, high coefficient of temperature expansion, and active electrolytic power.

Messrs. Perrine and Baum have therefore advised the erection of a new aluminium transmission line in connection with the Blue Lake and Stockton scheme, of somewhat heavier wire than the line which was first erected. But the writer feels some doubt as to the correctness of Messrs. Perrine and Baum's assumption that difficulties arising from impurities and lack of physical strength are the only ones that have to be surmounted in the successful use of aluminium for overhead transmission lines. The resistance of the metal to atmospheric influences is by no means so great as was at one time imagined, and the proof is still lacking that an aluminium transmission line will possess the permanent efficiency of one constructed of the rival, but dearer, metal—copper.

The writer last year discussed the liability of aluminium to corrosion, on exposure to damp impure atmospheres, very fully in the Paper named below*, and gave a summary of recent communications on the subject presented by Moissan and Ditte to the French Academie des Sciences. The need for experimental work upon the resisting power of aluminium to atmospheric corrosion before using the metal for large power schemes was insisted on, and the recent experiences in the Western States only further emphasises the need for such independent investigation.

In the Paper before the Electrical Engineers already referred to, Prof. Forbes stated that he was carrying out some exposure tests with several hundred feet of aluminium wire in Scotland; and the writer for the past 10 months has also had a large number of samples of wire of various metals and alloys exposed in two different localities in South Lancashire, under conditions somewhat similar to those obtaining in overhead transmission lines.

The results of these independent observations and of the further experience with the power transmission lines erected in America and elsewhere will be of considerable interest, for if aluminium does not possess the requisite resisting power to atmospheric corrosion, its use as a conducting material will be greatly hindered, and the caution displayed by English engineers in regard to its use for electrical conductors will be fully justified. If, on the other hand, aluminium is found to have all the physical characteristics demanded for overhead construction in schemes of electrical transmission, the future of the metal as an electrical conductor will simply depend upon the relative costs of aluminium and copper, and until the price of copper falls below £60 per ton the lighter and cheaper metal is certain to find increasing support from electrical engineers, especially on the other side of the Atlantic, where the atmospheric conditions are more favourable than in Western Europe.

Prof. Forbes has not stated whether he intends to publish the results of his own observations. The writer has nearly completed the first series of those in which he is engaged, and he hopes to publish the figures obtained before the close of the present year.

* *Lightning*, July 13 and August 17, 1899.

WHAT TO DO WITH OUR BOYS.

This is a question that is constantly giving parents and guardians concern, as it has done for a good many years past. The development of the electrical industries has undoubtedly assisted in answering the question, not only in regard to boys, but in a great measure also in regard to girls. The telegraph and telephone services have found, and will continue to find for some years to come, employment for a large proportion of our surplus female labour, and it would appear that the developments of telegraphy, both submarine and ærial, opens the door for a much larger force of operators than is at present being attracted to the service. We have on several occasions dealt with the educational requirements of the budding electrical engineer, and now a communication we have received from Messrs. Preece and Cardew, on behalf of the Cape telegraph authorities, points to the opportunities which the telegraph service in Africa offers to fairly educated young men.

We may take as an example the classification of the Cape Colony posts and telegraphs. Lads enter this service in the 5th Class (probationers) with a commencing salary of £60 per annum. When competent to take charge of a public wire, or to perform duties of like importance on the postal side, they receive an increase to £75 per annum, rising by £15 annually to £105 per annum. On promotion to the 4th Class the commencing salary is £120 per annum, rising by £12. 10s. annually to £145; in the 3rd Class the commencing salary is £160 per annum, rising by £12. 10s. annually to £197. 10s.; in the 2nd Class the commencing salary is £210 per annum, rising by £12. 10s. annually to £247. 10s.; and in the 1st Class the commencing salary is £260 per annum, rising by £15 annually to £320.

It will be seen that the Cape telegraph service compares favourably with the openings offered at home for young men. The department under Mr. French at Capetown has a training college, and doubtless eligible lads from the mother country would be welcomed, as it would appear from present requirements that the supply of operators in South Africa does not anything like keep pace with the demand, and we believe the same remark applies to the telegraph service generally, at home, and the Colonies, and abroad.

We announce on another page that the immediate requirements at the Cape is for sounder clerks, who must be from 19 to 25 years of age, single, and competent to send clearly about 30 words per minute. For such candidates as can show, at 19, four years' certified manipulative experience the commencing salary is £132. 10s. per annum; five years' experience at 20, £145 per annum. In the latter case promotion to the next class, with the minimum pay of £160 may follow after a three months' trial if the candidate is then able to satisfactorily take his full turn at any of the main lines.

Candidates with under three years' experience who possess the necessary minimum skill (30 words per minute) may still be taken on at £120.

Second-class passage is paid contingent on the signing of a two years' agreement. The salary is payable from the date of embarkation. The appointments are not by transfer from the English Post Office as in former years.

When it is further remembered that the railway system throughout Africa is greatly extending, and that the opening up of our newly-conquered territories and beyond is one of the first questions to be considered when peace is restored, it follows that the railway telegraph service alone must afford skilled and well-paid employment to large numbers of young

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men. We are, therefore, quite apart from present needs, fully justified in calling the attention of parents and guardians to the telegraph and telephone services as those which will go far to solve the problem "What to do with our Boys."

We have not, in these brief remarks on an interesting subject, dealt with the question of supplementing the present training facilities for the two services; but clearly these facilities are not adequate, and it is for the Governments of the world, into whose hands the telegraph and telephone systems are drifting, to do more than is now done to satisfy the educational needs of a great profession. The training afforded in the schools of the Postal Telegraph service is for its own requirements solely; private enterprise, aided in a small measure by a few polytechnics and other scholastic institutions, are alone the sources from which the Colonies can draw. It is obvious that these will not suffice to meet the requirements for skilled operators which is already a feature of the almost universal demand for more telegraphs and more telephones.

A PRACTICAL TELEGRAPH TRANSMITTER USING THE SINE-WAVE FOR OPERATING THE WHEATSTONE RECEIVER.*

BY ALBERT C. CREHORE AND GEORGE O. SQUIER.

The Paper pointed out that the existing Wheatstone transmitter consists of an apparatus driven by clockwork, through which a band of perforated paper is driven at regulable speed, and contacts are made between a battery and the line at intervals which are controlled by holes punched in the moving band. For dot signals short contacts are made, followed by a reversal, while for dashes longer contacts are made, followed similarly by reversal. Direct-current dynamos are frequently used in place of batteries. Such periodic applications of E.M.F. to the line are characteristically rectangular in wave form, or square-topped as distinguished from being sinusoidal.

It was shown that the authors had produced a transmitter in which by suitably punching the paper band, the signalling currents could be obtained from a small alternating-current dynamo, a dot being formed by a positive impulse, followed by its negative successor—*i.e.*, by one compete cycle; a dash is formed by a positive impulse, followed by two blank semi-cycles and a negative impulse —*i.e.*, by two complete cycles, with the middle two waves suppressed. These contacts are made by a pair of small brushes resting on a metallic drum with the intervention of the punched paper strip.

The contact apparatus is mounted in an extension of the shaft of the little alternator, so as to ensure the making and breaking of the circuit through the contact brushes at the moments when the alternating current is zero. For long lines and speeds not exceeding 100 words per minute the alternator may be bipolar, for greater speeds multipolar.

Instead of mounting the contact apparatus on the alternator itself, it may be mounted upon the shaft of a little synchronous alternating-current motor which drives the perforated paper strip, and which is itself driven by an alternator at any distance. By this means a number of different transmitters may all be operated from one and the same alternator.

The advantages claimed for the transmitter are:—

1. The capability of using higher transmitting voltages than at present, because there is no sparking at the contacts, these being lifted at the zero instants.
2. The greater speed that can be obtained on long lines, partly by the use of greater voltage, and partly by the use of sinusoidal voltages as distinguished from rectangular voltages.
3. The capability of giving the same speed to a number of different transmitters, and maintaining that speed indefinitely.
4. The absence of all transmitter batteries.
5. The simplicity of the apparatus.
6. The fact that the tape can be put into the transmitter upside down without affecting the transmission.
7. The elimination of repeaters by reason of the increased speed.

It was stated that comparative trials between the regular Wheatstone and the Wheatstone provided with this sinusoidal transmitter showed a gain of nearly 100 per cent. in favour of the latter. Tests were cited to this effect. It was stated that whereas a safe formula for ordinary Wheatstone was

$WKR = 10 \times 10^6$ where K = capacity of line in microfarads,
R = resistance of line in ohms,
W = working speed in words per minute.

The corresponding formula for sinusoidally operated Wheatstone was $WKR = 18 \times 10^6$, and this when not employing more than 230 volts of alternating-current pressure.

It was also stated that sine-wave transmitters have recently been installed upon the land line of the Commercial Cable Co. from New York City, U.S.A., direct without repeaters to the Atlantic cable landing at Canso, Nova Scotia, a distance of about 1,115 miles. The speed of transmission of the line thus equipped exceeds the entire carrying capacity of the Atlantic cables of this company.

* Abstract of a Paper communicated to Section IV. (Telegraphy and Telephony) of the International Electrical Congress, Paris, August 23.

ALTERNATING-CURRENT INDUCTION MOTORS.

BY A. C. EBORALL.

We give below a reprint of the discussion which followed the reading of the above Paper at the Institution of Electrical Engineers on May 17th last. The official report of this discussion having already been published in the *Journal*, and several speeches having been considerably modified under revision, it has been suggested to us that we should reprint this official report in place of our own report of what was said at the meeting. We have therefore followed out this suggestion, which will explain the departure, in this particular instance, from our usual custom to report in the third person.

DISCUSSION.

Mr. M. B. FIELD: Mr. Eborall commences his Paper with an apology for bringing before the Institution one which he says contains but little that is really new from the technical point of view. Now, I venture to think that this apology is quite unnecessary, for I believe I am right in saying that many of the ingenious devices which Mr. Eborall has explained to us to-night, although perhaps not new, are new to many of us; at any rate, they were to me. The Paper contains a large amount of information which is extremely useful, as well from the manufacturers' as the users' and theorists' points of view. The method of building up the stator core described by Mr. Eborall whereby all tooling is rendered unnecessary is very interesting. But it is to be pointed out that one has to depend entirely upon the friction between the individual plates to avoid displacement of the same, or rotation of the stator core as a whole. Where paper insulation between the core discs is employed, some 15 per cent. of the total space will be thus occupied, and with the

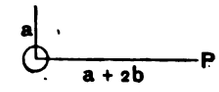

FIG. A.

continual heating and cooling of the motor this may shrink, and thus tend to relieve the friction between the end plates; consequently for large-sized motors this construction is not suitable. The question of tooling the stator cores is very important, but it is not very important whether the rotor core be tooled or not. The slip is very small, and hence the eddy currents produced in the rotor surface will likewise be small; moreover these will not be detrimental, but will add to the torque rather than decrease it. The figures on page 676 ("Notes on Performance and Design") are very instructive, but I would suggest that the author adds in his Paper when printed in the *Journal* the corresponding figures for continuous-current motors. I know this does not exactly fall under the heading of the Paper, but a comparison would be so very interesting that the departure would be quite warranted. The comparison between the efficiencies of polyphase and single-phase motors is also noteworthy. We must remember that a given rotor developing a given H.P. has twice the C^2R rotor loss if in a single-phase field, to what it will have in a three-phase field of the same strength; so that in order to get high efficiency in the single-phase case one can only do so at the expense of extra material, which fact, I think, is borne out by the table of weights given on page 676. From this it appears that the weight of the single-phase motor is about 50 per cent. higher than that of the corresponding polyphase motor.

I should like to make a few remarks with regard to the starting of the Heyland motor, as it seems to me that this is a radically new departure. I have always been under the impression that it was of no advantage to make the starting field larger than the working field, the aim of the manufacturer being to obtain as nearly as possible a pure rotating field at starting. This, of course, is not the case, as is easily seen by the following diagram. Let a be the strength of the alternating flux produced by the working phase winding, and $(a+2b)$ the corresponding flux produced by the starting winding. Suppose these two fluxes are in quadrature both as regards space and time. If we combine the working phase flux a with a portion of the starting flux equal to it in magnitude, we get, of course, a rotating flux of strength a, and superimposed upon that an alternating flux of strength $2b$ in the direction OP. Now, this latter flux we may consider replaced by two rotating fluxes, each of strength b, rotating in opposite directions with the same velocity, viz., that corresponding to the frequency. Further, these two fluxes b will coincide and be directed along OP at the same instant that the rotating flux a lies in this same direction; in short, the resultant of the working and starting winding fluxes will be a forward rotating flux of strength $a+b$, and a backward rotating flux of strength b.

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When the motor is starting the speed of rotation of these two fluxes is the same, and since each pulls on the rotor, the one forwards and the other backwards, with a force proportional to the square of itself, we get for the resultant starting torque an expression proportional to $(a+b)^2-b^2$ or $a\ (a+2b)$. In other words, the starting torque is proportional to the product of the two fluxes, which shows us at once the advantage to be gained by making the starting flux large. If the two fluxes are not 90deg. out of phase with one another, but differ by the angle ϕ, then the starting torque is proportional to $a\ (a+2b)\sin\phi$. Mr. Eborall says that in the Heyland motor ϕ may be 50deg.; assume it to be only 45deg, then we see it is only necessary to make the starting flux 1·4 times the working flux in order to obtain precisely the same starting torque as would be obtainable in the corresponding two-phase motor. We may say briefly, if A and B be the working and starting fluxes respectively and ϕ the phase difference, they represent, as far as their starting capabilities go, a rotating flux of strength $\sqrt{AB}\sin\phi$.

With regard to the method of winding the Heyland motors for the purpose of altering the number of poles, it seems to me that the Paper is not quite clear. Mr. Eborall says: "On the other hand, the method of altering the number of poles has two serious disadvantages. Firstly, the reduction of the number of poles causes an unfavourable distribution of the magnetic flux, a large increase of magnetic leakage and a loss of winding space. This is of course owing to the fact that after the reversal of the appropriate coils the currents flowing down one side of those coils are neutralised by the currents in the adjacent side of the unreversed coils, as will be readily seen from Fig. 14, illustrating the single-phase case." Now this is not necessarily so: at least it is entirely a matter of arranging the winding so as to have as many coils as poles, or as many coils as pairs of poles. In Fig. 14 we have four coils—that is to say, we have as many coils as poles, and that is the reason why part of the winding is neutralised when the two coils are reversed. If we change that winding and put as many coils as pairs of poles, making two coils instead of four, we shall find the

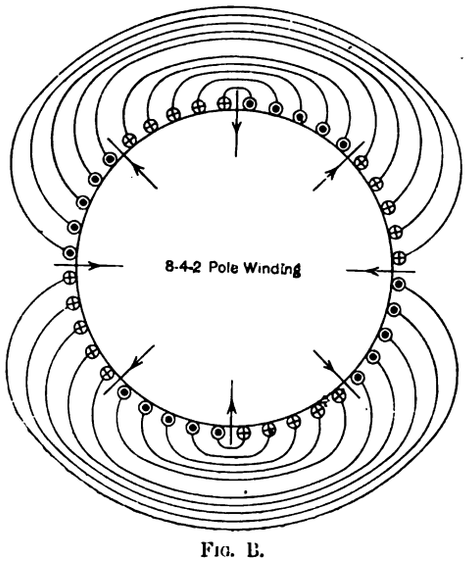

FIG. B.

windings are not neutralised when we reverse one coil. Fig. 16 shows this very well. This winding is not particularly a Heyland winding, but merely a normal winding with as many coils as pairs of poles. On the right-hand side there is an eight-pole winding with four coils. When we reverse two of the coils we get four poles. The Heyland winding corresponding to Fig. 18 for that case would be as shown in Fig. B. Fig. 18 shows a twelve-pole winding. If the connections of the coils be altered, we can get a six-pole or a four-pole or a two-pole winding. In the above diagram we can get an eight-pole, a four-pole, or a two-pole winding by similarly altering the connections between the coils. Fig. 16, on the other hand, shows an ordinary winding which has been known and employed for a very long time. It differs from the Heyland arrangement in that the only variation possible is 8-4 poles. We have, in fact, as above stated, an eight-pole winding with as many coils as pairs of poles. We can therefore reverse half, and get half the number of poles with none of the windings neutralised, thus obtaining as many coils as poles. If we were again to reverse half the poles, half the winding would be neutralised. The only variation feasible is thus from eight to four poles. That is the main difference between this and the Heyland winding shown in above diagram.

Mr. LANGDON DAVIES: There are one or two matters which I should like to refer to. The author says, "With single-phase motors which are usually arranged to start up light, wound rotors with slip rings should be used over 7½ B.H.P.," but he does not appear to give any explanation why this should be. I have seen larger sizes without them, and should therefore be obliged if the author would kindly give his reasons. With regard to one particular type of motor the author says: "The winding carrying the current of greater phase difference is made to have the smaller self-induction." I do not understand, considering that there is nothing exterior to the coils, what produces the "greater phase difference" if it has the smaller self-induction. It may be that he and I attach different meanings to the term "self-induction." Later he says: "The production of a rotary field on starting is not aimed at." This appears to require explanation, because a rotating field is absolutely necessary to start an induction motor of the type described. Also a considerable phase difference, I believe 50deg. or more, is claimed later on. The form of stator winding described is interesting, and appears to save turns. I should like to know if the author can give any details of starting torques for given current values without any resistance in the rotor; that is to say, with an ordinary short-circuited rotor of any type. These would be interesting, as they would show the difference produced by this stator winding, irrespective of the addition of resistance to the rotor windings, which is not new. The Paper is an exceedingly interesting one and raises many points for discussion.

Mr. W. G. RHODES: I have listened with very great interest to Mr. Eborall's Paper. It deals with a subject which has not for some time been brought before the notice of the members of this Institution, and one which certainly deserves more attention than it receives in England. It is, in my opinion, a subject which will eventually have to engage our attention, whether we will or no. There are, as Mr. Langdon Davies has pointed out, some rather peculiar remarks in the Paper which require elucidation. One regarding self-indnction, on page 677, perhaps may be explained in this way. I think that Mr. Eborall is rather misusing the term self-induction, because, in my opinion, the coil has a *larger* self-induction. The self-induction of a coil when there is another coil near to it is the number of lines of force which link that coil only and escape the other. Now Mr. Eborall distinctly states in his Paper that the starting coil is wound in such a manner as to produce large leakage. That large leakage, I take it, is the self-induction. The Heyland motor is wound so that the running coil has a minimum leakage—no self-induction—if possible, while the starting coil has a large leakage, that is, a large self-induction. The reason why a better result should be obtained with a small number of turns on the starting coil is that a larger current is allowed to pass, producing a large useful flux, or mutual induction, and at the same time a large self-induction to displace the current out of phase with the impressed potential difference. I prefer to view these problems rather from a physical aspect than from a mathematical one, although I have often looked at them from both points of view. On page 676 the flux density in the iron is given; I imagine that it is rather too high. In transformers it is not customary to go up to 10,000 lines or even to 5,000 lines per square centimetre, on account of the large hysteresis loss. An induction motor is like a transformer, and the stator is subject to the full frequency of the supply circuit, so that, in order to keep the efficiency of the motor within reasonable limits, it is advisable to keep the induction density moderately low.

With regard to Mr. Eborall's statement as to the standisation of periodicities and voltages for alternating-current motors, one cannot say too much in favour of it, because the want of such standardisation is undoubtedly the manufacturer's bugbear.

As to the possibility of starting monophase induction motors under load, it seems to me that too much attention has been devoted to the stator windings. Undoubtedly the Heyland winding is an extraordinarily good one; we will not dispute that. It produces good results. We are told that the phase difference between the starting current and the running current is about 50deg. The two mutual fluxes, the mutual flux of the running coil and rotor and the mutual flux of the starting coil and rotor, should approximately produce a uniform rotating field. The leakage flux of the starting coil should displace the current in it as much as possible, the nearer 90deg. the better, though of course this value cannot be attained, but the greater the displacement of phase the better it is for starting. If further improvement is to be made in the starting of such induction motors, we shall have to look to the rotor. The Heyland motor is, as far as the rotor is concerned, worked by inserting at the start a resistance into each of the three circuits. The object is to cut down the rotor currents at the start, because the rotor itself has a large self-induction, producing a large leakage field—a large field which does not cut the stator running coil. The insertion of resistance into the rotor circuits diminishes the leakage field, which, by its demagnetising action, tends to nullify the effect of the stator magnetising current, but it also diminishes the rotor energy current, which is in phase with the E.M.F. induced in the rotor coils and which produces the torque. What we ought to do, if possible, is to wipe out the self-induction of the rotor coils completely, in fact, to have no self-induction of the rotor coils, no self-induction of the running coil, and a large self-induction of the starting coil. It is impossible to wipe out the self-induction of the rotor coils by means of a non-inductive resistance to start with, and to put in an inductive resistance to start with is worse, because that will throw the current more out of phase with the induced E.M.F. I have tried myself to nullify the effect of the leakage field due to the rotor currents themselves by the injection in the rotor circuits of counter E.M.F.s which will act in opposition to the leakage field produced by the rotor currents, and I have got very fair results from it. For instance, I have got a motor to start with full-load torque with approximately 1½ times full-load current. That is not very good, but it is fairly so, and may probably be improved. I have now in process of manufacture by the Clayton Engineering and Electrical Construction Co. (Ltd.), a two-horse induction motor for 50 cycles and 200 volts, and I am anticipating that the starting current will not much exceed 13 amperes. The counter E.M.F.s are obtained by tapping the stator circuits in a suitable manner and connecting through a suitable switch with the rotor collector rings. It can be done by using transformers with negligible leakage. The necessity of having little or no self-induction of the rotor coils and running coil is obvious when we consider the low power factor of alternating-current motors. When we cannot get more than about 75 per cent. power factor, it shows that the leakage is considerable.

We cannot consider the alternating-current motor, either polyphase or monophase, anything like perfect until we can have at the same time a

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frequency changer. The present method of changing the speed is altogether crude and unscientific. It does not admit of any gradual change of speed at all. It can jump from one speed to another and back again suddenly, but the gradual change of speed is impossible with the present means. The only means of doing that and of obtaining the results which we hope to do with induction motors, is by the introduction of frequency transformers giving a very wide range of frequency.

Prof. ERNEST WILSON: Mr. Hurst has prepared some curves for me which are shown in the accompanying diagram. The data from which those curves have been obtained were supplied to me by well-known manufacturers of induction motors. In the diagram vertically the weight of the motor, suitable for belt-driving, is given in pounds, without reckoning foundation rails, starting resistances or anything external to the motor. Horizontally is plotted a quantity which I once ventured to call a "mass factor"—that is to say, it is the B.H.P. of the motor divided by the revolutions of the motor per minute. The curve A refers to a single-phase motor suitable for working at a frequency of 50 periods per second; the curves B, C, E and F refer to multiphase motors at 50 periods per second; whilst the curve D refers to multiphase motors at 60 periods per second: the data being such that the curves are comparable with one another. The dotted curve a refers to direct-current four-pole motors made by a well-known firm, and is included for comparison with the curves which have been obtained from the induction motor data. I should like to point out that different makers have widely different ideas as to what the weight of a motor should be for a given mass-factor. For instance, taking a mass factor of 0·1, the weight may vary through very wide limits, according to the ideas of the several makers; and this, I think, is an important matter. The prices of these motors have been plotted in terms of the

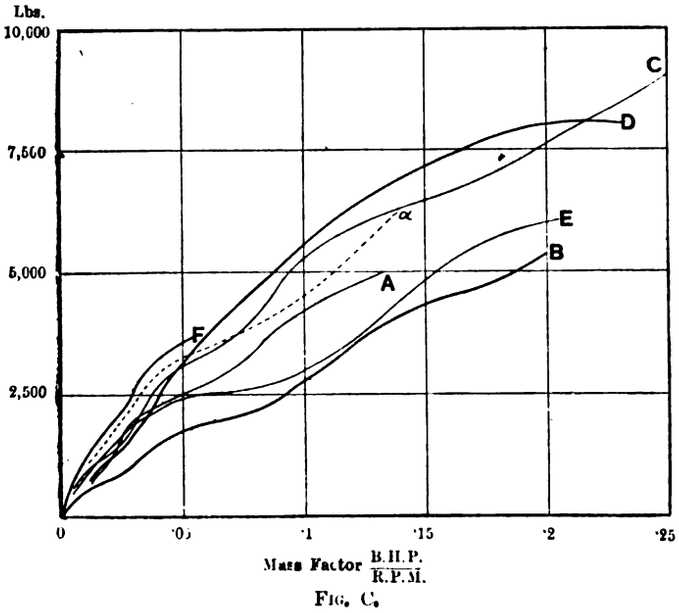

FIG. C.

mass factor. I have not got the diagram here, but there is not such a great difference between the prices as there is between the weights. In conclusion, I wish to congratulate Mr. Eborall on presenting such a valuable Paper.

Prof. C. A. CARUS-WILSON: The most interesting part of this Paper is that relating to starting devices for single-phase motors, I have endeavoured to make out from Mr. Eborall's Paper exactly how Mr. Heyland's device works, but it is not easy to ascertain what is the real action producing this result, and the difficulty is increased by the way in which Mr. Eborall uses the word "self-induction." The problem of the single-phase induction motor point is to get a strong field lagging well behind the primary field. One way in which this has been attempted is, as Mr. Eborall has indicated, to use an outside choking coil. The disadvantage of this method is that while you get a good lag you waste your field—that is to say, the flux in the choking coil is no use for producing torque, or, as Mr. Eborall puts it, "the strength of the cross flux, *in the motor*, is diminished by an amount equivalent to the leakage flux of the coil." If, on the other hand, you try to get your lag by using a starting coil of large self-induction, you find that the effect of the self-induction is neutralised by the reaction of the currents in the rotor, so that you have a strong field but a poor lag. What Mr. Heyland has done is practically this: He has taken a single-phase motor with the usual starting coil and no outside choking coil, an arrangement which, under ordinary circumstances, would give you hardly any starting torque, and he has allowed some of the useful flux of the starting coil to leak, by providing it with a carefully designed leakage path, and this leakage flux is enough to give a good lag. It is true that by permitting leakage he weakens his field, but in doing so, he gets a field out of step with the torque-producing field, and in that way he is able to get a good lag. I think that the real discovery Mr. Heyland has made is that it pays to take away part of the total field of the starting coil, when by so doing you can make it leak, and thus get a good lag. As to the reason why it is found advantageous to have but few turns in the starting coil, it seems to me simply a question of ohmic resistance, since by lowering the resistance you can increase the lag that you get for any given self-inductive effect. Mr. Heyland has certainly obtained good results, that is to say for single-phase motors, namely, a full-load starting torque with twice the full-road current. Looking at the diagram on page 811, one sees in the first place that the speed regulation is good for a motor of that size: in fact the speed regulation of a single-phase motor is in general better than that of a polyphase motor. The efficiency is very fair as shown by the diagram. The great defect is, no doubt, the low power factor. Few things are more provoking to the electrical engineer than lagging current. One feels that it is not doing the least good, and yet you cannot get rid of it. Of course with a single-phase induction motor all the bad effects due to lagging currents that you get in the polyphase motor are intensified, since the primary current has to carry the magnetising current for both the main field and the cross field, and consequently you get a very low power factor, as shown in the diagram, something between 50 per cent. and 60 per cent. at half load. Electrical engineers have made great efforts to increase the value of the power factor. In this connection it is difficult to avoid mentioning the name of Mr. Steinmetz, the Clerk Maxwell of alternating-current engineering, since it is almost impossible to say anything about induction motors that has not been written or said by Mr. Steinmetz. It is not, I think, out of place to refer to the remarkable discovery—as I think it may be called—quite recently made by Mr. Steinmetz of the single-phase condenser motor. In the course of experiments Mr. Steinmetz found that if in a single-phase induction motor you connect the starting coil, called by him a tertiary coil, to a condenser of suitable capacity, it can be made to supply the magnetising current for the cross field, thereby relieving the primary of the burden of supplying that current, and thus raising the power factor to that of an ordinary polyphase motor. Further, by increasing the capacity of the condenser, not only can it be made to supply the magnetising current for the cross field, but also that for the main field. In this way the condenser actually supplies the whole of the magnetising current, and the power-factor is raised to 100 per cent. It is true that this gives no advantage at starting, it simply enables you to run at synchronism with a high-power factor. Mr. Steinmetz gets his starting effect by shifting the tertiary or starting coil round through a certain angle. This seems to have led him to the idea of applying this method to an ordinary three-phase motor, that is to say, simply to put the condenser across one of the three-phase connections. In this ways he gets a good starting effect—though not as good as when the motor is running on a polyphase circuit. Not content with putting a condenser coil across one of his three-phases, he puts a reaction coil across the other, and finds that he is able in this way to make the starting torque and the output of a single-phase induction motor as high as could be obtained if the motor were running as a three-phaser, and at the same time with a power factor at synchronism of over 97 per cent. I think that is a remarkable result. It will be said that with this system you have to use condensers, and that there are serious objections to this. No doubt there are objections to condensers, but like many other objections they may perhaps be got over. In any case I think Mr. Steinmetz may be congratulated upon his achievement.

Mr. S. Z. DE FERRANTI: I have followed this Paper with the greatest possible interest, but the concluding remarks interested me even more than the Paper, because in them the author says that single-phase supply is practically played out. Well, if that is so, I think it is a very great pity to have taken up the time of one of the Institution's meetings with a Paper about single-phase alternating-current motors. So far as I can see, single-phase alternating supply is only just commencing, provided it is carried out in the right way. I do not say that to-day for a large power scheme I should feel inclined to lay down a single-phase system, but I feel confident that in less than a year's time we shall be planning single-phase power schemes for all purposes. Indeed, to-day it would be very hard to get anything better than a single-phase power-supply for feeding a continuous-current network. I think it would be found the cheapest way of doing it through motor-generators, and I think it will be found the most efficient and generally the most satisfactory way. For town lighting, where there is a fair amount of motive power work, very excellent motors, among them that of Mr. Heyland, have made this quite a practical system, and there is very little superiority of the continuous-current for ordinary motor work over a low periodicity alternating. There is, of course, the question of running lifts, and motors of that class still require a satisfactory solution. I am, however, quite confident, and that apart from what we hear that Mr. Steinmetz has done, that there will be before long commercial single-phase motors on the market with a power-factor of very nearly unity, and an efficiency of about 90 per cent., or even more, in ordinary practice. With regard to what we have heard about Mr. Steinmetz, it seems strange, since the problem is solved, that we do not see the result of the solution on the market. As a matter of fact, I do not think Mr. Steinmetz was at all original in the work that we have heard attributed to him. Who really started this idea I do not know, but I saw eight or nine years ago a motor fed on a single-phase circuit running practically as a two-phaser and using a condenser on one circuit which gave all the results that we have heard of, and yet that motor is not on the market. I suppose the reason is because one of the elements—the condenser—is commercially wanting. If we had the condenser it would settle a great many problems and improve a great many rather awkward positions. No doubt the demand will bring forth the article sooner or later, and I hope sooner. With regard to the question of single-phase motors as applied to the production of power in cities, ordinarily, I think that engineers running single-phase installations need not feel in the least uncomfortable or anxious about the future of their installations, provided they are of low periodicity. We have heard, as I said before, that this class of work is played out; but, on the other hand, I think this class of installation is just commencing its real career of usefulness. Still, I would like to point out that high-frequency installations are at a very great disadvantage, and whatever improvements are made in the way of motors and in the way of running these systems

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generally, I do not think that they will ever get to be as satisfactory commercially or as good generally as low-periodicity single-phase systems. There is no doubt that the low periodicity greatly assists the motor question besides many other questions, and I think that when we have got the few additionol developments which are still wanting we shall see the bulk of power-supply and distribution work done with single-phase alternating currents.

Mr. W. B. ESSON: The large attendance at this meeting shows the great interest which is being taken in induction motors, and Mr. Eborall is to be congratulated on bringing this subject before the Institution. But in the short time at our disposal the matter cannot be discussed in the way it certainly deserves. I should like to say that I appreciate in the highest degree a remark made by the author at the end of the first part of the Paper, where he says "that experience in designing and a large quantity of experimental data for the type in question are absolutely necessary if the best results are to be obtained." If you devour the whole literature of the subject the feast will not enable you at the first trial to design a good induction motor, and I think every designer knows that. Coming to the points of construction, I am very interested in Mr. Eborall's way of building up the stator plates, but there appear to be some disadvantages which Mr. Field has already alluded to, and which may become accentuated in motors of large size. In the motors my firm has made we have fitted the plates right into the cast-iron stator cases. We find that we cannot dispense with the tooling, because the stampings are not good enough to enable us to have a uniform gap of $\frac{1}{16}$in. with plates of 12in. diameter, without tooling inside. Mr. Eborall puts the matter in this way. He says: "I cannot use the hole stampings, because if I do I have to tool them, as the shred of iron left must be very small." On the other hand I put it this way: I have to use the hole stampings for small motors, because there is no other kind I can tool. If I have slotted stampings they cannot be tooled, because they burr up. There is a question in my mind as to whether the stators with the straight slots, as made by the American companies, notably the Westinghouse Company, or the stators with the hole winding made by the Continental firms, are the best. The one has certainly all the coils wound on formers, and you get a perfectly symmetrical winding, and a winding, I think, which should be easier to repair than the hole-wound stators, where you have bent coils and straight coils alternately. It is a very important point in sending motors abroad, where no technical skill can be found—or, at any rate, the technical skill is of a very low order — to have motors that require no repair, or very little repair; and when they do want repairing the repairs ought to be able to be performed in the easiest possible way. On page 644 Mr. Eborall refers to the starting of the motors, and he says: "For motors having to start against load (apart from crane, elevator, and mining motors) the author is decidedly of opinion that the squirrel-cage construction, or its modifications, should be avoided with all polyphase motors about 5 B.H P." That, I believe, is the Continental practice. Motors with squirrel-cage windings are not usually made above from 5 H.P. to 10 H.P., though I have got some firms to make them as high as 22 H.P. On the other hand, the American practice is quite the reverse. There they make motors of any size with squirrel-cage windings. The largest I have had was from the Westinghouse Company—a 50 H.P. with squirrel-cage winding, and it gave every satisfaction. I should like to hear more fully the author's reason for limiting the size of a motor with a squirrel-cage winding to such a low power as 5 H.P. It must be remembered that a wound rotor is much more expensive. In the case of a wound rotor you want, probably, four times the amount of copper to get the same result, and with the wound rotor you have a somewhat smaller power-factor. Coming to the figures which Mr. Eborall gives of the performance in "Notes on Performance and Design," in my Society of Arts Paper, read in 1897, I gave some figures of the power-factor. These were not the same as those of Mr. Eborall, and they differ in this way, that Mr. Eborall's figures are, I understand, guaranteed performances, whereas mine were actual performances. There is a very great difference. I have had the figures for power-factors, which Mr. Eborall gives specified and also guaranteed, but I have never got them. I can tell you what is given by the very latest and best practice on the Continent. I have had an opportunity of testing all sizes of two-phase motors, from 5 H.P. up to 100 H.P., and the very best power-factor we ever got with a 15 H.P. was 81 per cent. (that was with a squirrel-cage winding), with 25 H.P. 78 per cent., and with 100 H.P. 80 per cent. They were two-phase motors, with a frequency of 50. While therefore I am a great believer in the induction motor, I am no believer in Mr. Eborall's figures. That, I think, is all I have to say on the motor question. There is one point which has been referred to by Prof. Carus-Wilson, namely, the question of condensers. I should like to hear from Mr. Eborall whether latest advices from the Continent and America on the subject show condensers to be commercially successful. Several years ago the Stanley Manufacturing Co. in the States introduced as an ordinary thing in their catalogues condensers for working with two-phase motors, but I never heard whether they had been successful commercially or not. I should very much like to have some information upon that point.

Mr. G. L. ADDENBROOKE: I think Mr. Eborall is to be congratulated on the manner of his Paper, as well as the matter. It seems to me that he has presented the whole subject in a very well-balanced way. There is one point with regard to the power-factor which I should like to allude to, following on what Mr. Esson has said. It appears to me that the wattless current taken by motors, though not actually constant, is more or less a sort of constant over a considerable range, and it would be very useful if, in the figures he has given us, Mr. Eborall could split up this no-load current into two factors, the watt current actually taken for friction and magnetising the iron, and the actual wattless current required to produce the field. These figures are very useful, because if you have that constant for no load it enables you to get an approximate figure for the power-factor for any other load. I do not say that it is absolutely so, because leakage comes in with a heavy current, but it certainly gives a very useful approximate figure.

The only other point I wish to deal with is the question of single-phase *versus* two-phase or three-phase. It is rather unfortunate, when we are proposing to open out into this work, that this question should be raised again. I have spent some time in looking into the matter from a practical point of view, and it seems to me that it is difficult to form any very definite opinion on the subject, as one cannot go on any very clear-cut lines. You can get up to a certain point, after which we must speculate upon unexpected developments of some sort or other. Mr. Ferranti may know something which he has not told us which might modify our ideas, but I must say I cannot see anything on the horizon which would in the end make single-phase better than a two-phase or three-phase alternating-current for most purposes. Supposing we actually succeeded in making a single-phase alternating motor as good as a two-phase motor—to all intents and purposes—should we have a very great gain? Would it not still be better to have two-phase or three-phase? Are there not certain advantages in having two-phase and three-phase. I do not say in the motor itself, but in the whole system, which would outweigh a question of the apparent simplicity of single-phase? That is the point.

Mr. EUSTACE THOMAS: Mr. Eborall's Paper has raised many points of interest, but it will only be possible at this late hour to refer to one or two of them. The use of squirrel-cage rotors has been disparaged in a manner which is, I think, somewhat too general. There are many cases where a squirrel-cage rotor would produce objectionable disturbance even in a motor of only 1 H.P. or 2 H.P. On the other hand, there are cases where such rotors can be used with advantage in motors of 50 H.P. or more. Perhaps the only generalisation that can be made is that squirrel-cage rotors should be used in all the numerous cases where no serious disturbance will result, and where the other conditions are suitable; the engineer will have to decide each case on its own merits. An engineer cannot afford to get the reputation of being a "wound-rotor man," or a "squirrel-cage man," any more than he should allow himself to be considered a "continuous-current man" or a "three-phase man." Each system should receive application in its proper place.

In his "Notes on Performance and Design," Mr. Eborall gives values which are, I think, more applicable to the closed slot, or Continental design, than to the open slot American type. The latter undoubtedly has a larger magnetising current, but it possesses the advantages of form-wound, interchangeable windings, and seems to give somewhat better results as regards breakdown point, efficiency, and power-factor, although these do not depend only, of course, on the shape of the slots. In illustration of this, I may quote the following tests selected at random. The breakdown point of a 5 H P. motor occurred at 2·7 times full-load current, and of a 50 H.P. motor at 4½ times. Motors of intermediate capacities had values between. This is a matter of considerable importance, as the available torque varies as the square of the voltage, and such losses as commonly occur in distribution systems have frequently resulted in the motors failing to carry their load.

As regards efficiency, tests of a 5 H.P. motor showed 81½ per cent., and of a 15 H.P. motor 88·9 per cent. The 5 H.P. motor further gave a power factor of 87½ per cent. It may be that the values in the Paper are guarantees, in which case, no doubt, a factor of safety has been allowed, and the difference would not be so great. As further illustrating how motors of good design may differ, and still give good practical results, I may say that the air-gap on small motors may be larger, and on large motors smaller than Mr. Eborall's figures with good results.

The preceding discussion has made it clear that the Heyland motor starts in the same general way as other motors commonly used, and it is unnecessary to dwell at length on the matter. To Heyland is due the credit of seeing that a large field produced by the starting coil is an advantage, and that sufficient lag can be obtained in the coil alone, by bunching the windings and so shaping the slot that a considerable leakage path exists. Mr. Field's explanation of the value of the larger flux is new and interesting.

The question has been raised by several speakers as to the possibility of using condensers commercially with single-phase motors. I am able to say that they have to my knowledge been used for some time past with success. After what has been said, the Institution may be interested to hear some of the results obtained on the commercial, as distinct from the experimental scale. A 5 H.P. motor gave a power factor of 90 per cent. and an efficiency of 80 per cent. It further started with full-load torque at 1½ of the full-load current. The advantages of the system both as regards starting and running will thus be apparent, and should make it possible to use such motors on existing lighting circuits, having poor regulation on account of (magnetically) leaky transformers, or other cause.

Prof. CARUS-WILSON: Was a reactance coil used?

Mr. THOMAS: No. The motor may be described as a three-phase motor, the single-phase line circuit being joined direct to two terminals of the motor, while the third motor terminal was joined to one side of the single-phase circuit through a condenser. The condenser remains in circuit, and the motor with its condenser is treated as though the circuit were three-phase. In this case there is no starting coil to be cut out, but the whole of the winding is available both for starting and running, and hence the motor may be considerably smaller than the ordinary single-phase machine. This is of interest in relation to Mr. Eborall's remarks on the subject of size, and in that it enables the cost and weight of the motor and condenser combined to be kept within limits. The shipping weight of a 5 H.P. motor with all starting gear was 610lb., but this contained a considerable proportion of packing, probably about 20 per cent. The advantages of good power-factor, efficiency, and starting are thus obtained without extravagant weight or expense. The system of speed regulation described enables the speed of the motor to be doubled, but intermediate values must be obtained by resistance in the rotor circuit. I have the results of tests made on motors with a variable number of poles some time

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back, and it is evident, as might be expected, that the constants of the motor suffer. In the cases that have arisen in my own practice, a speed range of two to one has usually been the extreme limit, and the limit speeds have been seldom required, the motor usually running at some intermediate value. This unfortunately greatly moderates the value of variable pole speed control; but within their limited field of application, the devices of Mr. Heyland are ingenious and command respect.

Mr. A. C. EBORALL, in reply, said: I have to thank the various speakers very heartily for the honour they have done me in discussing the Paper, and for their appreciative remarks. Several questions of considerable interest have been raised, and regarding these I would like to reply as follows:—

Mr. Field thinks that the method of building up the stator core-discs of induction motors, employed by my firm and described in the Paper, may prove objectionable on account of the plates working loose under the continual heating and cooling to which they are subjected in the motor. I think Mr. Field will agree that his objection entirely disappears when I tell him that the rivets are put in hot. As stated in the Paper, however, the method is not so suitable for very large motors, and modifications are introduced for motors above 30 B.H.P.; up to this size it has proved thoroughly satisfactory, and several hundred motors so constructed have never given the slightest trouble. Mr. Field suggests that I should give some figures for direct-current motors relating to design and performance, for purposes of comparison with the induction motors. It is a little difficult to do this, because the figures for various makes of direct-current motor vary enormously, on account of the variation in design; with induction motors this difficulty does not come in to anything like the same extent, as the general design is practically the same with all makers. But I may say that, generally speaking, the efficiency figures guaranteed by different makers for semi-enclosed direct-current motors are about the same as those given in the paper for polyphase motors, and the same remark applies to the heating. But the overload capacity is much less, and the weight per B.H.P. considerably greater for such motors, compared with the figures for polyphase motors. I am sure we are all indebted to Mr. Field for his very clear proof that in order to get the greatest possible starting torque with a single-phase motor, it is necessary to make the flux of the starting coils much greater than that of the running coils, and that it is not necessary to aim at the production of a uniform rotating field at starting. Mr. Heyland arrived at this result in quite a different manner, his method being not nearly so simple as that of Mr. Field, but it is curious that this important point should have been missed by every other designer of single-phase motors. Mr. Heyland saw some years ago that the idea of two equal fluxes at starting was fundamentally wrong, because the current in the starting coils of the single-phase motor cannot be made by any known means to have a lag of anything like 90deg. (as with the second phase of a two-phase motor), and he proved that by allowing the starting flux to be stronger than the flux of the running coils by a definite amount, it is possible to imitate the starting conditions of a two-phase motor, which is, as Mr. Field says, a radically new departure in single-phase motor design. The result has been that the Heyland motors are far and away ahead of any other single-phase motor with regard to the value of starting torque obtained with a given current consumption. Mr. Field's remarks on the Heyland speed-changing device are perfectly correct, and may serve to make that portion of the Paper referred to somewhat clearer.

Mr. Langdon Davies asks for my reasons for stating that single-phase motors above 7½ B.H.P. should be furnished with slip-rings. My own experience in this matter has led me to this conclusion chiefly on account of the better starting and greater overload capacity (particularly the former) brought about by the employment of wound rotors and a non-inductive resistance. I have found that with a given single-phase stator winding, a wound rotor used in conjunction with a non-inductive resistance will start and run up to speed with 12-20 per cent. less current than any pattern of permanently short-circuited rotor, and, moreover, owing to the better distribution of current in the bars of a wound rotor compared with that in the bars of a rotor of the squirrel-cage type, the overload capacity is considerably greater. Again, a rotor with a permanently short-circuited winding is far more likely to have dead points at starting when used in a single-phase motor, which is perhaps the reason why the current consumption is greater. Slip-rings (normally short-circuited) give so little trouble, and cost so little, that I certainly think wound rotors are preferable. I may mention in this connection that the Heyland motors have wound rotors and slip-rings in all sizes, that is, from ¼-100 B.H.P.; and, also in reply to a question of Mr. Langdon Davies, it has been found with these motors for 40, 50 and 60 cycles, that running up to speed without load, the starting current is four-fifths of the full-load current when wound rotors are used, and at least equal to the full-load current when the most carefully designed short-circuited rotors are used. In reply to the other remarks made by this speaker, I would say that the phase difference of 40-50deg. for the flux of the starting coils is caused by the great magnetic leakage this flux has, compared with the flux produced by the running coils. The large magnetic flux of the starting coils (caused by the large current in this winding of few turns) mostly leaks along a definite path, and this leakage produces the above-mentioned phase difference. At starting there is very little rotary field, the field of the motor being more of the nature of a purely oscillating field, and the result is exactly as shown by the Paper and by Mr. Field.

In reply to Mr. W. G. Rhodes on the question of the action of the Heyland motor, and also to Prof. Carus-Wilson's remarks as to this, I am aware that the explanation given in the Paper is, to a certain extent, incomplete, but it had to be curtailed as the Paper was getting unduly long. I am sure, however, that the ideas of most of those present to-night will be fairly clear on this subject, after having heard the remarks made by different speakers. The action of all single-phase motors and their starting devices can be looked at from several totally different points of view, and most of those who have gone at all deeply into the subject get perfectly clear ideas about it, which may be and generally are very difficult to put on paper in a few words. Mr. Rhodes thinks that the values for the flux-densities given by me for induction motors are somewhat high. I put it forward, however—I think for the first time—that in order to get large overload capacity with induction motors, and particularly with single-phase motors, the flux-densities in the iron parts, particularly in the stator cores and teeth, should be carried to a very high value; the increased iron losses can be counterbalanced by allowing for smaller copper losses, but, as a matter of fact, the increase in the iron loss by forcing the material in this way (and using less of it), is not very much, at any rate not enough to affect seriously the efficiency at light loads. In my opinion the two most important points in the design of induction motors are the selection of the flux-densities, and the shape of the stator and rotor teeth, and it is more important to design the teeth properly than even the air-gap. Regarding the point now under discussion, we have found by actual test on many single and polyphase induction motors of various sizes, that very much better results are obtained when the flux-densities in the teeth and cores are forced than when they are not, and you will notice in the motors shown to-night that there is wonderfully little magnetic iron in them. With these motors, the overload capacity is 50 per cent. to 60 per cent. with constant pressure at the stator terminals, and I think that those present who are used to single-phase motors of other types will agree that this large overload capacity is much more than they have been accustomed to, and that it is good enough. On the other hand, you may think that if this question of flux-density is really so very important, why do I not keep it to myself.' My reply to this is that the fact of having the right flux-density in the iron does not necessarily mean that the motor will be good; a very great deal depends upon the arrangement of the iron parts, upon the proportioning of the teeth, &c., and regarding these things every designer has to make his own experience. I am greatly interested to hear about Mr. Rhodes' recent work in single-phase motors, and look forward to seeing his motor on the market in due course. If this motor will really start with full load torque, with a current not exceeding the full-load current, as indicated, and if this result is attained without excessive complication and cost, then the Rhodes motor will certainly be a very formidable rival to the Heyland motor, as this latter stands at present. But I may say that Mr. Heyland is continually making improvements, and even better results will be obtained in the immediate future.

Prof. Ernest Wilson's curves are instructive, and with regard to them I would remark that in my opinion the curves B and E best represent good modern practice in polyphase motor building, and that the motors represented by curves D and C are unduly heavy for their output and speed. It is interesting to note from the curves that the line of direct-current motors whose weights have been plotted are heavier than the single-phase motors represented by the curve marked A.

I have already partly replied to Prof. Carus-Wilson, and with regard to his remarks on the power-factor of induction motors I thoroughly agree. Most designers of these motors are constantly striving to improve the power-factor, especially at light loads, and in this connection it would certainly appear that Mr. Steinmets has met with considerable success—at any rate in the testing room. Whether his method of shunting the windings by a condenser, which, by the way, is quite old, will ever prove of use commercially is open to question, as in my opinion a commercial way of building a condenser for continuous service has yet to be found.

Mr. Esson's criticism regarding the building-up of our stator cores has been already met; and regarding his remarks on the tooling of cores, while admitting that the difficulty of tooling stampings with open slots is a very real one, especially for the case of small motors, I must say that, in my opinion, it can be got over. Several Continental firms using this form of stamping invariably tool the stators in all sizes, without burring the teeth, the only disadvantage being, as pointed out in the Paper, a considerable increase in the iron loss. I agree with Mr. Esson's remarks on the subject of using former wound coils for stators and rotors, when the motors in question have to be shipped to places where skilled winders are at a premium, but for ordinary work I consider the employment of straight slots and former wound coils a mistake. You have to balance ease of repair and saving of labour in winding against a large magnetising current and diminished power-factor, especially at light loads, to say nothing of inferior starting, and in the great majority of cases the latter disadvantages outweigh the advantages.

With reference to Mr. Esson's remarks on the subject of permanently short-circuited rotors, I can only repeat what is stated in the Paper on this point, and what I have already stated in reply to Mr. Langdon-Davies. At the same time, I cannot agree with Mr. Esson's statement that the use of wound rotors lowers the power-factor, and that such rotors require about four times as much copper as squirrel-cage rotors. The former is directly contrary to my experience, while the latter statement requires I think, considerable qualification. With large induction motors, whose rotors are wound with a three-phase cylinder winding, the extra copper required is, at the outside, 50 per cent.

I am in complete disagreement with Mr. Esson's remarks on the subject of makers' guarantees and regarding what he states to be the latest and best Continental practice in induction-motor performance. Although I am perfectly aware that the guarantees given by certain firms are absolutely worthless, I am equally aware that those given by others are well on the right side. The figures given in my Paper are, as stated, the average of the guaranteed figures of five well-known houses—one Swiss, two German, one American, and one Belgian—and the work of three of these firms is intimately known to me. Not only do I consider the figures in the Paper perfectly reliable, but I maintain, and am prepared to prove, that better figures are obtained every day in ordinary work. Regarding

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the figures Mr. Esson puts forward for the power-factor of 50-cycle two-phase motors, as representing the latest and best Continental practice, I may say that I consider the figures quoted as being distinctly bad; I should certainly reject any 100-B.H.P. 50-cycle polyphase motor having a power-factor of 80 per cent. at full load. I may, perhaps, be allowed to say in this connection that I have recently put down two 100-B.H.P. two-phase motors in this country, which have a power-factor of 91 per cent. at full load; with these motors 90 per cent. was guaranteed, and 88 per cent. would have been guaranteed under penalty. So it would appear that Mr. Esson has been somewhat unfortunate in his selection of a manufacturer.

Regarding Mr. Esson's final remark on the subject of condensers, I can only say that I believe all condensers have been complete failures up to the present, when they have been used for continuous work. The great difficulty is with the heating, and consequent rapid deterioration of the dielectric, while they are bulky, heavy, and therefore expensive. On the other hand, liquid condensers give quite good results when used intermittently, such as for starting single-phase motors, but they, in common with other types, are unmechanical, and consequently objectionable. Such liquid condensers quickly go to pieces if continuously in circuit; moreover, their capacity alters in an extraordinary way as they heat up.

I could say a great deal in reply to Mr. Addenbrooke, but will ask him to allow me to reply to his first remarks only, as the discussion of the relative merits of single-phase and polyphase hardly falls within the scope of the present Paper. Mr. Addenbrooke asks me to split up the no-load current of an induction motor into its components, indicating the relative values of the two factors. I may say that for most well-designed polyphase motors of medium and large size, the watt component of the no-load current is somewhere about 10 per cent. of the wattless component. Thus, referring to the left-hand diagram in Fig. D (the triangle), C_W, the watt current required for friction, ventilation, hysteresis, eddy currents, and the small no-load copper loss, is 10 per cent. to 15 per cent. of C_M, the wattless magnetising current of the motor. The resultant of C_W and C_M, namely, C_0, is the no-load current of the motor, and this quantity is, as stated in the Paper, 20 per cent. to 30 per cent. of the full-load

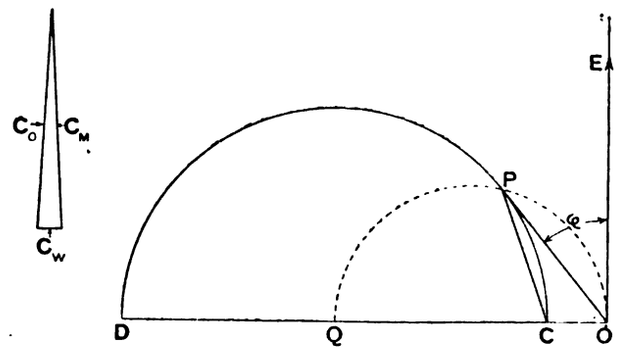

FIG. D.

current. As Mr. Addenbrooke says, knowing the magnetising current of an induction-motor (practically the no-load current), it is possible to predetermine the power-factor for any load. Fig. D illustrates any easy, graphical way of doing this, the diagram being constructed as follows:—

Let v_1 represent the stator leakage factor—that is, it is the ratio of the total magnetic flux produced by the stator ampere-turns to the flux that actually enters the rotor and cuts the winding *when the latter is open*. Similarly let v_2 be the rotor leakage flux—that is, the ratio of the total flux produced by the rotor ampere-turns to the flux actually entering the stator, and cutting its windings *when these are on open circuit*. Then write magnetic constant of the motor $= M = \frac{I}{v_1 v_2 - I} v_1$ and v_2 can be calculated, but are better found by a simple experiment. Their value lies between 1·02 and 1·07 for most makes of motor.

Referring now to Fig. D (which is the elementary diagram of the polyphase induction motor) set off the line OE to represent the phase of the applied E.M.F. per phase of the stator, draw the line OD at right angles to it, and set off along OD the magnetising current to scale, namely, OC. Now multiply this value of OC by the above constant M, and make CD equal to the value so found, the scale being of course the same as that of OC. Upon CD describe the semicircle CPD. Then all such lines as OP (that is, any point along the semicircle joined to point O) represent the stator current per phase in magnitude and phase, and all such lines as CP are proportional to the rotor current. The corresponding power-factor of the motor is given by the cosine of the angle ϕ. It will be seen that the maximum value of the power-factor occurs when the line OP is a tangent to the semicircle, as shown. For smaller and greater loads than corresponds to the value of stator current in question (OP), the power-factor diminishes, because the angle ϕ increases as the point P moves lower down or higher up the semicircle. The diagram clearly shows the effect of the magnetising current upon the power-factor of the motor, and also the effect of faulty design with regard to magnetic leakage.

With reference to Mr. Thomas's remarks, I think it would have been of interest had he told the meeting exactly what advantages are gained by building induction motors of large size with squirrel-cage rotors. Although I think with him that it is not possible to make hard and fast rules with regard to these things, particularly with regard to the relative merits of direct-current and polyphase working, still I think that after considerable experience with different conditions it is quite allowable to form and put forward an opinion. For instance, experience has conclusively proved that electric generators of any size should be direct driven, but it was not so many years ago that there was a very considerable amount of discussion on this point, and the early advocates of direct driving have now proved to be right. Regarding the point in question, it is clear to me that squirrel-cage rotors are inferior to wound rotors for all cases except those mentioned in the Paper, and I am confident that American constructors will come into line with those of the Continent before very long in this respect. It certainly seems to me that the apparent simplicity of the squirrel-cage construction (or its modifications) and the resulting advantages have been greatly overrated. There is an example of this at the Paris Exhibition, where an 800 H.P. induction motor, with permanently short-circuited rotor is being installed by one of the great American firms. This motor has to be run up to speed by a direct-current motor—a state of affairs bordering on the ridiculous.

Mr. Thomas's figures relating to the performance of induction motors confirm those I have given in the Paper, which, being guaranteed figures, of course are well on the safe side, as Mr. Thomas surmised. I would like to draw Mr. Esson's attention to the figures for these American motors, as they fully confirm what I have already said when replying to him.

[*Added, July 12, 1900.*] When replying to the discussion on the Paper I unintentionally omitted to reply to Mr. Ferranti, and therefore take this opportunity of doing so. I think if Mr. Ferranti were to reconsider his first remark, he would come to the conclusion that it is hardly fair. First, the Paper does not deal exclusively with single-phase motors, quite half being devoted to polyphase motors; and secondly, I distinctly state that the part relating to single-phase motor work is put forward simply as being of technical interest. Many men, including myself, *have* to take up the question of single-phase motors and single-phase systems, not because of any belief in their present or future possibilities, but because it is necessary to do so; but at the same time, this does not prevent the subject from being technically interesting both to them and to others. Mr. Ferranti's opinions on single-phase working are well known, and they are of the greatest value, because Mr. Ferranti has proved to be right on some of the most important points connected with alternating-current work many times before. At the same time, he does not give any reasons for his belief, and does not attempt to justify it in any way. But even with Mr. Ferranti's powerful championship of single-phase working, it is very difficult for those who have worked with single and polyphase systems to believe there is any advantage whatever in the former. Even in this country, many of the large single-phase systems are being converted into direct-current or polyphase systems, and all the most recent work of any magnitude is being carried out with either polyphase current, or a combination of this and direct current. My own opinion is that, as things are at present, continuous-current working is far preferable to any other for all large lighting schemes; and where it cannot be employed directly, it should be used, where possible, in conjunction with three-phase transmissions; or failing this, three-phase systems should be used throughout. For power work pure and simple, nothing can beat three-phase working, while for both lighting and power work, I am firmly convinced that the double-current generator (in combination with motor-generator substations) has a great future—that is, a special combination of the direct-current and three-phase systems.

THE BOILER EXPLOSION AT SYDENHAM ELECTRICITY WORKS.

A formal investigation was held at the Public Hall, Sydenham, on Aug. 30 and 31 and Sept. 3, under the Boiler Explosions Acts, 1882 and 1890, into the circumstances attending the explosion of a boiler at the Springfield Works of the Crystal Palace District Electric Supply Co. (Ltd.), on July 25 last. The investigation was held before Mr. Howard Smith, barrister-at-law, and Mr. J. H. Hallett, consulting engineer, Commissioners. Mr. Gough conducted the investigation on behalf of the Board. Dr. Kenrick appeared for Messrs. Hornsby & Sons (Ltd.), Mr. Willoughby Williams for the Crystal Palace District Electric Supply Co. (Ltd.), and Mr. Michael Longridge for the Engine, Boiler, and Employers' Liability Insurance Co. (Ltd.) and Mr. Charles A. Booth (their inspector). The boiler known at the works as No. 3 was of the locomotive type, and was made by Messrs. Hornsby & Sons in 1891 for a working pressure of 140lb. per square inch. The crown plate of the firebox was supported by seven girders, each being formed by two wrought-iron plates. At the ends of the seven girders were distance pieces with toes at their lower ends to fit on the vertical plates of the firebox. Each girder was supported by two hanging stays and the crown plate was attached to the girders by stay-bolts. The upper end plate of the shell was supported by 10 longitudinal stays, and, having regard to the position of these longitudinal stays and of the hanging stays, it was impossible to examine the fire-door or front end of the firebox without removing them. The boiler was originally insured by the National Boiler and General Insurance Co. (Ltd.), whose chief engineer's report on the inspector's examination of the boiler (dated March 8, 1898) was to the effect that externally the boiler was "in order." Of the interior condition the report stated:—

"No defects were met with, but the firebox stays prevented the inspector making closer inspection of the front part of the firebox. In the firebox the side plates are a little grooved at the edge of the firebox tube plate, also at the left side of the fire-door plate. The inspector states a test hole had been drilled at this latter place, but was plugged before his arrival. We understand the thickness was gauged by yourselves and found to be $\frac{7}{8}$in. Evidence of slight leakage was also noted

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past the bottom corners of the firebox tube plate and past a small patch at the right front corner. A short fracture has developed at the left front bottom corner of firebox, and the boilermakers were repairing same. The firebox crown is generally a little bulged downwards, the deformation being more pronounced at the front end than other parts. . . . The defects in the firebox are not of serious importance, and doubtless the various leakages would be made good by the boilermakers. . . . We would suggest, if you have not already inserted the tubes (withdrawn for purposes of the examination), that you have the pins uniting the sling stays to the girders and to the double angles renewed. When all is complete we would advise that you have the boiler put under a water test pressure of, say, twice the working pressure."

The water test (but only up to the certified working pressure) was duly made by the Insurance Company's inspector who had recommended the double-pressure test, and the Insurance Company's chief engineer's report on the test was made on March 31, 1898, and was as follows:—

"The boiler was put under a water-test pressure of 140lb. per square inch. The firebox crown plate deflected under this pressure from about $\frac{1}{16}$in. to $\frac{3}{16}$in. Several slight leakages were also noted in the firebox. The test pressure applied is inadequate to enable us to form an opinion as to the value or tightness of the sling stays attached to the firebox girder stays, but so far as the test went it would appear that the sling stays or pins in their holes have become worn, and that they do not take up their full share of the load until material deflection of the firebox crown plate has occurred. We note that the deflection of the crown plate was only temporary, and that the crown plate returned to its original position when pressure was removed."

The evidence showed that the Crystal Palace District Electric Supply Co.'s chief engineer was held responsible for the upkeep of the plant, machinery, and boilers, a fitter being regularly employed to examine the boilers when cleaned out, about every five weeks. Some time after the date of the reports above set out the insurance of the Electric Light Company's boilers was transferred to the Engine, Boiler, and Employers' Liability Insurance Co. (Ltd.). The latter company, knowing that the boilers had previously been insured and annually inspected by the National Company, accepted the risk, stipulating for thorough examinations as opportunity offered. In April, 1899, the boiler was examined by Mr. Booth, inspector in the employment of the Engine, Boiler, and Employers' Liability Insurance Co., and as a result of that examination the company issued a certificate, available for 15 months, to the effect that the boiler was fit for a safe working pressure of 140lbs. per square inch. The boiler was subsequently examined by the fitter in the employ of the Electric Supply Co., who reported that it was in good working order. On July 25 the fire was lighted about 6:30 a.m. At 9:30 a.m. the steam was turned on to the engine, the pressure by the steam-gauge registering about 86lb. At 10 a.m. the pressure was 96lb., at 10:30 105lb., at 11 130lb., at 11:30 120lb., at noon 120lb., at 12:30 p.m. 125lb., at 1 136lb. at 1:30 124lb., and at about 2:15 132lb. At about 2:40 p.m. the boiler exploded. The crown of the firebox was blown out, the boiler was swung round and upwards through the roof of the boiler-house,* which, together with the upper portion of the outer side wall, was demolished, and, passing across the roof of the engine house, in an oblique line, fell into the garden of an adjoining cottage. William H. J. Philbrook was killed; Frank Elliston was so seriously injured that he died the same evening, and Charles Barker, Frank Chamberlain, Frank Tranter, Ernest Page, and Joseph Adcock were all more or less seriously injured. (The inquest upon the bodies of the men who were killed by the explosion was reported in *The Electrician*, Aug. 24, p. 681.)

DECISION OF THE COURT.

The finding of the Court of Inquiry was given on Monday. The Court held that the explosion was caused by the cast-iron toes of the distance pieces at the front end of the boiler having broken off, the load which should have been borne by the vertical end-plate being thus transmitted to the flange of that plate, causing the crown plate to deflect, and in doing so to increase the weight of the hanging stays, several of which had broken, and several were partly broken before the explosion. The Court were of opinion that the toes of the distance pieces were never properly bedded on to the plate, that the hanging stays were not properly constructed, and that they had been severely punished when fitted. That the boiler when new was not properly constructed, and it was not then fit for a safe working pressure of 140lbs. per square inch.

The Court found that the Crystal Palace District Electric Supply Co. had not appointed competent persons to attend to the up-keep of their boilers, their chief engineer being an electrical and not a mechanical engineer, but that if the company had followed the advice of the National Boiler Assurance Co. they would have taken reasonable precautions to ensure that the boiler was being worked under safe conditions.

The Court found that the examinations by the fitter in the employment of the Electric Supply Company were not thorough examinations, and that the fitter was not competent to make such examinations.

The Court found that the examination by Mr. Booth, in April, 1899, was not a thorough and complete one, that it was incumbent upon him to make a most careful examination, particularly having regard to the difficulty of examining the front end of the firebox. They were of opinion that if he had used a straight-edge he would have discovered the deflection in the crown of the firebox which existed in March, 1898, and that his failure contributed to the explosion.

The Court found that the explosion was caused by the electrical engineer failing to carry out the recommendations made by the National Boiler Insurance Co. as to the double-pressure hydraulic test in March, 1898, and in their opinion it was imperative that this test should have been made, having regard to the difficulty of examination.

The Court held the Crystal Palace District Electric Supply Co. (Ltd.) responsible for the neglect of their chief engineer, and the Engine, Boiler, and Employers' Liability Insurance Co. (Ltd.) responsible for the neglect of their inspector.

The Commissioners pointed out that the boiler was constructed nine years ago, and that if it had been thoroughly examined periodically, as it should have been, the explosion would have been prevented.

At the conclusion of the investigation Mr. Gough applied to the Commissioners to order the costs and expenses of the investigation to be paid by Messrs. Hornsby & Sons, the Crystal Palace District Electric Supply Co. (Ltd.) and the Engine, Boiler and Employers' Liability Insurance Co. (Ltd.) and in reply to Mr. Howard Smith, he said that they would amount to about £230.

No order as to costs was made against Messrs. Richard Hornsby & Sons, but the Crystal Palace District Electric Supply Co. were ordered to pay £150, and the Engine, Boiler and Employers' Liability Insurance Co. were ordered to pay £50 towards the costs and expenses of the investigation.

* See *The Electrician*, Aug. 10, 1900, page 590.

LEGAL INTELLIGENCE.

Taff Vale Railway Co. v. Amalgamated Society of Railway Servants and Others.

Mr. Justice Farwell on Tuesday gave his reserved judgment in the motion for an injunction against the defendant society and their officers, Richard Bell and James Holmes, from watching or besetting, or causing to be watched or beset, the Great Western Railway station at Cardiff or the works of the plaintiffs or any of them, or the approaches thereto, or the places of residence, or any place where they may happen to be, of any workmen employed by or proposing to work for the plaintiff company for the purpose of persuading or otherwise preventing persons from working for plaintiffs, or for any purpose except merely to obtain or communicate information, and from procuring any persons who may have or may enter into contracts with the plaintiffs to commit a breach of such contracts. An interim injunction was granted last week against the defendants Bell (general secretary) and Holmes (organising secretary), it being submitted, however, that the defendant society was not a real person, nor a corporate person. It was pleaded that by the Trade Union Act, 1871, the Legislature for some purposes recognised trade unions, but did not recognise them or give them an entity except for particular purposes defined in that act. For the plaintiffs it was urged that under the 1871 Act a trade union can be proceeded against for penalties. The society had asked by summons that their name be removed from the motion as defendants, on the ground that they were not proper parties to the action.

Mr. Justice FARWELL said the defendant society pleaded that they were neither a corporation nor an individual and therefore could not be sued in a quasi-corporate or any other capacity. It was undoubtedly true that a trade union was neither a corporation nor an individual, nor a partnership between a number of individuals; but this did not conclude the case. A trade union was an association of men which almost invariably owed its legal validity to the Trade Union Acts, 1871-1876. The question he had to consider was what, according to the true construction of the Trade Union Acts, had the Legislature enabled trade unions to do, and what, if any, liability did a trade union incur for wrongs done to others in the exercise of its authorised powers. The Legislature in giving a trade union the capacity to own properly and the capacity to act by agents had, without incorporating it, given it two of the essential qualities of a corporation, essential in respect of liability for tort, for a corporation could only act by its agents and could only be made to pay by means of its property. The principle on which corporations had been held liable in respect of wrongs committed by the servants or agents in the course of their service and for the benefit of the employer, was as applicable to the case of a trade union as to that of a corporation. If the contention of the defendant society were well founded, the Legislature has authorised the creation of numerous bodies of men capable of owning great wealth and of acting by agents with absolutely no responsibility for the wrongs that they may do to other persons by the use of that wealth and the employment of those agents. They would be at liberty, for instance, to disseminate libels broadcast, or to hire men to reproduce the rattening methods that disgraced Sheffield 30 years ago, and their victims would have nothing to look to for damages but the pockets of the individuals, usually men of small means, who acted as their agents. It would require very clear and express words of enactment to induce him (the learned judge) to hold that the Legislature had in fact legalised the existence of such irresponsible bodies with such wide capacity for evil, nor did he see any reason for saying that the society could not be sued in tort in their registered name. Secs. 8 and 9 of the Act of 1871 expressly provided for actions in respect of property being brought by and against the trustees, and this express intention impliedly excludes such trustees from being sued in tort. If, therefore, he was right in concluding that the society were liable in tort, the action must be against them in their registered name. The acts complained of were the acts of the association. They were acts done by their agents in the course of the management and direction of a strike; the undertaking such management and direction was one of the main objects of the defendant society, and was perfectly lawful; but the society, in undertaking such management and direction, undertook also the responsibility for the manner in which the strike was carried out. It was not a question of the rights of members of the society, but of wrong done to persons outside the society. For such wrongs, arising, as they did, from the wrongful conduct of the agents of the society in the course of managing a strike which was a lawful

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object of the society, the defendant society was, in his opinion, liable. He therefore dismissed the society's summons to have their name struck out as parties to the motion, with costs. As to whether an injunction should be granted against the society in addition to that granted last week against Bell and Holmes, he was of opinion that it should. The objects of the society comprised the settlement of disputes between masters and men by arbitration, or other lawful means; the general management of the society was vested in an executive committee with power to represent the members in disputes about hours and wages; a protection fund was set apart out of the funds of the society for the more effectual protection of the labour and rights of members and for the better carrying on of any movement having that end in view, and in pursuance of its objects and powers. The society, by their letter of Aug. 20, signed by Bell, informed plaintiffs that they had decided to support the men in their action, and had instructed Bell to take charge of the movement, with a view to bringing it to a conclusion, and that all further negotiations were to be dealt with through him. Bell was the general secretary and Holmes the local organising secretary of the society. They, as agents for the society and on their instructions and for their benefit, put themselves in charge of the strike, and, on the evidence that was read before him last week, illegally watched and beset men to prevent them from working for the plaintiff company, and illegally induced men to break their contracts. He had already held that the society were liable for the acts of their agents to the same extent as they would be if they were a corporation, and it was abundantly clear that a corporation under the circumstances of this case would be liable. It was not a question of acting ultra vires, but of improper acts in carrying out one of the lawful purposes of the defendant society. In such cases the principal, whether an individual or a corporation, or an unincorporated body was answerable for every such wrong of the servant or agent as was committed in the course of the service and for the master's benefit though no express command or privity of the master be proved. Granted that the principal had not authorised the particular act, but he had put the agent in his place to do that class of acts, and he was answerable for the manner in which the agent has conducted himself in doing the business with which the principal had entrusted him.

An injunction was therefore granted against the defendant society in the terms of the order of the Court last week against the defendants Bell and Holmes (see *The Electrician* for August 31, p. 717).

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—The accounts of the electricity department for the year ended July 31 have been issued. The total revenue was £14,211. 3s. 10d., and the expenditure £6,062. 0s. 10d., leaving £8,149. 3s. to be carried to net revenue account. From this £2,343. 15s. 11d. was paid as interest on mortgages and other loans, £2,438. 15s. 4d. for depreciation, £1,336 to sinking fund, and £2,487. 18s. 11d. to reserve, which now stands at £2,609. 17s. During the year 1,005,505 units were sold, against 279,950 for seven months in 1899. There are 76 public arc and 80 incandescent lamps. The amount of capital authorised to be borrowed is £82,000, and the amount actually borrowed is £81,953.

African Telegraphs.—It is announced that the African overland telegraph system is complete from the Indian Ocean to the sources of the Nile, and that messages from Lake Victoria are now brought by steamer to Zanzibar over a distance which formerly occupied seven months.

Bangor.—Hitherto the demand for electric current has exceeded the most sanguine expectations, and already the electricity department has orders for the equivalent of 1,000 8 c.p. lamps more than it was originally calculated would be required in three years. The works have not yet been started, but it is likely that current will be available in two or three weeks. The question of extensions has already become pressing, and a third unit of plant will shortly be ordered. The proposal to engage in municipal electricity supply encountered long and determined opposition from the gas interest, which was strongly represented on the Bangor Council, and the success already achieved is locally considered the more gratifying on that account.

Batley.—The electric lighting estimates are to be increased by £2,000.

Birkenhead.—The Gas, Water and Electricity committee are to consider the question of reducing the price of electric current to 4d. per unit. The subject was introduced by Mr. Dodds at the Council meeting on Wednesday when he said that, although they had the monopoly of electric lighting, with the exception of a favoured few the public were debarred from utilising the light. There were in Birkenhead 248 electricity meters, against 15,600 gas meters, showing that the needs of the general public were not met by the committee, and as there was no other competitor, the public had to suffer. The time had surely come when the Gas, Water, and Electrical committee should be split up, and a committee appointed which would see that the public needs in respect to electric current were met at a reasonable price.

Blackpool.—Owing to the non-delivery of machinery which has been on order for several months, the traction plant at the generating station has been overloaded for some time, and there was a breakdown in connection with the electrical tramway system on Tuesday. The present machinery is only intended to generate sufficient current to operate 18 cars, but since the Claremont-park extension was opened it has been called upon to provide motive power for 25, the result being that on Tuesday night one of the 100 H.P. turbo-generators broke down, and the tramway traffic on the Promenade was disorganised. As quickly as possible the engineer (Mr. R. C. Quin) made arrangements with Mr. J. Cameron, manager of the Blackpool and Fleetwood Tramroad Co., for an emergency supply. The company had fortunately some reserve plant which they were able to place at Mr. Quin's disposal, and it was arranged that the whole of the electricity required on the Promenade line from the Gynn to the Central Pier should be supplied from the company's works, while the other 100 H.P. turbo-generator at the Corporation works would provide for the supply from the Central Pier southwards. The electric lighting plant is also, it is stated, running at its top load just now. Considerable extensions are to be made during the winter.

Brighton.—At the Corporation meeting yesterday (Thursday) that body had under discussion a report from the Tramways committee recommending that tenders be invited for the supply of tramcars in connection with the proposed electric tramway scheme. At the outset it is proposed to invite tenders for only 30 double-decked cars, similar to those at present in use at Liverpool and Sheffield. The estimated cost of each car complete has been put at £750. The report and its recommendations were adopted by the Council.

Carnarvonshire.—The Gwyrfai District Council and the Llanrug and Llanberis Parish Councils have decided to support Mr. E. W. J. Paterson's scheme for the construction of a light (electric) railway from Carnarvon to Dinas Dinlle. It is also proposed to supply electric current for lighting in the various districts.

Cheltenham.—There is at present the equivalent of 24,970 8 c.p. lamps connected to the mains. Extensions, estimated to cost about £6,000, are to be made, and sanction to borrow this sum has been applied for.

Devonport.—The Council have adopted the electric lighting scheme referred to in our last issue, and in addition six arc lamps are to be erected in the Albert-row, at an estimated additional cost of £100.

Dungannon (Ireland).—A provisional electric lighting order is to be obtained by the Council.

"Engineering Magazine."—The September issue contains articles on "Electric Mining Machinery in the British Collieries," "The Continuous Recording of Steam Engine Practice," "Commercial Organisation of the Machine Shop," "Commercial Requirements of Water Power Governing," and "Heavy Motor vehicles for Road Service."

Fire.—Owing to the overheating of a cable at the Bank station on the City and South London Railway early on Thursday morning a small fire occurred, which was speedily overcome by the Fire Brigade. Had the fire originated at a busy time of the day the only inconvenience that would have resulted would have been the temporary putting out of use of one of the lifts at this station. No interruption with the regular working of the line would have occurred.

Hawthorn (Victoria).—After various discussions on electric lighting matters the Municipal Council has resolved to transfer its electric lighting order to the Electric Lighting and Traction Co. of Australia for £150.

Ithaca (Queensland).—The streets are to be lighted electrically, current being obtained from the Brisbane Tramways Co.

Leeds.—Electricity meter rentals are to be abolished from Oct. 1. The Corporation resolved, on Wednesday, to promote a bill to authorise the construction of six additional tramway routes.

Leith.—The Burgh Electrical Engineer (Mr. J. Gray Scott) has reported that the cost of a new feeder to Newhaven-road would be £5,375. Interest and sinking fund would amount to £429, and the probable revenue would be £440 per annum. On account of the increasing demand for current a new feeder to Bernard-street was also absolutely necessary. This would cost £1,217, and Mr. Scott strongly recommended the work be carried out without further delay. The capital expenditure on electric lighting to date is £43,011. 1s. 8d., and in order to carry out further extensions it will be necessary to obtain further permission from the Secretary for Scotland to borrow. The entire question was remitted, on Tuesday, to the Executive sub-committee for report.

Light Railways.—The Light Railway Commissioners will hold an inquiry on 17th inst. into the application to construct the Kidderminster and Bewdley light (electric) railway.

An inquiry will be held at Wigan on 26th inst. by the Light Railway Commissioners into the application to construct a light electric railway in the district.

The Elland District Council have approved the proposal to construct a light railway in the Deanhead Valley, Yorks.

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Liverpool.—The Seaforth, Waterloo, Crosby and Blundell Sands electric tramway was opened on Saturday. The new line, between 2 miles and 3 miles in length, has been constructed by the Liverpool Overhead Railway Co., and is intended to form a continuation of their electric railway from Dingle to Seaforth.

Long Eaton.—The Council, who are considering the question of erecting gas-driven electricity works, have sent a deputation to Northwich to inspect the Mond system of gas production.

Market Harborough.—The Gas committee is investigating the desirability of obtaining electric lighting powers and has been authorised to engage an electrical expert to prepare a report.

Mexborough.—The Council, who are advertising for electricity generating plant, propose to light the leading thoroughfares electrically. Application has been made to the Local Government Board for sanction to a loan.

Municipal Telephony.—At the meeting of the Grantham Council on Wednesday the Telephone committee reported that they considered a municipal telephone system could be successfully worked, and promised to lay detailed estimates before the Council at its next meeting.

Merchant Venturers' Technical College Calendar.—The calendar of this college for the Session 1900-1901 is now published, and gives full particulars of the course of technical instruction. An excellent set of photographic illustrations of the engineering and physical laboratories and workshops, dynamo and testing rooms are included. Day and evening classes in all branches of electrical and mechanical engineering, telegraphy and telephony form a conspicuous feature of the syllabus.

Northampton Institute Calendar.—The calendar of the educational and social announcements of this Institute for the Session 1900-1901 is just issued, and contains full particulars of the tuition given in (1) engineering and metal trades, (2) artistic crafts, (3) electrical engineering and applied physics, and (4) technical chemistry, in addition to special instruction in the trades with which the district of Clerkenwell is intimately associated. The Institute is well endowed with laboratories and workshops, and illustrations of these are given in the calendar. On pp. 10 to 31 particulars are published of the chief new feature for this Session—the engineering day courses, to which the special attention of students is called.

Paisley.—At a recent meeting of ratepayers it was resolved to invite the promoters of the Glasgow and District tramway scheme, which was rejected in the last session of Parliament, to again promote a bill.

Paris Exhibition—Messrs. Boot and Son, of 24, Old Bailey, London, E.C., announce that the demand for the "Anglo-Saxon Guide" to the Paris Exhibition has necessitated a second edition. A copy of the new edition has been forwarded to us, and includes a list of the British awards. It is difficult to see how a visitor to Paris for the exhibition can do without this guide, and even those who are compelled to stay at home may spend a shilling much more wastefully than in purchasing a copy of the "Anglo-Saxon Guide to the 1900 Paris Exhibition."

Peterborough.—£8,118. 3s. 7d. has already been expended in connection with the electricity supply scheme, and the amount incurred in contracts and not yet paid is £8,450. 0s. 10d., making a total of £16,568. 4s. 5d. The engineer (Mr. J. C. Gill) estimates that £2,056. 16s. is necessary to complete the equipment of the works. There is a net excess expenditure to date of £2,660, but this is partly accounted for by the change of site for the generating station.

Penang (Straits Settlements).—The municipality have considered and adopted a scheme for the electric lighting of the town which has been prepared by Mr. O. V. Thomas. In the course of the discussion on the scheme, Mr. Bromhead Matthews said the town was at present inadequately lighted by 746 9 c.p. oil lamps, which each cost $2 per month. Including maintenance the total cost was $17,904 a year, and the increase in the price of oil made it impossible to renew the contract except at from 40 per cent. to 50 per cent. above the present rate. In his scheme Mr. Thomas proposes to light the public streets, roads, markets, quays, &c., by 40 arcs of 2,000 c.p. each, and 950 16 c.p. incandescents. The latter will be placed 50yds. apart, and the arcs 100yds. The estimated capital cost of the public lighting is put at $160,000, and the maintenance at $29,000 per annum. The generating plant will cost about $280,000. It is intended to make provision for supplying current to the equivalent of 7,500 8 c.p. lamps for private houses. The annual cost of maintenance of the entire project would be about $60,800, or $30,800 more than is being paid for oil. The scheme was adopted unanimously.

Ripon.—The Council have resolved to apply for a provisional electric lighting order, and Messrs. G. Harrison & Co. have been appointed consulting engineers.

St. Pancras (London).—At the Vestry meeting on Wednesday the chairman of the Electricity committee (Dr. W. Smith) presented a report setting out the net profit on the electricity undertaking since its inauguration in 1892. This profit amounted to £18,288, and admitted of a contribution in relief of rates of £3,000, a reserve fund of £12,000, and the carrying forward of £1,134. Dr. Smith explained that the Vestry would hand over to its successors, the new borough council, property worth £300,000, which had not, and would not cost the ratepayers a penny. Had their undertaking been a joint-stock concern, it would have paid a dividend at the rate of 6 per cent.

Saltburn.—The Cleveland and South Durham Assets Co. offer to sell their electricity supply undertaking to the District Council for £10,000.

Sheffield.—Ever since the appointment of Mr. S. E. Fedden to the important post of general manager of the electric light department at Sheffield that gentleman has been exercised as to the best means of dealing with the problem of adequately providing for the rapidly-increasing demand for electric current, more especially for motor driving. Mr. Fedden has presented a report (dated 24th August) to the Electric Light committee of the Corporation to guide them in purchasing additional generating plant. Mr. Fedden says:—

For some years it has been conclusively proved that the business of electricity supply, if properly managed, is one of the most profitable upon which a municipality can embark, and one in which a bold and liberal policy is not only the safest, but also the cheapest in the end. It is remarkable how enormous the demand for electric light and power has been when an efficient supply of energy has been available at a moderate cost, even though it may be somewhat dearer than gas. In consequence of this large demand (not yet felt by Sheffield) many electric supply works have required extensions in a very short time, on account of their having been originally laid out on too small a scale. The site chosen has in many instances been most unsuitable, or it has been impossible to extend the buildings, and therefore extensions have taken the form of entirely new works designed with more consideration for the district's requirements. By alterations such as these the waste of a large amount of capital is involved and the future cost of production thereby increased. In Sheffield very large provision must be made for the future, because not only are the suburbs extending rapidly (and these suburbs should be electrically lighted), but the central portion of the city, with its workshops and small power users, may be expected to make an unprecedented demand on the electric supply department as soon as you are able to supply electric energy suitable for power, heating, &c., at a reasonable charge (say, 1½d. to 1d. per unit). You are doubtless aware that in the present session of Parliament several very large power schemes have been sanctioned, and that intimation of intention to apply for one for this district has been received. If, therefore, Sheffield desires to preserve its monopoly of supply it can only be by looking forward to the future, and so designing the works as to cope with any demands that may be made. The cost of mains is, no doubt, considerable, but the advantage of a large and well-covered area of supply cannot be over-estimated, for it must not be forgotten that the applications of electricity will become increasingly varied. An electricity works is not laid down for the supply of light only, but also for the supply of power, which, in Sheffield, will almost certainly form a large proportion of your future demand.

In dealing with the future supply of the district one is hampered by what has already been done. If I had to design a completely new system for Sheffield I should, for numerous technical reasons, certainly propose to distribute on the continuous-current system in the central area, although I should generate and transmit my electrical energy from one large power station by polyphase alternating currents to different points in the city, and there transform it into continuous currents by means of rotary converters. You have, however, an extensive alternating system already laid down, for which a very large sum of money has been paid, and without further heavy expenditure the introduction of the system just described is impossible. I am glad, however, to be able to report that, with certain modifications, your existing system can be brought up to date, and this being so, I certainly do not feel justified in making so radical a change as that to continuous current supply, which would involve a very heavy, and, in the circumstances, unnecessary expenditure.

In considering the question of the best means of dealing with the future supply of the city, I have naturally carefully perused the reports that were last year laid before you by my predecessor, and by Mr. Robert Hammond. I specially bear in mind the five conclusions appended to Mr. Hammond's report of Oct. 31, 1899. With these conclusions I am in accord, except No. 3 as follows:—

(3) That the direction in which future economies can be effected is in the cessation of expenditure on further alternating plant, and the feeding of the central district by low-pressure continuous current.

With regard to this suggestion (3), I am convinced that the economies which were in view can be better effected by other means. I may remark, in passing, that I cannot help thinking that at the time Mr. Hammond made his report he had not the full data laid before him as to the method of feeding and distributing the electricity in the central area. Since I have been in charge of the undertaking I have, of course, made myself thoroughly acquainted with these matters, and I am glad to be able to say that I find the loss due to the magnetising watts of transformers, referred to by Mr. Hammond as an incubus on the undertaking, can be very considerably reduced by a change in the system of feeding. In support of the modification of the existing system rather than change to a new one, I may mention that the continuous-current low-pressure feeders alone to deal with the central area would cost not less than £30,000, the interest and sinking fund on which would far outweigh the economies which would ensue, from the avoidance of loss due to the magnetising watts above mentioned. The system of sub-stations hardly exists in Sheffield, but as you are aware, I am already inaugurating it, and suggest that the system should be gradually intro-

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duced, the result being that our magnetising watts, or in other words, wasted current, will be largely minimised.

I, therefore, conclude that the development of the undertaking, as far as principle is concerned, must be on the lines of extending the system already in existence, modified as indicated below. To make the system more suitable for motive power, I strongly recommend the reduction of the periodicities from 100 to 50. In connection with this recommendation I may point to Frankfort as a city where the single-phase alternating current, being the same as the Sheffield system, is in use. The motors upon the circuit amount to as much as 5,000 H.P., 2,800 H P. of which is distributed throughout the city to users in various small industries, the balance (2,200 H.P.) being applied in the form of motor generators for driving the tramways which belong to the municipality. Similar conditions, though in a smaller degree, also obtain at Derby, Huddersfield, Leeds, and numerous other towns in this country. Another advantage of changing our present plant from 100 periods to 50 periods would be that the plant would then be suitable for running in parallel with the large power station which Sheffield must shortly possess. I may add that the quality of the lighting would not be prejudicially affected by the change.

If you sanction the suggested change from 100 periods to 50 periods, the sets of plant would have to be changed one by one, as opportunity occurred, and, of course, during the change each particular set would be unavailable for service on the load. To enable the alteration being carried it will be necessary to order two sets of plant (alternating 50 period), say each of 100kw., to be delivered, if possible, before March, 1901, and when these are installed to gradually transform the present sets set by set. The cost of altering the present system to 50 periods will be about £9,400 (this includes alternators, motors, meters, and arc lamps). To carry out the above recommendations I estimate the following further expenditure for 1901 :—

Additions and alterations in boiler house	£3,500
200kw, of new plant complete.....	22,000
Additional feeders	5,000
Contingencies, say 5 per cent.....	1,995

This, if carried out, will completely fill up your present station, and the position will then be that your existing space will be all occupied and the machinery therein put on a footing to give the best possible results as a system. It will further have been put into a position to fit in and harmonise with the station to be designed and constructed on more extensive lines. As to this larger station, it should, in my opinion, be taken in hand without delay, so that it may be steadily proceeded with concurrently with the recommendations above made. I have already instituted inquiries as to a suitable site, and am now engaged in maturing the details of the subject and preparing estimate of cost, with a view of presenting to you a full report at an early date.

This report has been fully discussed by the Electric Light committee, and has been referred to Mr. R. Hammond for his views. In connection with this matter, a deputation consisting of Ald. Styring, Mr. W. W. Harrison (or, failing him, Mr. John Maxfield) and Mr. Fedden are visiting the Paris Exhibition in order to inspect and examine the latest machinery there on view. The deputation may possibly go to Frankfort to inspect the Brown-Boveri single-phase plant there installed.

Stalybridge.—The Council have approved the joint electric lighting and tramway scheme for Stalybridge, Hyde, Mossley, and Dukinfield, and the Mayor (Ald. Simpson), and Alds. Fentem, Norman and Ridyard, and Messrs. Thompson and Wood, have been appointed Stalybridge representatives, with full power to take all proceedings for promoting the necessary bill. On Tuesday the Mayor said the proposed scheme would entail an expenditure of something like £400,000, and the proposed tramways would cover an area of about 26 miles.

Standish (Lancs.).—A provisional electric lighting order is to be obtained by the District Council.

Tramway Provisional Orders in 1900.—The Board of Trade have issued a report on the manner in which the applications for tramway provisional orders were dealt with last session. The number of applications was 36, the largest since 1881, and 35 of these included power to construct new or extend existing tramways, the remaining one (that of the British Electric Traction Co. for Rothesay) was for authority to employ mechanical power on existing lines. Twenty-seven of the applications were by local authorities. The aggregate length of the proposed tramways was 59 miles 4 chains of double line and 99 miles 49 chains of single line, and the cost of construction was £1,626,307. Four applications were not proceeded with—viz. : Ealing (Council), Hemel Hempstead (British Electric Traction Co.), Surbiton (Council) and Walthamstow (Council). The first was withdrawn, the second refused in the absence of consent of the local authority, and the other two were rejected on account of non-compliance with the terms of the Tramways Act, 1870 ; 32 provisional orders were granted, and although considerable opposition was offered to the confirmation of some of the orders by Parliament, all the confirmatory bills were passed and received the Royal assent on Aug. 6. The list of the orders confirmed is identical with that which appeared in our issue of Jan. 5 last, with the exception of Ealing, Hemel Hempstead and Walthamstow, which should be omitted.

Tunbridge Wells.—As will be seen from the list of tenders accepted, set out in another column, the Council have definitely committed themselves to a municipal telephone scheme. Tunbridge Wells thus becomes the second local authority in the kingdom to embark upon municipal telephone enterprise, Glasgow having the honour of premier place. The Council anticipate being able to provide a system which will cost subscribers less by £2. 10s. than they are now paying the National Company. To meet the threatened competition the company has lately been advertising reduced rates, but still the Corporation maintain they can provide a better and cheaper service without trenching upon the borough rates to any extent. As the result of a canvass upwards of 300 subscribers have already been obtained, the majority of whom are at present customers of the National Company. The scheme also provides for a service to the surrounding villages, where the proposal has, it is said, already been regarded with approval. It is estimated that the initial cost of the installation will be £9,000, and the annual cost of working about £1,000.

Warrington.—The charge for electric current for motive power has been fixed at 2d. per unit for the first 3,000 units per quarter and 2d. after.

Worcester.—The charge for electric current to private consumers has been increased from 6d. per unit for the first two hours' maximum demand and 2½d. after to 6½d. and 3d. respectively. For waterworks motors, the charge will be 1¾d. per unit ; for the public arc lamps, an additional £2. 2s. for each all-night lamp, and £1. 1s. for a half-night lamp, and for the public incandescent lamps 5s. each per annum will be charged.

Workhouse Lighting.—Bradford Workhouse is to be lighted electrically, and the Local Government Board have sanctioned a loan of £6,500 for the work, to be repaid within 10 years.

Worthing.—The Council have received a number of tenders for the supply of electricity generating plant, and on Monday these were referred to the consulting engineers (Messrs. Burstall and Monkhouse) for analysis and report.

Wrexham.—The Council are making progress with their electric lighting scheme, and it has been decided to charge 6d. per unit for current for lighting and 3d. for power.

The undertaking of the Wrexham Tramways Co. has been acquired by the Drake and Gorham Electric Power and Traction Co., and the lines are being converted to electric traction.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d. ; by post, 7s. 9d. ; abroad, 8s. *New Edition nearly ready.*

"BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d. ; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"THE ELECTRICIAN" READING CASE.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"WIRELESS TELEGRAPHY : SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

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"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"THE ALTERNATE CURRENT TRANSFORMER."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"ARMATURE WINDING OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"LABORATORY NOTES AND FORMS."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

TENDERS INVITED.

Walthamstow District Council invite tenders for the supply and erection of electric lighting plant and apparatus, including gas plant, gas engines, dynamos, switchboard, boosters, balancer and measuring instruments. Specifications may be obtained from the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., after Sept. 4. Further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m., Sept. 25.

Sunderland Corporation invite tenders for triple expansion high-speed direct-current steam dynamos, Lancashire boilers, and feed pumps. Specifications may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland, and tenders (addressed to the chairman of the Electric Lighting committee) must be sent to the town clerk (Mr. Francis M. Bowey) by noon of Sept. 21. An advertisement gives further particulars.

Dublin Electric Lighting committee invite tenders for the supply and laying of electricity supply mains and accessories. Specification may be inspected at the office of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and may be seen at and obtained from the offices of the consulting engineer (Mr. Robert Hammond, 64, Victoria-street, London, S.W.), after Sept. 3. Further particulars are given in an advertisement, and tenders, addressed to the town clerk (Mr. Henry Campbell), City Hall, Dublin, must be in by 4 p.m. of Oct. 4.

Dublin Corporation also invite tenders for supply and erection of power machinery at Ringsend, including pumping engines and pumps, boilers, electric motors and pumps. Specification, &c., may be obtained from the city engineer (Mr. Spencer Harty), or from the consulting engineer (Mr. G. Chatterton), 6, Sanctuary, Westminster, London, S.W. Further particulars are given in an advertisement, and tenders must be sent to the town clerk (Mr. Henry Campbell), City Hall, Dublin, by noon, Oct. 3.

Dundalk District Council invite offers for the transfer of their provisional electric lighting order. Some particulars are set out in an advertisement, and any further information can be obtained at the office of the borough surveyor. Tenders to the town clerk (Mr. Mathew Comerford), Town Hall, Dundalk, before 1 p.m. Sept. 18.

Mexborough District Council invite tenders for electricity generating plant, particulars of which are set out in an advertisement. Copies of the specification, &c., can be obtained from the electrical engineer to the Council (Mr. H. Waring), 18, Berkeley-road, Crouch End, London, N., and tenders must be delivered to the clerk (Mr. J. W. Hattersley), Mexborough, before Sept. 15.

Manchester Tramways committee invite tenders for two steel boilers, cast-iron pipes, rubber rings, bolts and nuts, steel stanchions, &c., and 100 car trucks. An advertisement gives further particulars, and specifications may be obtained from the general manager, Tramways Department (Mr. J. M. M'Elroy). Tenders (addressed Chairman of Committee), to the town clerk (Mr. W. H. Talbot), by 18th inst.

Eastbourne Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, feed pumps, &c.; 400kw. steam alternator, with exciter (vertical enclosed high-speed engine); and main switchboard and connections. Further particulars are given in an advertisement, and specification may be obtained at the offices of the town clerk (Mr. H. West Fovargue), Town Hall, Eastbourne. The works are to be carried out to the plans and specification of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information may be obtained. Tenders to the town clerk before noon Oct. 4.

The Vestry of St. John, *Hampstead* (London) invite tenders for eight dry-back marine boilers, steam and water pipes, feed pumps, &c., feed-water heater (or feed-water detartariser), fuel economiser, cast-iron water tank, and two blow-off tanks. Tenders to vestry clerk, Vestry Hall, Hampstead, N.W., by 4 p.m., Sept. 27.

Salford Corporation invite tenders for twelve months' supply of high and low-tension single and concentric cables, house fuse boxes, meters and meter boards. Tenders to town clerk before Sept. 10.

Oldham Electric Light committee invite tenders for dry-back marine boilers, with mountings, gangways, feed and drain pipes, &c., complete, and also for mechanical stokers with shafting and gearing for driving; or water-tube boilers as an alternative to the dry-back marine boilers, including mountings, &c. Tenders to superintendent (Mr. A. Andrew), Gas and Water Office, before Sept. 11.

London County Council invite tenders for mains for the electric lighting of Victoria Embankment and Westminster Bridge. Tenders to clerk (Mr. C. J. Stewart) before noon Sept. 24.

London County Council Asylums committee invite tenders for boilers, engines, dynamos, &c., at Horton Estate, Epsom, Surrey. Tenders to committee, 6, Waterloo-place, S.W., by 10 a.m. of Sept. 22.

Aberdeen Electric Lighting committee invite tenders for two 200kw. direct-coupled continuous-current generators and one 120kw. balancing set; also for one 420kw. direct-coupled continuous generator. Willans engines are specified in both cases. Tenders to city electrical engineer by Sept. 29.

Hackney (London) Electric Lighting committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, arc lamps, meters, crane, and workshop equipment. Tenders to vestry clerk by 4 p.m., Sept. 12.

Hammersmith (London) Vestry require tenders for the supply, delivery and erection of two single-phase alternate-current motors, coupled to two centrifugal pumps, with accessories. Tenders to clerk before 5 p.m., Sept. 12.

The managers of the *Poplar* and *Stepney* Sick Asylum District invite tenders for sundry work in connection with a telephonic installation at their sick asylum. Tender to clerk, Bromley, Middlesex, by 5 p.m., Sept. 17.

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Hull Electric Lighting committee invite tenders for steam and water pipes, feed-pumps, water-softener, &c., for their Sculcoates-lane generating station. Tenders (addressed chairman of committee) to town clerk's office by noon, Sept. 27.

British Electric Traction Co. invite tenders for constructing about 7 miles of light railway in Middleton and Castleton. Tenders to secretary, Donington House, Norfolk-street, London, W.C., by 15th inst.

Tenders are invited for the electric lighting of the new drill hall, *Portsmouth*. Tenders must be sent to the Col.-Commandant (A. R. Holbrook), Drill Hall, Alfred-road, Portsmouth, by 5 p.m. Sept. 10.

Blackpool Tramway committee require tenders for constructing tramways equivalent to 5 miles single track. Tenders to chairman of committee by 17th inst.

Perth Commissioners require tenders for direct-current electricity meters and cutouts. Tenders to clerk by 15th inst.

Glasgow Corporation invite tenders for the power station piping required at Pinkston. Tenders to town clerk by 5 p.m. Sept. 28.

Tunbridge Wells Corporation invite tenders for high and low-tension cables. Tenders to town clerk by Sept. 29.

Nelson Corporation invite tenders for a 200kw. steam dynamo. Tenders to town clerk by Sept. 8.

Southampton Harbour Board invite tenders for a 30-cwt. portable electric wharf crane. Tenders by Sept 17.

Luton Town Council require tenders for watt and demand meters. Tenders to town clerk by Sept. 14.

The Government of *South Australia* invites tenders for 400 miles of galvanised wire netting (200 miles 36in. wide, 1½in. mesh, 18 S.W.G.; and 200 miles 42in. wide, 1½in. mesh, 18 S.W.G, delivered in lots of not less than 100 miles of each size and in rolls of 100 yards each). Forms of tender, conditions, and all further information can be obtained at the office of the Agent-General for South Australia, 1, Crosby-square, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Hanley Town Council have received the following tenders for boiler house requirements for their electricity supply works :—

Two Lancashire Boilers.

E. Danks & Co. (*accepted*)	£1,660 0	Tinkers Limited	£2,010 0
Wm. Arnott & Co.	2,260 0	J. and J. Horsfield	1,935 0
R. Taylor & Sons	2,029 0	W. R. Renshaw & Co.	1,895 0

Water Tank and Pumps.

T. Shore & Sons (*accepted*)	£323 0	Edwin Danks & Co.	£387 10
Davie and Horne	585 0	Geo. Fletcher & Co.	386 0
Hunt Brothers	395 0	W. R. Renshaw & Co.	384 10
Wheeler Condenser Co.	393 10	J. Whitley & Co.	374 0
Phœnix Foundry Co.	387 10		

Fuel Economiser.

	Engine.	Economiser.	Total.
E. Green & Son (*accepted*)	£25 0	£473 18	£498 18
Phœnix Foundry Co.	35 0	676 10	711 10
Edwin Danks & Co.	—	—	550 0
Clay Cross Co.	26 0	489 0	515 0
W. R. Renshaw & Co.	25 0	459 0	484 0
J. Carter & Sons	36 10	434 2	470 12
Arthur Lowcock (Ltd.)	24 0	417 12	441 12

Smoke Fans and Engines.

	Fans.	Engines.	Total.
Davidson & Co. (*accepted*)	£165 0	£164 0	£329 0
W. R. Renshaw & Co.	177 0	176 0	353 0

Feed-Water Heater.

T. Shore & Sons (*accepted*)	£219 10 0	W. R. Renshaw & Co.	£275 18 5
Davie and Horne	527 0 0	Edwards and Barnes	249 15 0
Ditto	250 0 0	Isaac Storey & Sons	210 0 0
Phœnix Foundry Co.	365 0 0	Ditto	196 0 0
Edwin Danks & Co.	327 10 0	Wheeler Condenser Co.	196 0 0
Joseph Wright & Co.	293 0 0	G. Fletcher & Co.	171 0 0

Forced-Draught Furnaces.

Wilton Furnace Co (*accepted*)	£252 10 0	W. R. Renshaw & Co.	£290 0 0
W. A. Grainger	356 0 0	Meldrum Bros.	275 0 0
Horsfall Destructor Co.	305 0 0	A. Pillatt & Co.	231 0 0

Coal Conveyor.

New Conveyor Co. (push plate) (*accepted*)	£258	Spencer & Co. (spiral)	£340
Graham and Morton (push plate)	492	E. Bennis & Co.	359
Spencer & Co.	476	S. S. Stott & Co. (spiral)	166
		Barry Henry & Co. (spiral)	145

Mechanical Stokers.

Wilton Furnace Co. (*accepted*)	£190	J. Proctor	£303
E. Bennis & Co.	480	Meldrum Bros. (stokers alone)	285
Ditto	320	Ditto (with furnaces)	560

Grease Separator.

Joseph Wright & Co. (*accepted*) £160

The building works contract has been given to Messrs. C. Cornes & Sons at £649. 10s.

On Wednesday Tunbridge Wells Town Council accepted the following tenders in connection with their proposed municipal telephone exchange :—

W. T. Henley's Telegraph Works Co. (supplying, laying, and jointing armoured telephone cable)	£2,373 10 0
General Electric Co. (telephone instruments)	843 0 0
Ditto (insulators)	216 19 8
Wade & Co. (creosoted poles)	702 2 3
Bolton & Sons (hard copper wire)	518 0 0
Ditto (soft ditto)	21 11 8
Telegraph Manufacturing Co. (switchboards)	282 15 6
Ditto (insulated wire)	218 10 0
International Electric Co. (lightning and high-tension guards)	102 1 0
Bullers Limited (miscellaneous ironwork)	92 2 2
Apsden & Co. (oak arms)	64 9 2
W. F. Dennis & Co. (iron and steel stay wire)	37 15 0
Indiarubber Co. (batteries)	35 5 0
Potter & Co. (arm-bolts, nuts and washers)	10 0 0

The contracts for fixing subscribers' instruments and for supplying erecting and staying poles, wires, arms, insulators, &c., have not yet been let.

Limerick Town Council had before them last week the report of their consulting engineer (Mr. J. Enright) on the tenders recently submitted for the supply and erection of electricity generating plant. Nine tenders were received for the plant, the figures ranging from £12,157 (Alliance Electrical Co.) to £14,050 (British Schuckert Co.). Eleven tenders were received for the cables, the lowest being from Messrs. Porte, Sykes & Co., at £4,226, and the highest from Messrs. Johnson and Phillips, at £6,349. 5s. 2d. Mr. Enright stated that he had written to Messrs. Porte, Sykes & Co. asking for an explanation of their quoting £1,000 less for Glover cables than that at which Messrs. W. T. Glover & Co. themselves offer. The report states that from the small differences in the totals of the different contractors it would be seen that the competition had been particularly keen. Two tenders for cables differed only by a few pounds. The whole of the work could be done for £16,797. 10s. if the Council wished to have three separate contractors. Messrs. Porte, Sykes & Co. offered to do the whole work for £17,000, and Messrs. Crompton & Co. for £17,498. 15s. 2d. The report is at present under consideratiion.

The following tenders have been received by the Darlington Town Council for the supply of arc lamp posts and brackets :—

Maxim Electrical and Engineering Export Co.	£1,181 5 0	J. Allan & Son	£485 12 6
W. A. Baker & Co.	767 7 6	Rowland Carr & Co.	477 15 0
F. E. Kershaw	490 0 0	J. and A. Law	428 15 0
		Mackenzie Bros.	378 17 6

Torquay Town Council have accepted the following tenders for additional plant for their electricity works :—

Babcock and Wilcox (two water-tube boilers and superheaters, without brickwork)	£1,380
Ditto (pipework, condenser, tank, &c.)	2,653
Rosling, Appleby and Fynn (one 250kw. and one 40kw. steam alternator)	3,635
S. Z. de Ferranti, Ltd. (switchboard extension)	220
General Electric Co. (meters)	60
British Electric Transformer Manufacturing Co. (four transformers)	258
S. Blatchford (foundations)	144

Fulham (London) Vestry have received the following tenders for wiring the town hall :—

Cecil Cooper & Co. (*accepted*)	£493 10	F. Troy & Co.	£695 0
W. Douglas & Sons	1,249 6	G. E. Taylor & Co.	671 10
J. Bolding & Sons	899 10	National Electric Wiring Co.	649 0
D. Hulett & Co.	750 0	Concentric and General Contract Co.	637 0
T. L. Hellyar	725 4		

The Bradford Guardians have accepted the following tenders for electric lighting plant :—

Messrs. C. A. Parsons & Co. (generating plant, &c.)	£920
Electrical Power Storage Co. (storage battery)	1,025
Mr. G. A. Steinthal (wiring, &c.)	308
G. F. Cook & Co. (building)	613

The Hart Accumulator Co., Marshgate-lane, Stratford, have obtained the contract for the supply of the storage battery required in connection with the extension of the Blackpool Corporation electric tramway system.

Accrington Corporation have accepted the tender of Messrs. Maund and Seed, of Southport, for wiring the electricity works at £245. Tenders were also submitted by the following :—National Electric Wiring Co., Thomas Barton, Simpson Bros., G. H. Woods & Co, Alliance Electrical Co., H. A. Jackson & Co.

Liverpool Tramways committee have ordered from Messrs. Dick, Kerr & Co. 100 additional electric tramcars of similar type to those at present being supplied under the existing contract, and at the price specified therein. The firm have already supplied 300 cars to the entire satisfaction of the committee.

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Cardiff Electric committee recommend the acceptance of the tender of Messrs. Lace & Son for the supply and erection of steam pipes, feed-water heater, and pump for the electricity works in Eldon-road at £1,379. Six tenders, varying from £1,379 to £2,500 (by Messrs. Danks & Co.) were received. The committee have also accepted the tender of the British Insulated Wire Co. for street cables.

Newcastle-on-Tyne Corporation have accepted the tender of Messrs. Mather and Platt for pumping plant at the tramway power house at £1,470. Contracts for laying the east section of the tram lines (for £26,072) and the west section (for £24,405) have been let to Mr. E. Nuttall and Mr. J. J. Robson respectively.

Salford Electric Light committee are reported to have recommended the Corporation to place an order with Messrs. W. T. Glover & Co. for supplying and laying electric lighting cables, tramway feeders, &c., for £159,648. 12s. 8d.

Aberdeen Town Council has accepted the tender of Mr. Alexander Spark for the supply of house main fuse boxes for twelve months, that of Messrs. S. Z. de Ferranti (Ltd.) for electricity meters, and that of the British Insulated Wire Co. for cables. There were 6 tenders for the fuse boxes, 6 for the meters, and 8 for the cables.

The tender of Messrs. Wilkinson and Houghton has been accepted for the erection of a power station for the Great Grimsby Tramways Co. at £6,310, and for the erection of a depôt at £5,003.

The tender of Mr. G. L. Adamson has been accepted by the Rochdale Council for wiring the town hall.

Chelmsford Council have accepted the tender of Mr. T. H. P. Dennis for keeping the fire alarm system in order for three years at £15. 15s. per annum.

Gloucester Corporation has ordered 30 more electricity meters from Messrs. Chamberlain and Hookham.

APPOINTMENTS VACANT AND FILLED.

Messrs. Preece and Cardew, 13, Queen Anne's-gate, London, S.W., inform us that, notwithstanding that a considerable number of telegraph operators have been sent out to South Africa on behalf of the Cape Government during the present year there are still openings for a large number of good sounder clerks at salaries commencing at £120 to £145 per annum. The appointments are of a permanent nature, although they arise from changes consequent on the war. Clerks have to sign on for two years, and the salary is payable from the time of embarkation. The age limit is 19 to 25 years and candidates must be single. Second class passage is paid, out and home, promotion is fairly rapid, overtime is paid for, and a pension scheme is in operation. Altogether the prospects for these operators in South Africa are good.

An instructor in electrotyping and stereotyping, also an electrical laboratory demonstrator (two evenings per week), are required for the Northampton Institute, Clerkenwell, London, E.C. Particulars from and applications to the principal (Dr. R. Mullineux Walmsley).

Eccles Corporation require a consulting electrical engineer to advise on the extension of the electricity supply undertaking. Applications to town clerk (Mr. Wm. Henry Hickson), Town Hall, Eccles, by 17th inst. See advertisement.

Lowestoft Corporation invite applications for the position of resident electrical engineer. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. R. Beattie Nicholson) before 21st inst.

County of London and Brush Provincial Co. require an assistant engineer for one of their London stations. Applications to chief engineer (Mr. C. P. Sparks), Moorgate-court, Moorgate-place, London, E.C., by Sept. 12. See advertisement.

A practical works manager is required for an electrical accessories manufactory in the Midlands. See advertisement.

Partick Commissioners require a resident electrical engineer. Applications to town clerk, Burgh-chambers, Partick, by Sept. 24.

Belfast Gas and Electric Committee require an assistant electrical engineer. Applications to city electrical engineer by noon Sept. 10.

Accrington Corporation require an assistant electrical engineer, a fitter driver, cable jointer and switchboard attendant. Applications to town clerk by 15th inst.

Swansea Electric Lighting committee recommend the appointment of Mr. James H. Cawthra, chief assistant at Leeds, as borough electrical engineer at £300 per annum. There were 75 applications, and these were referred to the consulting engineer (Mr. E. Manville) for report. The number was eventually reduced to the following: Mr. Horace Boot, chief engineer at Tunbridge Wells (who, however, expected £400 a year); Mr. S. E. Britton, chief engineer at Barking, Essex; Mr. James H. Cawthra, chief assistant engineer at Leeds; Mr. H. Coles, of Swansea (manager to Messrs. J. C. Howell, Ltd.); Mr. P. N. Hooper, resident engineer, King's-road station, St. Pancras (London); Mr. J. D. Knight, chief engineer at Ealing; Mr. H. R. Forbes McKay, chief assistant engineer, Edinburgh; Mr. D. J. Brindle, of the Brush Company; and Mr. R. W. L. Phillips, chief assistant engineer, Bristol. The committee made the selection on Wednesday, and on the first ballot Messrs. Coles, Hooper and Boot fell out; on the second Messrs. Knight, McKay and Phillips; on the third Mr. Britton; and on the final round Mr. Cawthra was selected by 25 votes to 5.

Liverpool Electric Power and Lighting committee have made the following promotions:—Mr. A. Clough, works manager, with a present salary of £460, increasing to £500, to be assistant electrical engineer at £550, to be increased in twelve months to £600; Mr. R. S. Downe, assistant engineer, to be first assistant engineer, at £390, increasing £40 per annum to £400 (present salary £250, increasing to £300); Mr. C. H. Smith, engineer's secretary, to be office superintendent, at £150 (present salary £120); Mr. J. Stirrup, meter inspector, to be superintendent meter department, at £130 (present salary £110).

Mr. P. M'Cullough, works superintendent and general assistant of the Liverpool Tramways department, has been appointed assistant manager at £500 per annum.

Mr. H. Eady, manager at Bournemouth of the National Telephone Co., has been appointed district manager of the company for the Channel Islands.

Mr. E. Stanley Harpham has been appointed assistant in the distributing department of the Charing Cross and City Electric Co. (Ltd.)

Mr. J. F. M. Bennett has been appointed engineering clerk of works at the Reigate electricity works.

BUSINESS NOTICES.

Owing to ill-health, Mr. S. A. Parkes is retiring from the business carried on under the style of Prestwich and Burt, electrical engineers, Kingston-on-Thames. The business will be continued by Messrs. E. E. Prestwich and Leslie N. Burt at the works, South-lane, Kingston-on-Thames.

The offices of the City and South London Railway have now been removed to 71, Finsbury-pavement, E.C., over the company's Moorgate-street station.

BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee (Mr. J. A. Binns, O.R., Bradford) in the bankruptcy of Arthur Blackburn (Marriott-street, Dewsbury) and James Walker (88, Dale-street, Batley Carr), trading as Blackburn, Walker & Co., electrical and mechanical engineers, Upper Lane Mills, Cleckheaton, Yorks., has been released.

Claims against B. Symmons (trading as B. Symmons & Co.), electrical engineer, 2, North-street, Quadrant, Brighton, and 14, Highland-road, Hove, Brighton, must be in by Sept. 15. Mr. R. J. Ward, 17, North-street, Brighton, is trustee.

Application for the discharge of W. J. Green, electrician, &c., 45, Birchfield-road, Aston, will be heard on Oct. 11, at the Birmingham County Court.

A second and final dividend is payable at Messrs. Carstairs, Hunter and Campbell's, 196, St. Vincent-street, Glasgow, on Nov. 1 in the estate of Wilks, Sloan & Co., electrical and consulting engineers, and J. L. Sloan, sole partner.

A meeting of the Eastbourne Electric Light Co. (Ltd.) will be held at Eastbourne on Oct. 8 to receive an account of the winding-up. Mr. H. Towner is liquidator.

Electrical Engineering Business for Sale.—The business of P. C. Middleton & Co. (Ltd.), electric light and power engineers, of Aberdeen, Edinburgh, Inverness, &c., is for sale as a going concern. Further particulars are given in an advertisement. The business includes the electricity supply plant and mains at Cults, Aberdeen. The liquidators offer the business for sale as a whole, but are prepared to consider separate tenders for the various branches. Offers to either Mr. W. R. Reid, advocate, 46A, Union-street, Aberdeen, or to Mr. S. Easton Simmers, C.A., 58, Bath-street, Glasgow, joint liquidators; or to their law agents, Messrs. Wilsone and Duffus, advocates, 146, Union-street, Aberdeen, who will supply all further information.

Plant for Sale.—Leeds Corporation invite tenders for the purchase of plant at present in use in connection with their system of electric tramways. Further particulars are set out in an advertisement. The plant, which is in excellent condition, can be inspected on application to the engineer-in-charge at the Corporation generating station. The consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., will supply additional information; and tenders (addressed to Tramways Committee) should be sent to town clerk's office, Town Hall, Leeds.

Messrs. Fuller, Horsey, Sons and Cassell will sell by auction at the Old Mill Works, Cowley Mill House, near West Drayton, Middlesex, on Thursday, Sept. 20, at 12 noon precisely, a quantity of engineering and electrical plant and machinery, some particulars of which are set out in an advertisement. Catalogues can be had of Messrs. Pond & Sons, 6, Butter Market, Ipswich, and of the auctioneers, 11, Billiter-street, London, E.C.

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Messrs. Fuller, Horsey, Sons and Cassell will also sell by auction at 65, High-street, Kingston-on-Thames, on Sept. 26, at noon, some modern plant, machinery and stock. Additional particulars are given in an advertisement. Catalogues can be obtained from the auctioneers, 11, Billiter-square, London, E.C.

Works Premises for Sale.—Factory buildings are advertised on another page for sale or to let of large dimensions, fitted with chimney stack, hoists, combined condensing engine, &c., with canal frontage. Particulars can be obtained of Messrs. Milne, Gaff and Stirling, 63, Old Broad-street, London, E.C.

Electric Light and Power Regulators.—The Electrical Development Syndicate of Halifax has issued a new catalogue, describing and illustrating electric regulating apparatus made under the patents of Mr. Walter Emmott and others. Included in the catalogue are a number of curves of tests made on the syndicate's regulators at various installations.

"A.B.P." Accumulators.—Messrs. Ashmore, Benson, Pease & Co., of Stockton-on-Tees, forward a new price list of "Invicta" storage batteries for electric ignition and portable cells, for which advantages are claimed over dry batteries for electric ignition. The new list is accompanied by a number of testimonials from users of these batteries, supplied by the affiliated company in France.

Brown-Boveri Plant.—An interesting report is issued by Messrs. Brown, Boveri & Co. (Ltd.) on the more important installations carried out by the firm during the eight short years of the firm's existence. It is a good showing. The illustrations include several excellent views of supply works interiors, including those at Frankfort, St. Petersburg, Porta Volta (Milan), Chevres (near Geneva), Olten-Aarberg and Rathausen (near Lucerne), as well as of individual examples of generating machinery for lighting, traction, and power transmission. Some good views are also shown of interiors of the extensive works at Baden. The extent of the company's operations is indicated in some measure by the number and importance of many of the installations briefly detailed in the report.

Paris Exhibition Awards.—Elmore's German and Austro-Hungarian Metal Co. have been awarded a gold medal for their exhibit at Paris.

The Schuckert Co. was represented in four sections (No. 23, Electrical Machinery and Motors; No. 25, Electric Lighting Plant; No. 29, General Plant; and No. 118, Electrical Apparatus for Marine and Naval Purposes), and was awarded in all four sections the Grand Prix. The engineers and representatives of the firm received nine gold medals and eight silver and bronze medals.

Messrs. Ruston, Proctor and Co. received one Grand Prix, two gold medals and one silver medal; and the managing director of the company (Mr. A. Borneman) and the director and engineer (Mr. F. H. Livens) were each awarded a silver medal.

"Notes on Electric Tramways" is the title of a pamphlet issued by Mr. W. E. Kenway, 17, Burlington-chambers, New-street, Birmingham, chiefly with a view to show the advantages of the "Victor" joint and bond in tramway working.

Building Trades' Gift to the Nation.—A list of members of the electrical section of this gift who have, up to Aug. 29, promised contributions in kind or in cash to the Bisley Homes of Rest for Disabled Soldiers can be obtained from the hon. sec., Mr. W. G. McMillan, Institution of Electrical Engineers, 28, Victoria-street, London, S.W. It is pointed out that at present the response to the appeal is somewhat disappointing.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 29 to Sept. 4, with the ports of destination:—

Africa—Cape Town, £417; Durban, £174; East London, £167; Port Elizabeth, £519. *Argentina*—Buenos Ayres, £1,021 (including £296 telegraph material). *Australasia*—Auckland, £714; Fremantle, £2,342; Melbourne, £3,755 (including £903 telegraph material); Port Chalmers, £41; Sydney, £1,701 (including £404 telegraph material); Wellington, £100 (including £60 telegraph material). *Brazil*—Rio Janeiro, £196 (telegraph wire). *Canada*—Halifax, £122 (including £102 telegraph apparatus); St. John's (N.F.), £13. *Denmark*—Copenhagen, £184 (telegraph wire). *France*—Bordeaux, £30; Boulogne, £150. *Germany*—Cologne, £12; Hamburg, £980 (including £800 telegraph material). *Holland*—Amsterdam, £35; Rotterdam, £207 (telegraph material). *Hong Kong*—£37. *India*—Bombay, £68; Calcutta, £621 (including £98 telegraph wire); Madras, £42. *Japan*—Hiogo, £257 (telegraph material); Nagasaki, £169; Tokio, £135 (telegraph cable); Yokohama, £12,581 (including £11,946 telegraph apparatus). *Russia*—St. Petersburg, £352 (including £343 telegraph material). *Spain*—Seville, £280. *Straits Settlements*—Singapore, £111. *Sweden*—Gothenburg, £19 (telegraph wire); Stockholm, £269 (telegraph material). *United States*—New York, £18. *West Indies*—Jamaica, £59 (telegraph material); Trinidad, £37. Total £27,935, against £11,102 in the corresponding week last year (Aug. 30 to Sept. 5.)

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

June 26, 1900.

11,571. H. Blumenberg, jun. London. Improvements in battery compounds.*

11,584. C. Pauthonier. London. Improvements relating to incandescent electric lamps. (Date applied for under Patents, &c., Act, 1883, sec. 103, March 30, 1900, being date of application in France.)

11,588. G. E. Kent. London. Improvements in electric railway systems.

11,597. H. G. Osburn. London. Improvements in flexible conduits for electrical conductors.*

11,609. P. H. Thomas. London. Improvements in means for protecting electrical apparatus from abrupt changes in static potential. (Date applied for under Patents, &c., Act, 1883, sec. 103, Nov. 27, 1899, being date of application in United States.)

11,610. (Exactly the same as 11,609.)

11,620. H. F. Joel, senior. Essex. Improvements in dynamo electric machines and electric motors.

June 27, 1900.

11,659. M. Haase and E. Röder. London. An improved cutout plug.*

11,677. H. C. Leake. London. Improvements in apparatus relating to the parallel running of alternate current machinery.

11,692. H. G. Nicholson. London. Improvements in or connected with electrical tramways or railways.

11,695. W. L. Wise. London. Improvements in alternating-current watt-meters. (The Union Elektricitäts-Gesellschaft, Germany.)

June 28, 1900.

11,704. W. E. Burnand. Sheffield. New or improved electric brush-holder.

11,709. Hardy and Padmore (Ltd.) and J. Southall. Worcester. Improvements in the construction of electric lamp pillars.

11,720. H. T. Dawson and H. A. Dawson. Coventry. Improvements in or relating to electrical ignition apparatus for exploding the charges in internal combustion motors, and for other similar purposes.

11,727. W. Kingsland. London. Improvements in or connected with electric switches having intermittent or step by step motions.

11,768. J. F. Cornuand. London. Improvements in electric light brackets or fittings.

June 29, 1900.

11,787. A. H. Hickley. Liverpool. Improvements in electrical starting and regulating switches.

11,797. The British Thomson-Houston Co. (Ltd.). London. Improvements in regulating devices for alternating electric current circuits. (E. Thomson, United States.)*

11,808. L. Cerebotani and C. Moradelli. London. Improvements in automatic switches for telegraph and telephone circuits.*

11,812. A. M. Hart. London. An improved method of fixing the china or other insulator and also conducting wire in sparking plug for ignition by electricity for gas or other explosive vapour or oil engines.

11,819. Siemens Bros. & Co. (Ltd.). London. An instrument for measuring rotary field currents. (Siemens and Halske Aktien Gesellschaft, Germany.)

11,825. J. F. Smith. Birmingham. Improvements relating to electrical installation and distribution.

11,835. E. R. Hill. London. Improvements in electro-pneumatic controlling apparatus. (Date applied for under Patents, &c., Act, 1883, sec. 103, Jan. 13, 1900, being date of application in United States.)

11,840. J. V. Sherrin. London. Improvements in means for preventing sparking in electric switches, commutators, current conductor contacts, contact breakers, and other electric devices.

June 30, 1900.

11,853. J. K. Grindred. Rochdale. Improvements in and relating to flag or banner poles or for use in connection with arc lamps or for other like purposes.

11,861. R. Kennedy. London. Improvements in or connected with secondary batteries.

11,869. H. V. Weyde. London. Electric generators for military and other cycles.

11,891. A. Baisieux. London. Improvements relating to electric traction for tramway and other similar vehicles.

July 2, 1900.

11,897. J. T. Pearson. Burnley. Improvements in trolleys for overhead electrically driven tramcars.

11,907. J. Bolton. London. An improved block or mounting for electrical gas and like fittings.

11,914. J. C. Richardson. London. Improvements in the manufacture of electrodes for secondary batteries.

11,915. G. R. Tomb. London. Improvements in and in connection with trolleys for overhead cable railways or tramways.*

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11,929. F. C. F. KNAAK and J. S. CAMPBELL. London. Improvements in or relating to production of type by means of electric current.
11,933. R. LUNDELL. London. Improvements relating to the regulation of electric motors.*
11,937. F. B. STAFSING and C. EGNER. London. Improvements in telephone systems.
11,941. W. H. SCOIT. London. Improvements in electric motors and regulating appliances for turret turning, gun training, and analogous purposes.
11,944. V. F. FEENY. London. Switching arrangement for Nernst and vacuum incandescence lamps. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

July 3, 1900.

11,965. A. BARR, W. STROUD and L. BECKER. Glasgow. Improvements in electric receivers and electric clocks.
11,970. J. MILNES. Manchester. Improvements in or relating to the construction of electric switches and contact makers used for electric tramways and the like.
11,991. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in rheostats for electric motors. (J. L. Hall, United States.)*
11,997. R. RODRIAN. London. An improvement in accumulators or secondary batteries.
12,002. E. P. BARFIELD. London. Improvement for providing an automatic lock for the purpose of securing electric and other lamps in lamp holders, electric and other shades in holders, and locking couplings of a like nature.
12,003. J. WETTER. London. Improvements relating to dynamo-electric mine-exploders or apparatus for firing explosives. (L. C. Gomant, France.)*
12,016. T. J. RYAN. London. Improvements relating to electrically-propelled motor vehicles.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

9,436. CANTONO. Electric telegraphic apparatus. (Date applied for under International Convention, Jan. 12, 1899.)
9,437. CANTONO. Electric telegraphic apparatus. (Date applied for under International Convention, April 13, 1899.)
12,249. THOMSON and WARNFORD-DAVIS. Telephone systems and apparatus therefor.
13,773. THOMPSON and WALKER. Electric traction on a road-contact or like system.
13,930. F. BRYAN and A. H. BAYLEY. Magneto-electric and dynamo-electric generators.
14,250. HUDSON and WIGHTMAN. Casings for electric light and similar cables.
14,265. WEHNER and LAUBE. Automatic signalling apparatus for electric tramways.
14,489. GILL. Coin-controlled call recording device for telephone systems.
14,501. HILLS and MATTHEWS. Electrical accumulators.
14,736. HURRELL. Winding for dynamos.
15,166. LANGDON. Form of electrically-actuated railway signal.
15,551. DAVIDSON. Means for supporting electric incandescent lamps.
15,581. JEVONS and LLOYD. Switch and ceiling rose or other like fitting for electric lighting purposes.
15,599. PARTRIDGE and ELPHINSTONE. Electric switches and like apparatus for making and breaking electric circuits.
15,744. LUCAS. Electric regulating switches.
15,807. WRIGHT. Terminals of electric batteries and the like.
15,967. KAMM. Electric arc projecting lanterns.
15,973. DAVIDSON. Direct coupling or connection of rotary fans or pumps with electric or other motors or engines driving same.
16,094. ECKSTEIN and COATES. Watchman's electric tell-tale system or apparatus.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28⅝d. per oz. (Sept. 6). Consols (2¾ per cent.) 98⅜ – 98½ for money, 98⅝—99⅛ for account; 2½ per cent. 97—97½ (Sept. 6). Stocks and Shares Continuation Days, Sept. 12 and 26; Ticket Days, Sept. 13 and 27; Pay Days, Sept. 14 and 28; Mining Share Carry-over Days, Sept. 11 and 25.

AN AMERICAN COMBINE.—It is now definitely announced in the American electrical papers that a combination has been effected between the Stanley Electrical Manufacturing Co. of Pittsburg and the Northern Electrical Manufacturing Co. of Madison.

CHLORIDE ELECTRICAL STORAGE SYNDICATE (LTD.)—The annual general meeting of this syndicate was held at Clifton Junction on 28th ult., the chairman of the company (Mr. F. H. Bowman, D.Sc., F.R.S.E.) presiding. The directors' report for the year to June 30, stated that the business of the syndicate had continued to increase in a very satisfactory manner, the amount of orders received and goods manufactured being considerably greater than in any previous year. The capability of production at the works had been taxed to the utmost, and a large volume of orders had either gone by or been refused owing to inability to execute them within a reasonable period. To meet the continually increasing demand considerable extension of the works and plant is becoming an imperative necessity, as also the provision of additional working capital. Negotiations have been entered upon for acquiring additional land adjoining the present works. The profits for the year, after providing for debenture interest, amounted to £8,649. 15s. 5d., which the directors considered satisfactory, when the large increase in the cost of raw material and the conditions of production which obtained during the year are taken into consideration. Those, together with the execution of contracts arranged in 1897 and 1898, previous to the advance in prices, had seriously militated against the year's profit. After writing off from several accounts £4,391. 2s. 1d., there remained a balance of £4,258. 13s. 4d., and £7,026. 10s. 5d. brought forward, making £11,285. 3s. 9d. The directors proposed to carry forward the balance, out of which a dividend may be paid at their discretion. The report and accounts were adopted, the retiring director (Mr. J. S. Baker) and the auditors re-elected, and votes of thanks to the chairman and directors, and to Mr. Grindle (the general manager), the secretary and the staff, terminated the proceedings.

CLONTARF AND HILL OF HOWTH TRAMROAD CO.—The annual meeting was held in Dublin last week. The report stated that the opening of the line, which was delayed owing to the difficulty of getting rolling stock delivered, took place on July 26 last. The traffic had been satisfactory, and promised well for the future of the undertaking. The chairman (Sir F. Brady) said the receipts up to the present (for four weeks and five days) amounted to £1,078, and they carried 95,000 passengers. They had now their full supply of cars delivered, and hoped to be able to handle any traffic that might arise. The Howth line had to depend chiefly on summer traffic, but as the capital of the company was small and the working expenses comparatively low, the shareholders might look forward to satisfactory dividends out of the summer traffic alone. Under their special act the tramroad was the company's property for ever and not for a period of years, which made their property more than usually valuable. The whole of the share capital of £50,000 and £21,000 out of £25,000 debentures were issued. £45,000 had been called up on the shares. The Great Northern Railway Co. were constructing an electric tramroad round the Hill of Howth, which it was expected would be opened for next season's traffic. This line would greatly increase the attraction of the district, and consequently improve the traffic on their line, which in turn would assist the Great Northern Company's line. The report was adopted.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. has been declared payable on Oct. 1.

HONG KONG ELECTRIC CO.—The annual meeting was held at Hong Kong in July. The chairman (Mr. C. S. Sharp) moved the adoption of the report and accounts, which showed steady progress during the year. The principal increase had been from the incandescent lighting service, the arc lighting remaining almost stationary. Expenses had increased, but coals did not show any material advance. The capital of the company had been increased to $600,000, in 60,000 shares of $10 each. Of the 30,000 new shares offered to shareholders 25,896 were taken up, and $2 per share had been called up and paid on them. That had provided sufficient capital for their present purposes, but it might be necessary to provide for further financial requirements later in the year by calling up a further amount on the issued shares, and disposing of the 4,104 shares not then taken up. Several additions had been made to the company's plant during the year. The profit on working account amounted to $43,596.62, and the balance at credit of profit and loss account was $18,216.36. It was proposed to appropriate this as follows: Dividend of 7 per cent. per annum ($22,812.72), depreciation $24,354.23, and to carry forward $1,049.41.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—An extraordinary meeting of this company was held on Wednesday to receive the directors' statement on the present position of the company, and regarding a proposed issue of further capital. Major S. Flood Page presided, and said the directors had resolved to issue 25,000 shares, and, in acordance with the promise given at the meeting in 1898, they were prepared to issue 25,000 shares pro rata to the shareholders at £3 per share. They had entered into a provisional agreement with an important London financial firm who were prepared to guarantee 12,500 of the 25,000 shares at £3 each, and to take at that price such of the 12,500 shares as were not applied for by the shareholders, in consideration of their being paid a commission of 5s. per share on the 12,500 shares, and in further consideration of their having a call at £3. 10s. each up to March 31, 1901, on such of the remaining 12,500 shares as were not taken up by the shareholders. The directors regarded the proposal as beneficial to the company, and the present meeting had been called to discuss it. He pointed out that it was not the directors' estimate of the value of the shares, but a bona fide offer from a firm of considerable financial eminence and very great financial strength, and he thought this estimate of the cash value of the business was in itself a testimonial to the company. Many inaccurate statements had been made by newspaper correspondents as to what the company were going to do in the Navy. They had contracted for the fitting up of the apparatus on 28 ships and four land stations. An officer in the Navy, who had been experimenting, could not get beyond 25 miles, but the Admiralty required the company to supply instruments to work at a distance of 90 miles. There would soon be other land stations which would enable the Admiralty, practically, to talk from Dover to the Scilly Islands (about one-fourth of the coast line), and no doubt they would soon wish it extended along the whole coast, and he thought the mercantile marine would soon have to follow suit. It had been stated that it was easy to tap the wireless telegraph, but their previous experience had proved that the instruments could be so tuned that this would be impossible. They were also in treaty with a foreign government for the application of the company's system to its navy. That business, if carried to a successful issue, would be very profitable to them.

MATHER AND PLATT (LTD.)—The ordinary general meeting was held on Friday last. The directors' report stated that the net profit for the

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year ended June 30, after allowing for depreciation and directors' remuneration, was £71,655. Adding £4,523 brought forward there was an available total of £76,178. The preference dividend for the half-year to Dec. 31 absorbed £8,126. Out of the balance (£68,052) the directors recommended dividends at the rate of 5 per cent. per annum on the preference shares (£8,126), and 7 per cent. on the ordinary shares for the year to June 30 (£28,000). £25,000 has been transferred to reserve and £6,925 carried forward. The report and accounts were adopted, and the payment of the dividends authorised. The chairman (Mr. W. Mather, M.P.) said most engineering firms had been caught by the rise in prices of materials during the past year or 18 months. Up to the present the company had not to any great extent been able, nor had they been inclined, to make demands upon their customers to share the burden of such increase, being of opinion that it was unwise to disturb the relations between themselves and their old customers in particular unless there was the best ground for believing that the rise would be more than temporary. They looked forward to the future with confidence, and had consequently acquired an additional 50 acres of land eligible for the development of large engineering works, being bounded by railways on one side and possessing water communication on the other. Seeing the advantages now possessed by the youth of the nation in the public elementary schools, and in the secondary and high-class technical schools, the directors looked forward to the time when the engineering trades of England would command the services of quite an army of young men who were not only highly trained for the carrying on of a great technical industry, but were men of character, devoted to duty, earnestness of purpose, and animated by the noblest ambition to make their country greater in the future than it had been in the past.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed 10th inst. a special settling day for the further issue of £125,000 3½ per cent. Mortgage debenture stock of the *Metropolitan Electric Supply Co.* (*Ltd.*), and has ordered the same, as well as the further issue of 21,902 £3 fully-paid shares (Nos. 32,099 to 54,000) of *Crompton & Co.* (*Ltd.*) to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in, and to grant a quotation to, the further issue of 50,000 £10 shares of the *Eastern Extension, Australia and China Telegraph Co.* (*Ltd.*), and to allow the 4 per cent. debenture stock of the *Western Telegraph Co.* (*Ltd.*) to be quoted in the official list.

TELEGRAPH MANUFACTURING CO. (LTD.)—The transfer books of the preference shares will be closed from 15th to 29th inst. inclusive, for the payment of the dividend due Oct. 1.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Sept. 1	4,495	+ 144	8	36,398	+ 1,479
Blackpool Corporation...	Aug. 30	1,503	+ 445	22	19,185	+ 4,356
Blackpool and Fleetwood	Sept. 1	1,519	+ 48	9	13,125	- 337
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	Sept. 2	568	+ 129	22	11,041	+ 1,920
Brisbane Trams	July 18	1,631	+ 250	2	3,300	+ 602
*Bristol Trams & Carriage	Aug. 31	3,455	- 43	9	32,001	- 637
*Buenos Ayres & Belgrano	,, 5	1,899	- 332	5	10,369	- 1,168
Central London Railway	Sept. 1	4,499	+ 114	5	22,828	...
City & South London Ry.	,, 2	1,528	+ 637	9	13,536	+ 4,983
Cork Elec. Trams	Aug. 30	493	- 26	35	14,195	+ 1,172
Dover Corporation	Sept. 1	289	- 4	22	5,254	+ 319
Dublin & Lucan Rly. ...	...	...	...	...	...	...
Dublin United	Aug. 31	4,257	+ 679	9	35,124	+ 3576
Dublin Southern Dist....	,, 31	1,630	+ 508	9	10,632	
*Glasgow Corporation ...	Sept. 1	9,269	+ 67	...	...	...
Hull Corporation	,, 1	1,307	+ 709	9	12,038	+ 6,795
*Liverpool Corporation...	Aug. 25	8,688	+ 512	34	259,304	+ 29,107
Liverpool Overhead Rly.	Sept. 2	1,735	- 259	9	15,695	+ 40
*Sheffield Tramways	,, 2	2,562	+ 1,089	35	75,773	+ 26,902

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Aug. 29.	Price Wednesday, Sept. 5.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 5. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£96,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	99	...
25,000	10	...	Amazon Telegraph.....	...	...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£822,720	Stock	15/0	Anglo-American	58 61	58 61	6 0 11	Feb., May, Aug., Nov.	59⅜	...
£3,088,640	Stock	30/0	Do. Preferred	110½ 111½	110½ 111½	5 7 7	,, ,,	111¼	110¾
£3,088,640	Stock	27/0	Do. Deferred	12¼ 12¾	12¼ 12¾	10 11 8	,, ,,	...	...
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	,, ,,	102½	10.⅜
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0		...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100% 104%	100% 104%	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	11 11½	11 11½	6 1 9	Jan., Apr., July, Oct.	11½	11
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	145 150	146 151	4 12 9	Jan., Apr., July, Oct.	149	146
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	97 100	97 100	3 10 2	,, ,,	100	98
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	111 116	112 117	3 9 0	May and November ...	115	...
250,000	10	2/6	Eastern Extension.....	14¾ 15½	14¾ 15½	4 11 10	Jan., Apr., July, Oct.	15⅛	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110 115	111 116	3 9 0	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	99 102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	100% 103%	100% 103%	3 17 8	May and November ...	...	...
180,227	10	4/6	Globe Telegraph and Trust	11 11½	11 11½	4 11 10	Jan., Apr., July, Oct.	11½	11½
180,042	10	3/0	Do. 6 per Cent. Preference	14¾ 15½	14¾ 15½	3 19 0	,, ,,	15 1/16	14⅞
150,000	10	5/0	Great Northern of Copenhagen	31 33	32 34	3 13 6	January and July.....	32	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	98 101	98 101	4 9 1	June and December ...	100¼	...
17,000	25	37/6	Indo-European	51 55	51 55	4 10 11	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105 108	103 106	5 13 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7⅞ 8¼	7⅞ 8¼	4 14 1	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 12 10	,, ,,	...	...
15,609	10	...	West African Telegraph	2⅛ 3⅛	2⅛ 3⅛	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.) x1	98 101	96 99	5 1 0	March and September	...	...
30,008	2½	...	West Coast of America.....	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 13 7	January and July.....	...	...
88,321	10	1/0	West India and Panama	⅝ ⅞	⅝ ⅞	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	,, ,,	7	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5 6	5 6	10 0 0	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	102 105	103 106	4 15 3	January and July.....	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	15⅛	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	½ 1	½ 1	5 0 0	,,	...	...
590,000	5	3/0	National	4⅜ 4⅞	4⅜ 4⅞	6 3 1	February and August	4⅛	4⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	13 15	13 15	4 0 0	,, ,,	13⅜	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	13 15	13 15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	4¼ 5⅛	5 5¼	4 15 3	,, ,,	5⅛	5 1/16
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	98 101	3 9 8	June and December ...	100	...
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4½ 5½	4½ 5½	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference.....	4½ 5½	4½ 5½	5 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	,, ,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Aug. 29.	Price Wednesday, Sept. 5.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 5. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckb'n & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	...	...	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red.)	...	100 103	4 7 5	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6 6½	6 6½	...	...	6⅝	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp.	9 10	9 10	4 12 6	February and August	9½	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5⅝	5½ 5⅝	3 18 3	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7½	6½ 7½	4 0 0	March	...	...
†£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	103 111	103 111	4 1 6	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	3/0	City of London Electric Lighting Ord.	7½ 8½	7½ 8½	4 14 2	February and August	...	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 16 0	January and July	12⅛	12½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 128	123 133	3 18 5	June and December	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½ 9½	8½ 9½	6 6 4	...	9⅛	8⅞
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11 12	11 12	5 0 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	109	103½
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1⅛	1 1⅛	...	...	...	...
42,840	5	3/0	Do. 6 per Cent. Preference	3⅞ 4⅛	3⅞ 4⅛	6 13 4	...	4⅛	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	99 101	99 101	3 19 9	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord.	14 15	14 15	3 13 4	April and October	14⅞	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December	...	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93 98	96 99	3 11 6	...	97⅛	97½
6,452	10	6/0	Notting Hill Electric Ordinary	14½ 15½	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5½ 6½	5½ 6½	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	⅞ 1⅛	⅞ 1⅛	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	107	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14 15	14 15	4 16 8	February and August	14⅛	14½
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 2	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3 4	3 4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12 13	12 13	5 0 0	March and September	13½	12½
29,437	5	...	Do. £3 10s. paid	8½ 9½	8½ 9½	...	...	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	⅞ 1⅛	⅞ 1⅛	4 8 11	...	...	...
120,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞ 1	1 1⅛	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅜ ½	⅜ ½	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅜ ½	⅜ ½	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½ 12½	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅞ 6⅛	5⅞ 6⅛	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅝ 5⅛	4⅝ 5⅛	...	...	...	...
90,060	2	1/2½	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	4 5 4	September	...	...
90,000	2	1/2½	Do. 5 per Cent. Pref. Non-Cum. xd	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2⅛	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock xd	103 113	106 111	4 0 11	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 103	101 103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	13 14	12½ 13½	5 11 1	,, ,,	12⅝	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 5⅝	5½ 5⅝	4 6 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	6 8 0	...	...	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/3⅜	Chadburn's Ship Telegraph Ordinary	⅜ ½	⅜ 1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ ¾	⅝ 1⅛	5 6 8	...	1	...
54,000	3	2/-	Crompton and Co. (Nos. 1 to 32,098)	3½ 4½	3½ 4½	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 103	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ ¾	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	1⅜ 2⅛	1⅜ 2⅛	8 0 0	February and August	2	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅝ 4⅛	3⅝ 4⅛	6 13 4	,, ,,	...	...
£344,028	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	89 91	90 92	4 7 5	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	68 73	69 74	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4½ 5	4½ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	1⅞ 2⅛	1⅞ 2⅛	5 13 11	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛ 3⅛	2⅛ 3⅛	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	104 105	3 16 2	January and July	103½	103½
30,000	5	4/0	Henley's Telegraph Works Ordinary xd & new	12½ 13½	11½ 12½	6 0 0	February and August	13	...
30,000	5	2/3	Do. 4½ per Cent. Preference xd & new	5 5½	5 5⅛	4 1 10	,, ,,	5½	5⅛
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) xd	110 114	108 112	4 0 4	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 104	101 104	3 17 10	March and September	...	...
37,350	12	1/3/0	Telegraph Construction and Maintenance	35 39	35 39	4 13 4	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 5⅞	5½ 5⅞	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½ 11½	10½ 11½	6 4 4	April and October	11⅛	10¼
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7	6½ 7	4 5 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	2/0	Blackpool and Fleetwood Tramways xd	14 15	14 16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103 105	103 105	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	21½ 21¾	21½ 21¾	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	19½ 19¾	19½ 19¾	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10 10½	10 10½	4 15 3	May and November	...	...
45,000	10	11/0	British Elec. Trac. Ord.	15½ 15¾	14½ 15½	6 9 0	...	15	...
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12⅛	12½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123 124	123 123	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	131 134	131 134	...	...	133⅛	133½
40,000	5	2/8⅜	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4½ 5½	4½ 5½	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 103	103 103	4 15 0	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Sch. Prov. Certs. (all pd.)	93 99	93 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	9½ 10½	10 10½	2 17 2	June and December	10⅜	9½
£355,000	Stock	1½%	City and South London Railway Con. Ordinary	57 60	57 60	2 6 0	February and August	...	...
37,500	10	1/3⅛	Do. (Nos. 24,531 to 60,000)	5 6	5 6	2 9 4	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	133 143	133 143	3 9 11	,, ,,	...	...
£240,000	Stock	5%	Do. (1896)	130 135	130 135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary xd	21 23	21 22	3 12 9	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference xd	14½ 15	14½ 15	3 19 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	...	...	...	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	⅛ ¼	⅛ ¼	...	...	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	...	9½ 10½	4 17 7	,, ,,	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary xd	8½ 9	8½ 9	4 8 11	May and November	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	13 13½	13 13½	3 15 6	February and August	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	102 104	103 104	3 16 11	,, ,,	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3¾	...	January and July	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	...	18 19	...	February and August	...	...
4,000	10	6/0	Do. 5 per Cent. Preference	...	10½ 10¾	4 15 8	,, ,,	...	...
18,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 8	February and August	...	...
540,000	Stock	3%	Waterloo and City Ordinary	91 94	92 95	3 3 7	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,165. [No. 21, Vol. XLV.] FRIDAY, SEPTEMBER 14, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 30c., or 70pf.

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NOTES.

As we go to press, the highly successful meeting of the British Association at Bradford is being brought to a conclusion, though, indeed, the practical business of reading and discussing Papers came to an end on Wednesday. Favoured by delightful weather, the members have had abundant opportunity to combine pleasure with business, this recreation being greatly assisted by new and decidedly improved arrangements for the various excursions. As regards the electrical Papers, these appear to have been quite as numerous as in previous years, especially in Section A; and on the whole they may be considered quite up to the usual standard. We shall comment in detail on several of these Papers simultaneously with reprinting them in our columns. This week we publish a short summary of the electrical proceedings, together with reprints in full or in abstract of some of the communications. The Paper by Prof. J. CHUNDER BOSE, of which we commence a reprint, and on which we comment in our leading article, is worthy of careful study; and there is a useful Paper descriptive of a new standard resistance which is deserving of attention from our scientific readers.

YEARS ago, experiments were made in telegraphing across rivers and streams without crossing them with wires. Earth plates were sunk at a considerable distance apart on one side of the river, and facing them were similar plates on the other side. Some of the lines, when a current flow was made to pass between the earth plates on one side, traversed the river, and noticeable currents could be obtained by connecting the two earth plates on the other side through a sensitive instrument. As the telephone is the most sensitive means of detecting minute currents, it has been employed as the receiver in this method, and vibratory currents have been sent at the transmitting end. Sir WILLIAM PREECE's so-called electromagnetic system of wireless telegraphy consists of extending two lengths of wire parallel to one another on each side of a channel, earthing these at both ends, and connecting in circuit with one a source of vibratory current, and in circuit with the other a telephone. On comparison, however, it is seen that the two systems really employ identical means (parallel lines terminating in earth plates) to the same end, and it is probable that the result is due to a combination of conduction and induction effects. Whether inductive or conductive, it is also apparent that if a sufficiently large proportion of the transmitted current can be obtained in the receiving circuit, articulate speech instead of mere musical (or unmusical) notes might be transmitted by this method. The experiments made by Sir WILLIAM PREECE and Mr. GAVEY (described in a Paper read by Sir WILLIAM at the British Association, an abstract of which is given in another column of this issue) have proved that telephonic communication is possible by this means, provided the length of the lines or the distance between the two earthing points which are on the same side of the channel, is sufficiently great.

THIS result adds to the importance of a well-known problem in telephony—viz., that of designing a microphone for a larger current than that suitable for the instruments now in vogue. The employment of larger currents would, in ordinary telephony, permit of the reduction of the sectional area of the line wires, or, what is perhaps more important, enable less sensitive receivers to be employed and so diminish the disturbing effects due to induction from telegraph, lighting and power circuits. In wireless telephony, according to the

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system described, the possible employment of larger currents is of still greater moment, since only a certain small fraction of the original current reaches the receiving instruments in each case.

Several attempts have already been made in the direction required, but none appear to have met with sufficient success to have led to the adoption of a new class of instrument by the large telephone users in various countries. Many carbon microphones in multiple have been tried, as also the effect of placing the microphonic contacts in vacuo, which is said to do away with the sparking that otherwise sets in when a certain current has been attained. There appears room for experiment with other substances than carbon—say, for instance, granules of a non-arcing metal such as zinc. Some "loud-speaking" telephones are exhibited at the Paris Exhibition, which probably are based on the principle of using large currents; but these are disappointing, as the voice is undoubtedly distorted, and in all of them is frequently most indistinct. This may be due in a large measure to the megaphone employed for making the receivers speak out, but no provision was made at the exhibition for testing the instruments with shunted receivers, and we were unable to obtain any useful particulars of the construction of the microphones.

Of the proceedings at the Bradford meeeting, outside the purely electrical sections, we may note in particular the presidential address of Sir George S. Robertson to the Geographical Section. An abstract of this address appears on another page. Sir George took for his theme "The British Empire," and started by emphasising the necessity for patriotism before true cosmopolitanism can be attained by the geographer. To this teaching no exception can be taken, but when Sir George expanded his theory and applied it to submarine cable enterprise, he seems to have wandered wide of the mark. Referring to the immense importance of the great submarine lines of telegraphs in relation to the bringing together of the scattered portions of our empire, we are pleased to see that an ungrudging meed of praise was bestowed upon the great part played in the extension of submarine telegraphy by the late Sir John Pender, whose untiring and unselfish efforts to advance our imperial interests will, we predict, be more fully and generously recognised when the inside history of our national advance during the latter half of the nineteenth century comes to be written. We, however, take strong exception to the "lessons of the past" as depicted by Sir George Robertson. It is grossly untrue, and far from patriotic, to aver that "the power of the great telegraph corporations enables them to treat public opinion with indifference," or that "boldness and foresight in finance are naturally less prominent features in the management than contentment with a high rate of interest on invested capital." And what can be said for the statement: "If it were a question of the added security or the close coupling up of the empire on the one hand and a loss of profit (however splendid the dividends might still remain) on the other, we know what would be the result of the deliberations of the companies." Sir George wished his hearers to believe that the imperial would be sacrificed to the purely commercial aspect of such a question, but in doing so he cast an absolutely unwarranted insult upon the men who have engineered the great British submarine cable industry. We emphatically deny that these men, or the shareholders who have trusted them, have reaped such rewards of their boldness and farsightedness, and of their faith in the success of their enterprise, in spite of the great disappointments of the early days, as would justify such an expression of opinion as Sir George S. Robertson has chosen to publish.

If patriotism means, as is generally understood, the placing of the interests of your country before all things, the pioneers of the telegraph have done their country yeoman service. They have made the telegraph cable industry for half a century a purely British industry; have placed at the service of the State the most perfect system of intercommunication the world has ever known: have, in fact, provided the grand and glorious British Empire with a telegraph service which is the admiration of the whole world, whatever its self-constituted critics and those who have a particular axe to grind may say to the contrary. It is, in truth, the main complaint of foreigners that the service is too patriotic. It is surely not to the discredit of those who have accomplished this great work that such results have been secured without ruining those who have provided the financial support necessary for so vast an undertaking. It is quite untrue, as was shown in the statement presented to the shareholders of the Eastern Telegraph Company, in July last, by the Marquis of Tweeddale, to assert that an unusually high rate of interest is earned or paid on the capital of the Associated Companies, who are obviously the target for Sir George Robertson's remarks. We commend the speech of the Marquis of Tweeddale, here referred to, to the attention of Sir George Robertson and those who think with him, and especially so far as it deals with the Indian rates. It is, further, demonstrably untrue to say that increased profits have invariably followed reduction in cable rates. We have by no means exhausted the erroneous statements—to put it mildly—to which Sir George has given publicity, and it is time these haphazard and misleading statements were laid by the heels.

It is passing strange that it should be necessary, but so it seems to be when discussing the future of oversea telegraphs, to spread broadcast against the existing owners of these lines the most glaring untruths. We can only assume that the statements are made "for effect." But surely the question of the purchase of the telegraphs by the State, the price to be paid, and other matters connected with the future position of ocean telegraphs can be discussed without calling in question the patriotic *bona fides* of those who have for many years ably conducted a difficult enterprise, requiring skill and tact of a high order. We, therefore, much regret that a British Association meeting should also be made the occasion for a most unmerited attack upon many honoured names in science: for it must be remembered that not a few of those who have shared in the prosperity of these commercial undertakings are numbered among the best known members of the scientific professions. Sir George S. Robertson owes a public apology to the men who represent the most patriotic industry of this country.

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With a rapidity comforting indeed to advocates of electric traction the old order changeth and is giving place to the new as regards passenger traffic between the City and the western suburbs along the line of the "Tuppenny Tube." We daily note the enormous volume of traffic pouring into and out of the stations, and the ample accommodation left unused in the disconsolate-looking 'busses, and are convinced. But the figures published last Wednesday in the *Financial News* are not less convincing, for they indicate the falling off in omnibus receipts which has taken place. In the week ended August 16, for example, the decrease in receipts for the two principal omnibus companies, as compared with the corresponding week last year, amounted to over £4,600. We are sorry for the omnibus companies; but the march of civilisation is inevitable—and the London omnibus is *not* a civilised vehicle.

Erratum.—In the title of our reprint of Dr. Larmors' Presidental address last week, p. 732, for "A Section" read "Section A."

British Association Meeting for 1901.—Prof. A. W. Rücker, Secretary of the Royal Society, has been nominated President of the British Association for next year, when the meeting will be held at Glasgow.

Underground Railway for Buenos Ayres.—A New York contemporary states that a concession has been granted for an underground electric line in Buenos Ayres to Carlos Bright, an American engineer.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

The Society of Model Engineers.—A monthly meeting of the Liverpool branch of the Society of Model Engineers was held at the Balfour Institute on September 5th, when a collection of models and also a large number of detail drawings of model locomotives were on view. The next meeting of the Society will be held in the recreation room at the Balfour Institute, Smithdown-road, Liverpool, on Wednesday, October 3rd, at 7:45 p.m.

The Galveston Disaster.—A notice issued by the Berne Bureau intimates that, owing to the terrible hurricane which has visited Galveston (Texas) and district, messages over the Mexican Telegraph Co.'s lines are subject to delay, and the traffic to Mexico and beyond will go by the land lines of the Mexican Government. The cables of the Mexican Telegraph Co. are worked in conjunction with those of the Central and South American Telegraph Co.

Telephone Time Service.—A new arrangement has been inaugurated in connection with the Berlin telephone service, by means of which a subscriber can obtain a time signal every morning at nine o'clock. Subscribers wishing to receive the benefits of this system must pay an extra subscription of 10s. per annum, and must see that their telephone is not in use at about the time the signal is expected. The signal is given to all subscribers precisely at nine o'clock by their bells ringing, and continuing to do so for about one minute.

Proposed Tramway Subways at Chicago.—Plans have been drawn up for a system of tramway subways underneath some of the principal streets in Chicago. The cost of the construction is estimated at approximately £400,000 per mile. It is proposed that the subways should be built by the city, and that arrangements should be made for the tramway companies to run their cars through them rather than on the roadway overhead. Provision is to be made in the subways for water and gas pipes and all kinds of underground wires, conductors, &c. The arrangement of the subways is in the form of six loops, so constructed that passengers can easily transfer from one loop to another at definite points. The cars would circle continuously in these loops. The estimated depth of the subway, viz., from the road level to the drain pipe beneath the subway, is 32 ft., and electric pumping plant would be erected for draining the subways into the Chicago River.

Tramway Exhibition Humour.—The following story of an incident which took place at the recent International Tramways and Light Railways Exhibition, in London, is told by an American contemporary:—

Mr. Harold P. Brown, of New York, gave away as a souvenir a little leather purse, and enclosed therein was what looked like a $1,000 bank bond, but on examination turned out to be an advertisement for plastic bonds. The chairman of the —— City Council visited Mr. Brown's exhibit, and was much interested in the explanation of the bonding process. He had an armful of catalogues and pamphlets that he had previously collected, and Mr. Brown, noticing this, remarked that he would give him a little remembrance that he would be likely to retain when the mass of printed matter had been mislaid, and thereupon presented him with a purse, which was accepted with many thanks; but when it was opened and the folded bond inside came in view great was the chairman's indignation. "You have fallen very low in my estimation, sir," he exclaimed. "You cannot influence my vote by giving me a purse of money, sir; such proceedings may prevail in your land, sir, but not here, sir. I will have nothing more to do with you, sir." And with that he started away. Mr. Brown, however, after considerable talk, convinced him that the gift was not a bribe, and that the enclosed bond was not negotiable, and the chairman departed with the purse and his bond, with the laugh against him.

Electromotive Force of a Moving Charge.—In a note on M. Cremieu's experiment, read by Prof. G. F. FitzGerald, F.R.S., before Section A of the British Association at Bradford, it was stated that M. Cremieu has shown that, if his experimental methods can bear criticism as well as they seem to do, there is no induced electromotive force on a coil of wire surrounding a rotating disc when the strength of an electric charge on the disc is changing. He has deduced from this the conclusion that there is no magnetic induction through the disc due to the moving charge, such as Rowland's experiments showed. Prof. FitzGerald's note was intended to point out that too little is known of the theory of the ethereal effects of a charge of electricity force to move by mechanical actions for us to be quite sure that both M. Cremieu's and Rowland's observations may not be true, *i.e.*, that it is possible that a charge of electricity, while it is being accelerated by moving matter, may produce such an action on the surrounding ether as to neutralise the electric force that would otherwise be produced by the changing magnetic induction due to the moving charge.

University College, London.—In conjunction with the Technical Education Board of the London County Council, classes have been arranged by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., to be held during the ensuing winter in the Pender Electrical Laboratories, University College, Gower-street, W.C. These classes are intended for students practically engaged in the electrical trades or allied industries during the daytime, and not for the ordinary student who can attend day classes. (i.) A course of ten lectures, followed by laboratory practice in advanced electrical measurements, by Prof. J. A. Fleming. These lectures will comprise a theoretical and practical treatment of advanced methods in electrotechnical measurements, of the character required in electrical works and factories, in connection with electric lighting and electric power transmission. The treatment of the subject will be adapted for those who have already made some progress in practical electrical knowledge, but not for those who are entirely ignorant of electrical theory. The lectures will be given from 7:15 p.m. to 8:15 p.m. on Wednesdays from Oct. 17 to Dec. 19, 1900, inclusive. Each lecture will be followed by 1½ hours' practical work in the laboratory. (ii.) A course of lectures on the Electric Motor and its Application in Electric Traction, by Prof. C. A. Carus Wilson, M.A. This course will comprise ten lectures given on successive Wednesdays from Jan. 23 to March 20, 1901, inclusive. The lecture hour will be from 7:30 p.m. to 8:30 p.m. Each lecture will be followed by an experimental demonstration or by a class for the practical working of numerical examples in connection with the subject.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Lightning Photographs.—It is well known that when a flash of lightning is photographed by a camera kept in a constant state of motion the photograph usually shows the flash broadened out or made multiple. Three different explanations of this effect are conceivable. The motion of the camera, held in the hand or against the chest of the observer, may render the image of the flash diffuse owing to the discharge not being instantaneous. That is, however, not likely. A more probable explanation is that a large number of successive discharges take place along the same path, and this would in effect lengthen the time of the discharge. Lastly, we know from Toepler's researches on globe lightning that the conducting path created by a lightning flash may be carried forward and distorted by the wind. C. Forch has examined some photographs in the light of these various hypotheses. The photographs were taken at dusk, and show the outlines of houses as well as the flashes. One of the photographs show the path of the flash broadened, and the outlines of the buildings broadened in the same direction and to the same amount. This would testify to the permanence of the path, as well as the finite duration of the flash. The other photographs are not so conclusive. It appears certain, however, that distortion by wind plays no part in the phenomena.

[C. Forch, *Physikal. Zeitschrift*, Sept. 1, 1900.]

Non-Permanence of Weight.—The whole system of modern chemistry is based upon the axiom of the indestructibility of matter, and that indestructibility is proved by the permanence of the weight of a given substance through all the physical or chemical changes it is made to undergo. Any experiments, therefore, which shake our belief in that primary property of matter must have a far-reaching effect. Landolt's classical researches in 1893 (for which see the *Zeitschrift für Physikalische Chemie* of that year) embodied the first work done with all the modern instruments of precision. Certain minute changes of weight were then placed in evidence, and these have since been confirmed. A. Heydweiller has endeavoured to trace some connection between the change of weight and the changes in other physical properties, such as magnetic permeability, electrolytic dissociation, and material or optical density. He has failed to trace any such connection, though he has distinctly established a diminution of weight of about 1 part in 50 million in a number of reactions, such as the mixture of copper sulphate with water, where a loss of weight of 1 milligramme was observed. Researches such as these take place in the extreme borderland of science, but the logical outcome of the results would be nothing less than the destruction of matter.

[A. Heydweiller, *Physikal. Zeitschrift*, August 25, 1900.]

Hall Effect in Gases.—According to the modern ionic theory, the Hall effect may be calculated from the difference between the positive and negative ionic velocities, and such a calculation, carried out in the case of electrolytes, indicates that no appreciable effect can be expected in them. In gases the electromagnetic transverse and longitudinal effects are very appreciable, but no quantitative results can be as yet obtained owing to the many complications which arise. One case of gaseous conduction, that of flame gases, is, however, sufficiently simple and well known to yield results of theoretical importance. In flame gases the transport of electricity is carried out by electrolytically dissociated ions, whose velocity is about a million times greater than in electrolytes, and shows a considerable difference in the positive and negative ions. E. Marx has therefore studied this case experimentally and has succeeded in finding a Hall effect which is distinctly appreciable, though necessarily small. He used a flat Bunsen flame, into which a fine spray of the solution of some alkaline salt was blown. He found that as the atomic weight of the metallic base of the salt increased, so did the velocity of the ions, and the cæsium ions had therefore the greatest velocity. The Hall effect in electrolytes will probably remain too small for measurement.

[E. Marx, *Ann. der Physik*, No. 8, 1900.]

Production of Röntgen Rays.—When a spark-gap is introduced in a Röntgen-ray circuit, the maximum gaseous pressure at which X-rays can be produced is increased. According to A. Winkelmann, the maximum pressure attainable depends upon the length and position of the spark-gap, the nature of the gas, and the dimensions of the tube. At the highest pressures, Röntgen rays are only seen when the spark-gap lies between the cathode and the induction coil. As the pressure decreases, rays begin to appear also when the spark-gap is next the anode; but they are feebler than in the other arrangement. At low pressures the influence of the position of the spark-gap becomes less pronounced, and finally disappears. Hydrogen yields Röntgen rays at greater pressures than air or carbonic acid. The latter allows the least pressure, but its difference from air in this respect is not great. The admissible pressure may be considerably increased by making the tube narrow. Thus in a tube only 5mm. in diameter it was found possible to increase the pressure of the air contained in it to 10mm. of mercury, and yet obtain effective X-rays. But a further narrowing has the contrary effect, and in hydrogen the maximum pressure of 30mm. is already reached in a tube 1cm. in diameter.

[A. Winkelmann, *Ann. der Physik*, No. 8, 1900.]

Magnetic Behaviour of Liquid Crystals.—When O. Lehmann announced his discovery of liquid crystals, 10 years ago, he was greeted with a chorus of doubt and disapproval, but he has since succeeded in proving that all the characteristics of crystallisation which his liquid crystals do not possess cannot logically be made part of the definition of a crystal. The only general characteristics of crystals are that they are not isotropic, and that they possess a molecular directive force which governs their shape and the distribution of accretions. The directive force is preserved by means of the surface tension, and crystals may therefore be liquid or solid, but they cannot be gaseous. Liquid crystals may be produced by depositing solid crystals from a mother liquor on the cover glass of a microscope and gently heating the latter until the fusing point is exceeded. Their optical properties can then be conveniently studied. Their double refraction and dichroism indicate a difference in the dielectric constant and the electric conductivity respectively in different directions, but these differences cannot be placed in evidence owing to the electrostatic rotations which free crystals immersed in a liquid undergo in an electrostatic field. In a magnetic field, however, the crystals show a distinct tendency to place their axes of symmetry normal to the lines of force. The author expects to obtain valuable results by applying this discovery to living cells.

[O. Lehmann, *Ann. der Physik*, No. 8, 1900.]

Cold Light.—The most economical light is that whose spectrum is confined to the visible rays, and which does not involve the simultaneous emission of either infra-red or ultra-violet rays. Electric light marks in this respect a distinct advance on the older methods of lighting, and electric luminescence decidedly so. But no form of light hitherto produced equals that of the glow-worm in efficiency. The light of luminous organisms only contains an infinitesimal amount of heat. R. Dubois has been exhibiting some "photo-bacterial" products at the Paris Exhibition, and he now gives some particulars of the liquid medium which best suits their development. The liquid exhibited at the Palais de l'Optique consists of water containing sea salt, glycerine or mannite, and either peptone or asparagine, with an addition of some phosphorated compound like nucleine, phosphorated lecythine, or potassium phosphate. The author gives no information concerning the species of bacteria used. He says that the permanence of the light varies with the purity of the ingredients and the ventilation and agitation of the liquid. It may last six months. A room may be lighted up with a luminosity like that of the full moon. It may be that these photo-bacteria will acquire the industrial importance of the yeast fungus, but that will probably be eclipsed by some purely physical method of generating cold light.

[R. Dubois, *Comptes Rendus*, August 27, 1900.]

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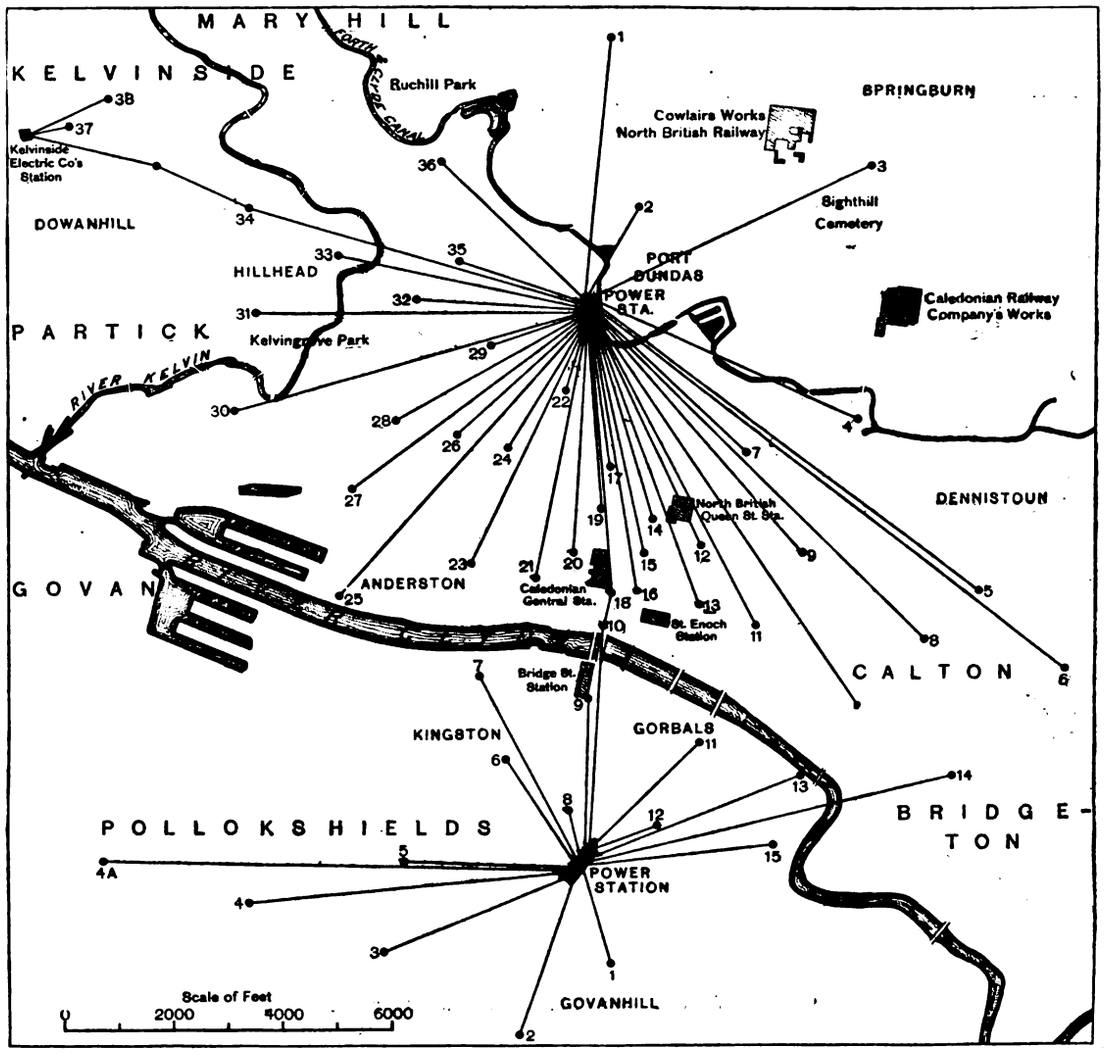
THE NEW ELECTRICITY WORKS OF THE GLASGOW CORPORATION.

Yesterday the two new electricity works of the Glasgow Corporation were opened with all the pomp and ceremony of a civic function. A large company assembled at the municipal buildings at 11 o'clock and then drove to the Port Dundas station, which was declared open by the Lord Provost (Mr. Samuel Chisholm), a gold key being presented him by the contractors. After an inspection of these works a similar ceremony took place at the South Side works, Bailie McLay being this time the wielder of the golden key. The programme also included a luncheon in the banqueting hall of the municipal building, a number of congratulatory speeches, and a presentation made to Bailie Willcox, Convener of the Works committee, by the cable contractors, the British Insulated Wire Co. and the Callender Co.



MAP OF GLASGOW, SHOWING POSITION OF SUPPLY STATIONS AND FEEDERS.

The Corporation had prepared a brochure for the occasion, describing the undertaking from its earliest days. As far back as 1882, in a Corporation gas bill, it was proposed to take statutory powers to supply electricity; but the clauses were struck out before the bill came before any of the Parliamentary committees for consideration. Three years or so before this, however, the first practical attempts towards a public supply were made almost simultaneously by the British Electric Co., at the St. Enoch's Station of the Glasgow and South Western Railway, where they laid down Gramme dynamos to light the station, and by Messrs. Crompton & Co., at the Queen-street station of the North British Railway, for a similar purpose. The stations were lighted at a fixed rate, but the expectation that a general supply business would grow up was not fulfilled, and the respective railway companies finally took over the plant for their own use entirely. In connection with St. Enoch's Station, it is an interesting fact that after various lots of new plant and different arrangements, the directors of the company have just entered into an arrangement with the Corporation whereby they take the whole of their electrical energy from the Corporation mains.

The next attempt at a public supply was made by Messrs. Muir and Mavor (the pioneers of the firm which is now known as Mavor and Coulson), who laid down a plant to supply the General Post Office in George-square. The plant was first put down on the site where the municipal buildings now stand, was then removed to the basement of the post office, and later, in 1884, permanent plant was put down in Miller-street, and the current was carried by overhead cables across the intervening buildings. This was the first post office in the United Kingdom to be lighted by electricty.

The supply from the Miller-street station was on the low-tension continuous-current at 100-volts, but at John-street, for public supply purposes, it was decided to lay down high-tension plant, so a Ferranti alternating-current plant was erected, generating and distributing at 2,400 volts, and transforming down to 100 volts on the consumer's own premises, the supply being conveyed by overhead wires. The company in 1890 applied for a provisional order to supply Glasgow generally, but the Corporation having awakened to the fact that electricity promised to be a rival to their gas supply, also applied for a provisional order, and in view of this the company withdrew their application in favour of the Corporation. The Corporation's order was granted, and subsequently the Corporation agreed to purchase the company's undertaking for £15,000.

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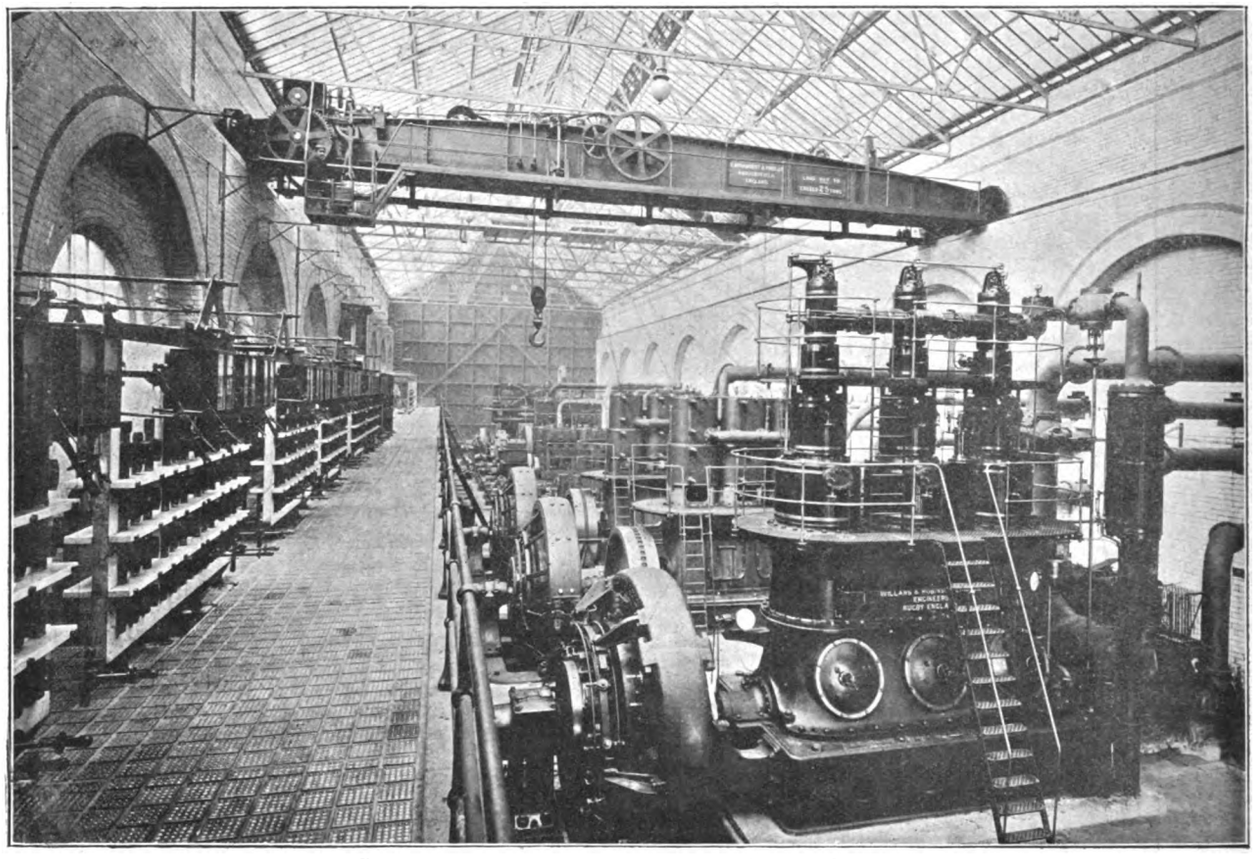
The capacity of the plant at the time was 297kw., and the number of consumers 87. A very interesting feature of this early installation is the fact that it was the first time that energy was charged on the maximum demand system. The system as used by Messrs. Muir, Mavor and Coulson differed from the Wright system, there being a fixed charge for the current with a scale of discounts increasing according as the consumption was equivalent to 301, 501, 1,001, or 1,501 hours per annum of the calculated maximum demand.

It was on March 1, 1892, that the Corporation took over the company's business. As the Board of Trade had only sanctioned the overhead system of high-tension supply until August, 1893, it was necessary to push on with the re-modelling of the system as quickly as possible. On the advice of Lord Kelvin, Prof. A. B. W. Kennedy was appointed consulting engineer to prepare the scheme for the general supply. The Corporation purchased ground at 75, Waterloo-street for the sum of £8,000, and the erection of the present Waterloo-street electricity station was commenced in the spring of 1892. The low-tension three-wire continuous-current system was adopted at the then Board of Trade limit of 200volts. Already, on Feb. 25, 1893, Lord Provost Bell was able to inaugurate the street lighting, and the supply was switched on to the consumers' mains on April 22 following. At this time the plant for the low-tension supply consisted of seven Willans units of a gross total of 1,400 H.P. to 1,500 H.P., with two Brush arc lighters, driven by two Easton, Anderson, and Goolden engines for the street lamps. The latter at first consisted of 77 Brush arc lamps, being afterwards increased to 112. The mains laid down at first were entirely on the Kennedy bare copper system. So great was the demand for current that extensions were required the following year, and two 225kw. Willans-Siemens sets were laid down. In order to make room for these plants the arc lighters were removed to the then disused John-street station, which station we may here note was, after various changes, finally closed some two or three years ago, and is now used as a store and workshop. In 1895, and again in 1896, it was found necessary to increase the capacity of the station, and in each of these years two 225kw. plants were added, after which there was no room for more. The increase of the boiler plant followed on the same lines as the engines, the original plant consisting of five marine type boilers of 300 H.P. each, another similar one being added in 1894, two 700 H.P. Babcock and Wilcox in 1895, and another of the same size in 1896.

Table showing Development of Electrical Supply in Glasgow.

Year ending May 31.	Total max. supply dem'd.	Total capacity of plant.	Maximum load.	Quantity sold.	Quantity generated.	Number of consum'rs	Revenue.			No. of public lamps.
	kw.	kw.	kw.	B.T. units.	B.T. units.		£	s.	d.	
1893	790	800	570	287,712	408,529	108	7,784	5	4	71
1894	1,684	1,250	894	702,248	854,766	378	18,015	19	2	102
1895	2,090	1,700	1,140	901,287	1,022,730	586	21,196	11	4	103
1896	2,638	1,700	1,440	1,090,959	1,279,687	855	25,862	8	6	112
1897	3,366	2,150	1,776	1,497,842	1,729,483	1,090	30,474	16	1	112
1898	4,800	2,150	2,232	2,114,036	2,619,019	1,437	36,360	14	10	119
1899	6,114	2,600	3,096	2,824,350	3,401,731	1,858	44,141	4	7	227
1900	7,732	6,402	4,258	4,250,669	5,226,818	2,852	59,762	2	0	265

A glance at the table reproduced above, from the brochure mentioned, will show at once the very rapid growth of the undertaking, and it will be noticed that with the exception of the first year not only was the maximum demand well in excess of the capacity of the plant, but the actual maximum load had in 1896 approached very closely the total capacity of the plant. To meet, therefore, the increased demand for the following year, and to cope with the peak, two large Tudor batteries were put down, each of 2,000 ampere-hours capacity and capable of being discharged in an hour if necessary, one being placed about a mile to the east of the central station, and the other about a mile to the west.



General View of Engine Room in Port Dundas Station.

When, in 1896, the electricity department was removed from the control of the Gas committee and placed under the care of a separate committee, the total inadequacy of the existing station to supply the needs of a city like Glasgow was realised. In 1896 therefore, the Corporation purchased ground at Port Dundas, an area containing 21,026 sq. yds., and bounded on the north by the Forth and Clyde Canal. At the same time ground with an area of 8,926 sq. yd. was purchased in Pollokshaws-road, and bounded at the rear by the Glasgow, Barrhead and Kilmarnock joint railway.

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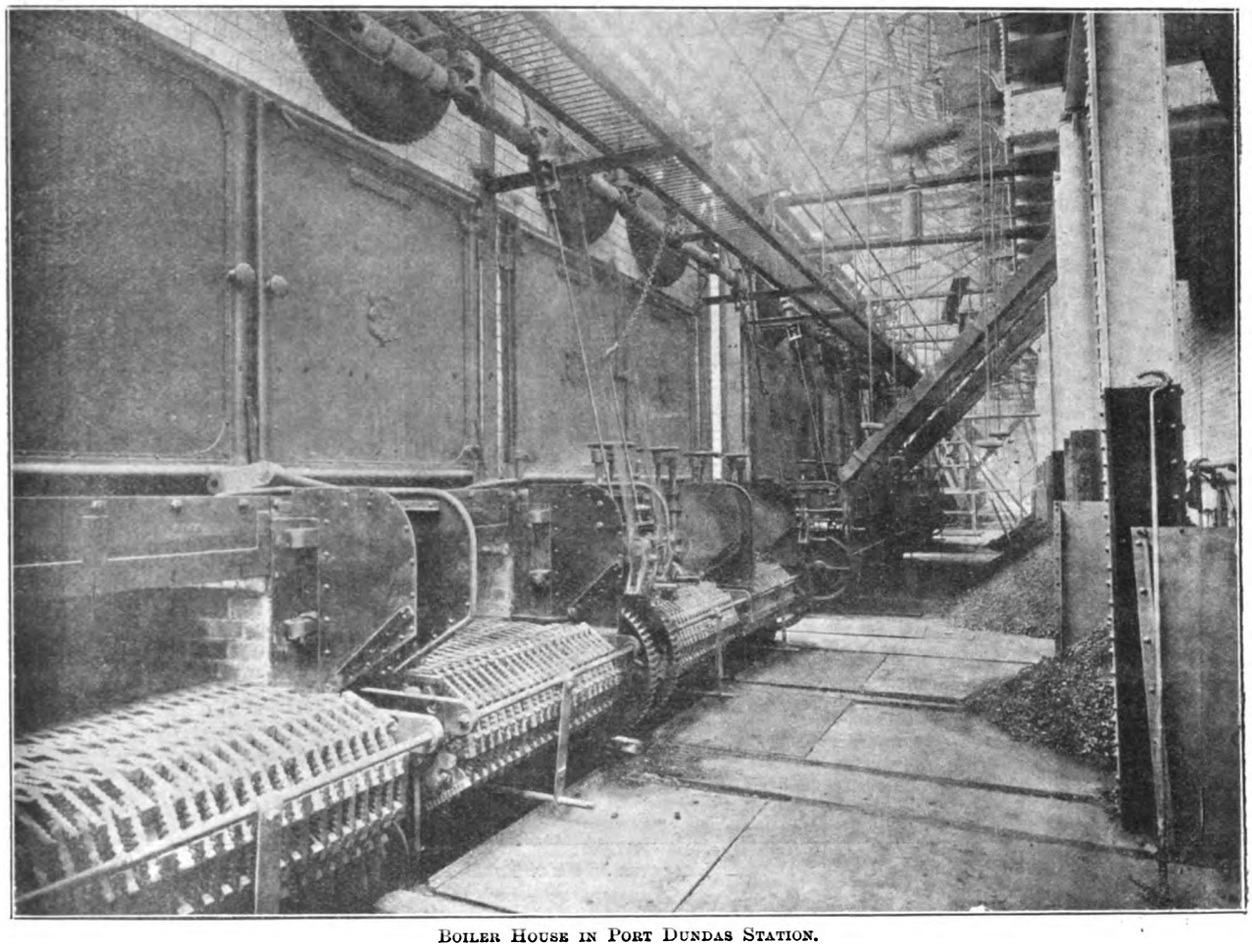
A trouble arose about this time with regard to the supply of power to the tramway department for running their cars. One cause of the friction was doubtless due to the electricity department itself, as a very animated internal discussion arose with regard to the system to be adopted in the new stations, a strong party advocating a high-tension alternating system. Had such a system been adopted it would, of course, not have been suitable for tramway purposes, and the Tramway committee contended that if the Electricity committee would have to put down special plant for tramway purposes, the Tramway committee could do it themselves equally well. However, the matter was compromised by an arrangement that for the experimental line the tramway department should lay down its own power plant; and so was inserted the thin end of the wedge which ultimately resulted in two distinct electricity departments being worked under the same Corporation. Just at this time, also, Mr. William Arnot, who had been resident engineer since the opening of the Waterloo-street works, resigned to take up a consulting practice, and the committee appointed a successor to him in the person of Mr. W. A. Chamen, who was engaged to act both as consulting and resident engineer. Mr. Chamen entered upon his duties on January 28, 1898, and immediately set about formulating his scheme for the new works, which were to embrace the whole of the city, and under his direction the Port Dundas station was planned and the erection was immediately pushed forward.

As will be noticed from the table already referred to, the winter of 1897–98 was a very serious time, principally owing to an extended period of fog which occurred in December and caused a demand beyond the capacity of the whole of the plant, including the accumulator sub-stations. It was obvious to the engineer, as the demand continued to increase by leaps and bounds, that it would be impossible to wait for the delivery of plant and the completion of the station in the ordinary course, and that therefore something had to be done to meet the load of the winter 1898–99. Advertisements were therefore issued for such plant as manufacturers might be able to deliver quickly, and as a result the first instalment of plant described further on in this article was purchased for immediate delivery. Owing to disputes in the building trade and other causes, it was quite impossible to get the permanent building completed in time, so it was decided to put down the plant on permanent foundations and erect a temporary wooden shed over it, an part of this plant was put into use in December, 1898.

While the station was being proceeded with, sight was not lost of the state of the distributing system. At the time Mr. Arnot resigned, the system was half the original three-wire system with 100 volts on either side of the middle, and half a two-wire system using the outer to supply lamps at 200 volts; this, of course, being done with the idea of introducing a three-wire 400-volt system. However, Mr. Chamen advised his committee to increase the pressure across the outer of the three-wire network to 500 volts instead of 400 volts. The difficulties in making this change from 100 volts and 200 volts consumers' pressure to 250 volts were not slight.

In August, 1899, the undertaking of the Kelvinside Electricity Co., which had previously been running with only moderate success, was purchased by the Corporation. Although this company's mains were laid for a three-wire system, the supply was only on a two-wire 100-volt system.



Boiler House in Port Dundas Station.

During the past spring and summer it has been gradually changed over to the 250-volt supply, and at the present time it is entirely supplied from Port Dundas, the Kelvinside works having been shut down to facilitate putting down new plant for the coming winter.

At present the Port Dundas works are supplying current from Bridgeton Cross on the east to Whittinghame Drux, Kelvinside, on the west; and from Springburn Park on the north to Eglinton Toll on the south. The supply at Eglinton Toll, however, is only of a temporary nature, it being used to furnish power to the overhead electric crane now in use for erecting plant at the Pollokshaws electric station. These latter works when completed, probably during the coming month, will meet all requirements on the south side of the river, and will also help to supply certain streets on the north side by feeders laid across Glasgow bridge, and also Bridgeton through a feeder laid across the new bridge. We will next proceed to descriptions of the new stations in greater detail.

(To be continued.)

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THE PARIS EXHIBITION.—VI.*

(BY OUR SPECIAL CORRESPONDENT.)

Another combined continuous-current and three-phase set for the light and power supply within the exhibition is the one exhibited by the Lahmeyer Company in conjunction with the Augsburg-Nuremberg Company, and shown in Fig. 30. The two dynamos are placed on either side of the engine, which is compound, with 865mm. and 1,350mm. cylinders and 1,100mm. stroke, and runs at 94 revs. per min. The three-phase machine is of the flywheel type, the magnet wheel having a diameter of 5,800mm., and weighing about 54 tons. Figs. 30 and 31 show the general design of the machine. It is seen that the armature, which is stationary, is held in a well-designed casting, supported by cast-iron arms. The outside diameter of the armature casting is 6,920mm. (22ft. 8in.), and the whole machine weighs 115 tons. The frequency being 50 ∼ per sec., there are 64 poles bolted on to the fly wheel. These are wound with flat copper strip, placed on edge, and insulated with "presspahn." Exciting current is furnished by a small continuous-current machine carried on a bracket fixed to the outside bearing of the alternator, its armature being overhung. In order to be suitable for 500 volts pressure, the armature windings of the three-phase machine are insulated with great care, being laid in closed micanite tubes.

A peculiar method of connection is employed for the measuring instruments. Part of the winding of each phase of the alternator armature is not connected up to the remainder, but is connected instead to the primary of a transformer, whose secondary is in series with the main part of the armature winding, and thus takes the place of the disconnected coils. The voltmeter, however, is connected between the terminals of this smaller section of the winding, and the ammeter is in series with these coils in the primary circuit of the transformer. No high pressure fuses or cut-outs are employed on this switchboard, the makers trusting to the self-induction of the dynamo and the cut-outs on the exhibition distributing switchboard to prevent damage by short-circuit.

The continuous-current machine has a capacity of 350kw. (400 on overload) at 550 volts. As will be seen in Fig. 32, its most noticeable feature is the width of the armature compared with that of the pole-pieces. The armature is drum-wound with rectangular copper bars, and its diameter is 2,400mm. Each winding is bent from a single bar, so as to have as few joints as possible. The armature core is slotted to receive the windings, and lined with mica and "presspahn," and brass segments (which are screwed on and are easily removable) hold the bars in place against the action of centrifugal force. As seen in Fig. 32, there are 12 pole-pieces radiating inwards from the main casting. These poles are of steel. The armature weighs 12 tons, and the whole dynamo 25 tons.

The fourth generating unit for the exhibition supply is the Borsig—Siemens & Halske set shown in Figs. 33 and 34. The triple-expansion engine is a vertical two-crank one, with two low-pressure cylinders, the cranks being set at 180deg. Its main dimensions are: H.P. cylinder 760mm., intermediate cylinder 1,180mm., L.P. cylinders both 1,340mm., stroke 1,200mm., speed 90 revs. per min., and output about 2,500 H.P. when running condensing and with steam at 14 atmospheres pressure. The crank-shaft is in two parts, and at one end of it is a crank disc driving two coupled single-acting air pumps under the floor, for the jet condenser. At the other end of the crank-shaft is the dynamo, whose armature is supported by two large bearings (with ring lubrication), which can be moved along their bed-plates. The exciter is also coupled to the crank-shaft, and is placed beyond the outside bearing of the alternator.

The bedplate of the engine is in two parts, joined together by flanges and bolts; and, between the two main bearings on each portion, the casting is made slightly concave to catch waste oil. Two small rotary pumps, driven through spiral springs of steel wire from the crank shaft, convey the oil to a filter, whence it is again distributed. Between the bedplate and the larger dynamo bearing, a 41-ton flywheel is hung on the crank-shaft, and its rim is toothed for barring, which is

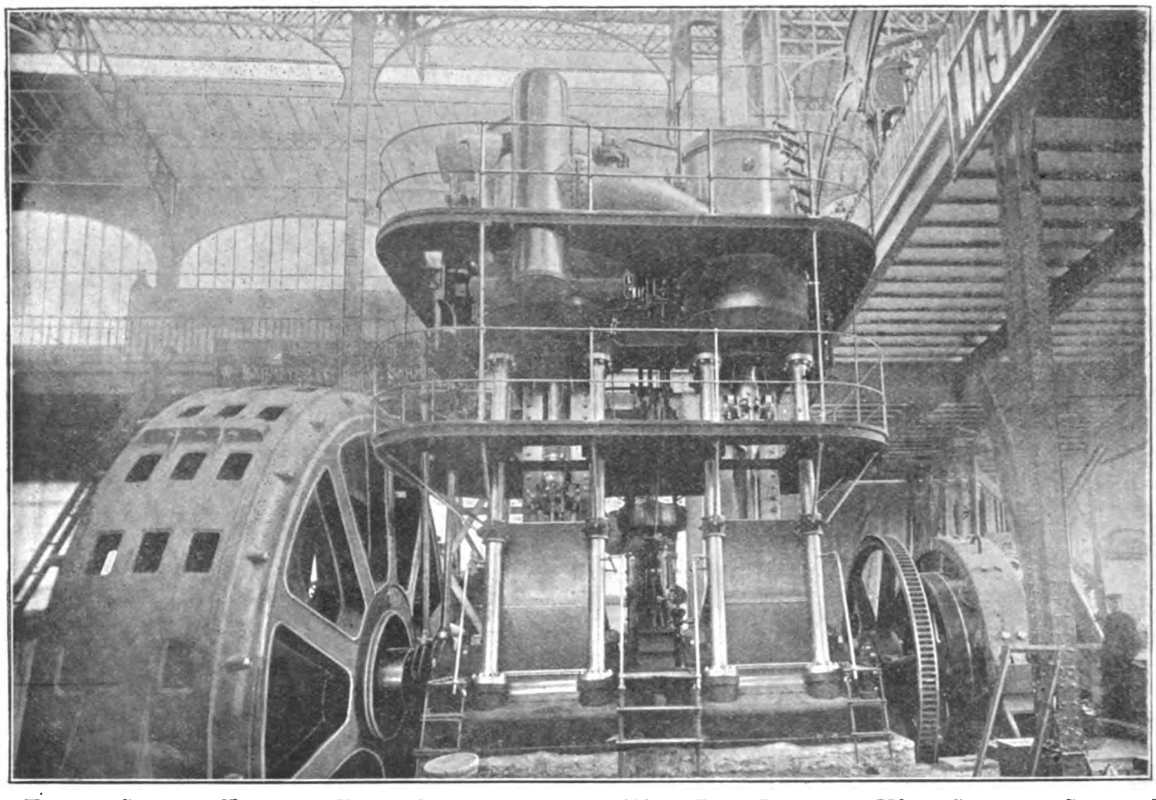

FIG. 30.—VERTICAL COMPOUND NUREMBERG ENGINE, DRIVING LAHMEYER 1,000KW. THREE-PHASE, AND 350KW. CONTINUOUS-CURRENT DYNAMOS.

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31.

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done by a motor. The two massive standards holding the slide bars are bolted to the bedplate both internally and externally, and are stiffened by the two forged steel pillars seen in front in Fig. 33. On these standards are placed the two low-

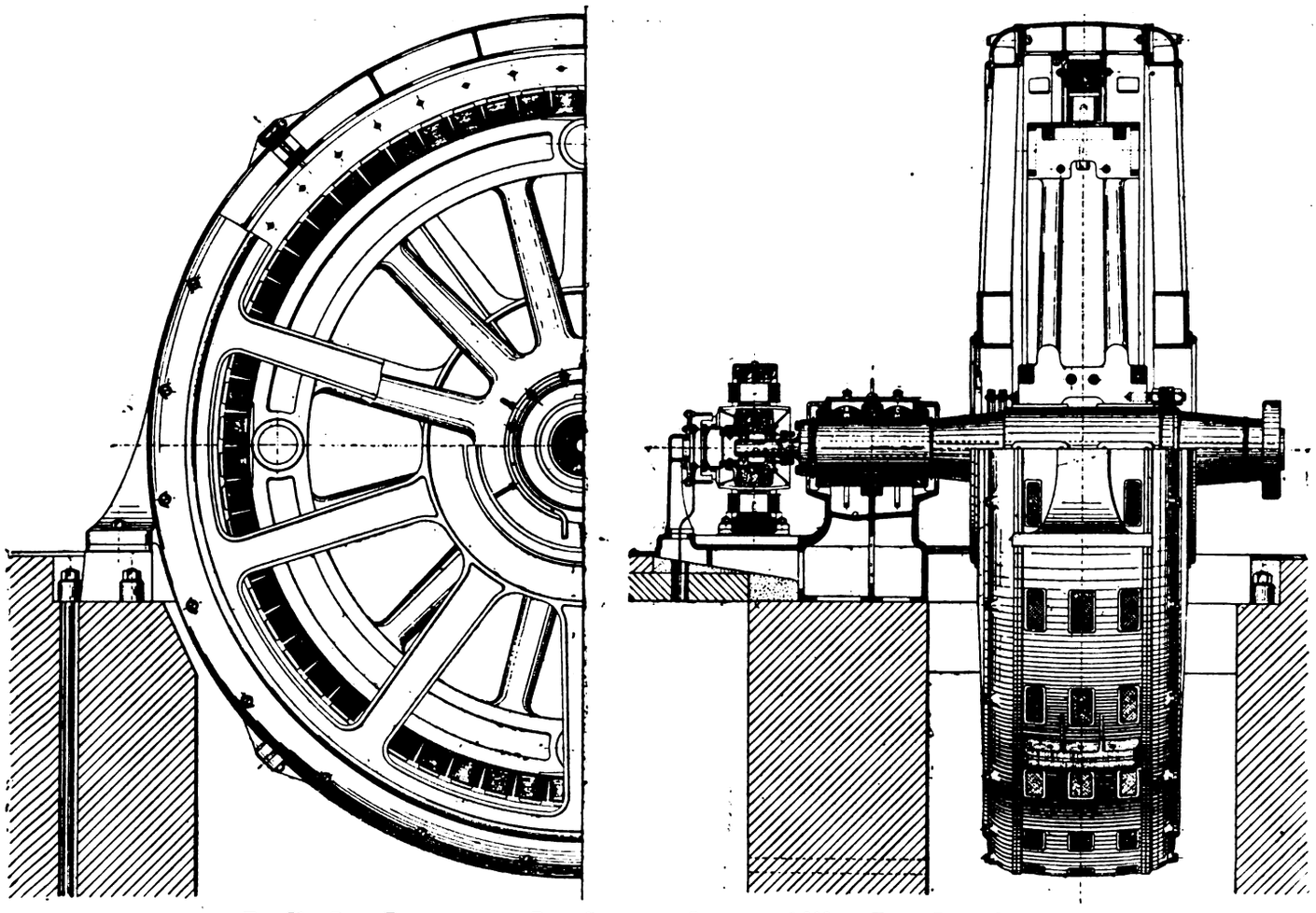

FIG. 31.—PART ELEVATIONS AND PART SECTION OF LAHMEYER 1,000KW. THREE-PHASE DYNAMO.

pressure cylinders, which are securely bolted together. Each of these cylinders is jacketed with low-pressure steam, and the

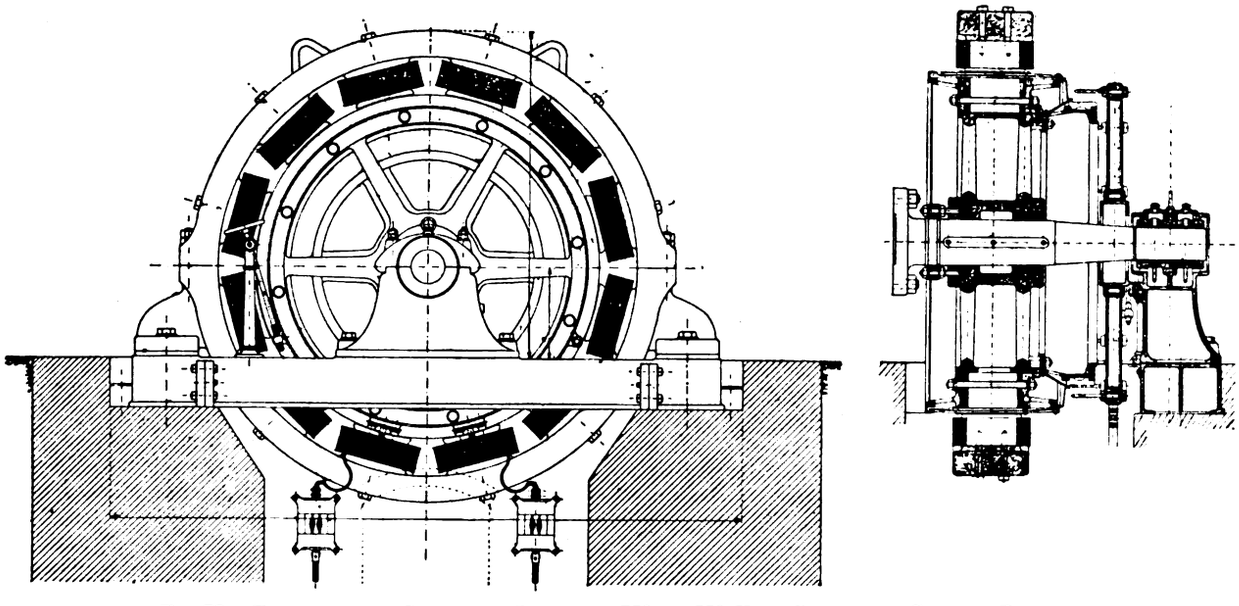

FIG. 32.—ELEVATION AND SECTION OF LAHMEYER 350KW. 550 VOLT CONTINUOUS CURRENT DYNAMO.

intermediate and high-pressure cylinders with steam at the intermediate and high pressures respectively. The high-pressure piston has Ramsbottom cast-iron rings, and the pistons of the other cylinders Buckley rings of the newest design. The pistons themselves are of steel.

Double-seated valves, constructed according to a recent patent of Collmann's, Fig. 35, are employed for all the cylinders. They are fitted on extensions of the cylinder castings at the side of the L.P. cylinders and on the hinder side of the other cylinders. To actuate the valves a horizontal shaft, supported in six bracket bearings behind the L.P. cylinders, is driven by bevel gearing from the crank shaft

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through the intermediary of an inclined spindle on which also the governor is fixed. The admission and exhaust valves of all four cylinders are moved by trip gear driven by eccentrics on the above-mentioned horizontal shaft. The governor acts on the trip gear of the admission valve of the H.P. cylinder in more or less the usual manner, and the other valves can be adjusted by hand. One eccentric suffices for each admission valve and the corresponding exhaust valve, on the H.P. and intermediate cylinders; while each of the valves of the L.P. cylinder is driven by its own eccentric. The speed of the engine can be adjusted while the engine is running by means of a supplementary spring in the governor, controlled by a hand-wheel.

The rotating masses of the connecting rods, &c., are balanced by counterweights bolted on to the crank shaft. Marine types of connecting rods and crossheads are employed, and the piston rods for the pair of cylinders on each side of the machine are in one piece. Oil is led under pressure to all the stuffing boxes, and for the remaining parts of the engine, oil is pumped up from below to a reservoir on the

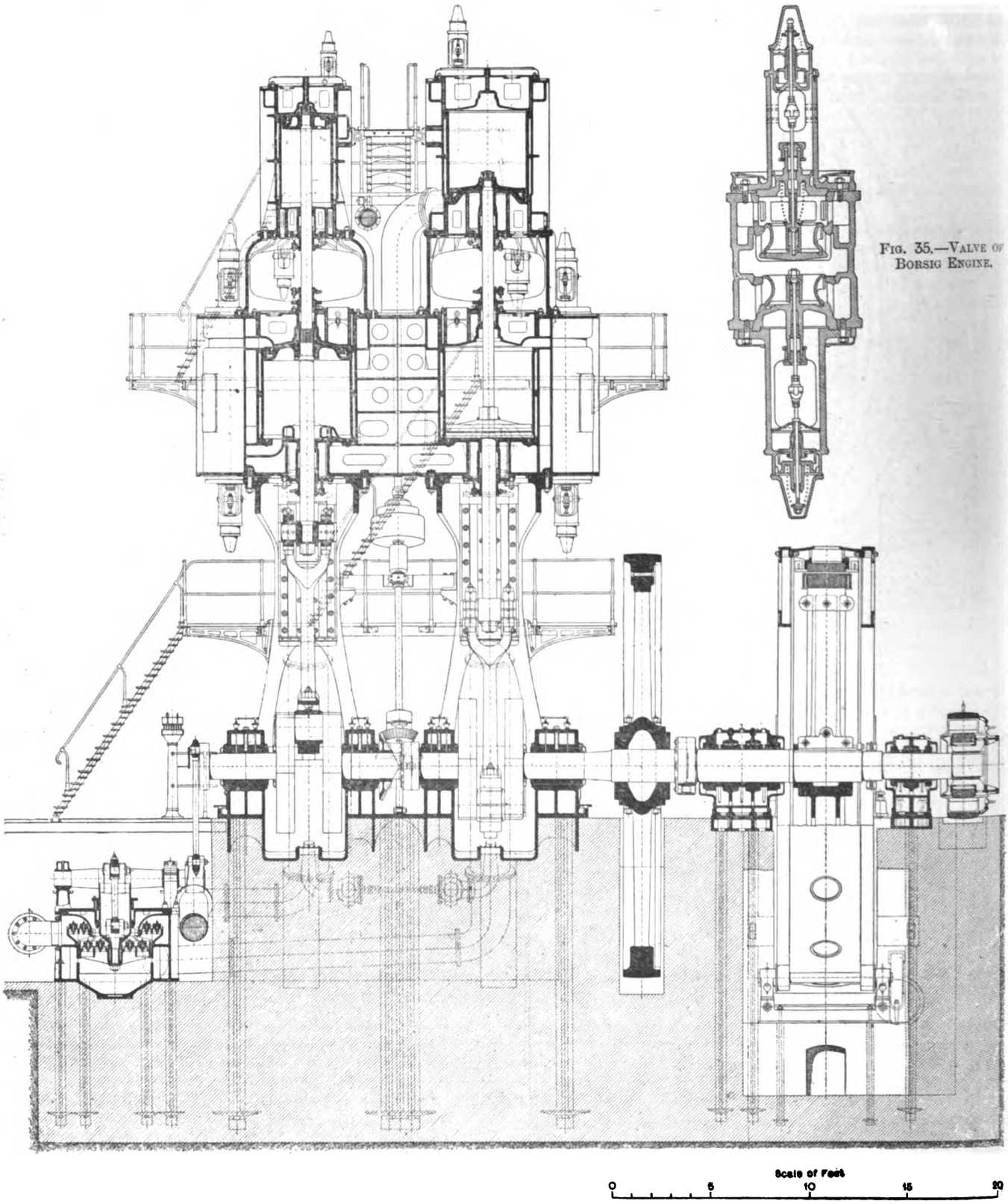

FIG. 34.—SECTIONAL ELEVATION OF BORSIG-SIEMENS 2,000KW. SET.

FIG. 35.—VALVE OF BORSIG ENGINE.

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top of the engine, from which it flows down by gravity through a complete system of pipes controlled by cocks at the upper platform. At the exhibition, the engine is supplied with steam at 9·5 atmospheres pressure instead of 14, and runs at a speed of 83½ revs. instead of 90 revs. per min.

The Siemens and Halske three-phase machine is designed to generate 2,000kw. on a non-inductive load at 2,000 volts to 2,200 volts and 50 ∿ per sec. As the engine only develops 2,000 H.P. instead of 2,500 H.P. when running under

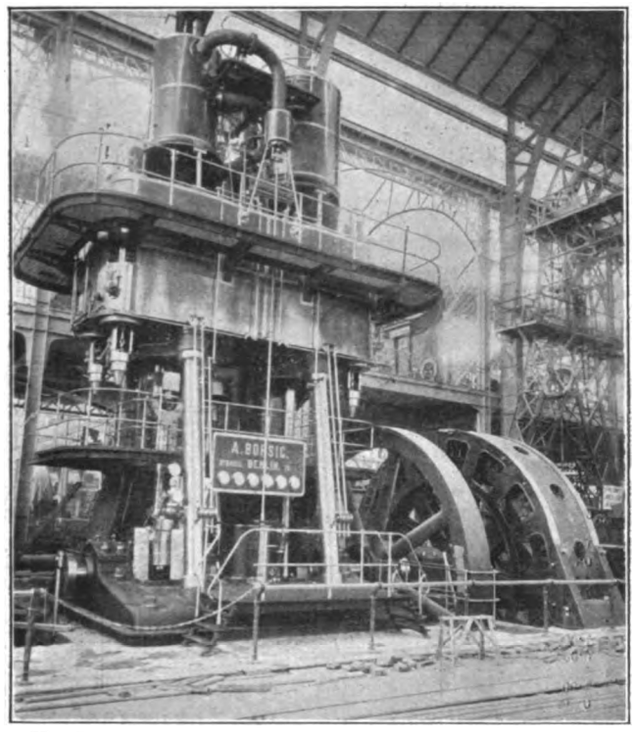

FIG. 33.—BORSIG 2,500 H.P. TRIPLE EXPANSION ENGINE, DRIVING SIEMENS AND HALSKE 2,000KW. THREE-PHASE DYNAMO.

the above conditions, the dynamo is able to supply 2,000 kilo-volt-amperes at a power factor of 0·7. The revolving field-magnet consists of a two-part cast-iron wheel, on which are 72 poles of elliptical section. The latter are laminated, the discs being held by a steel prism of square section and three bolts. The prism is threaded to take the bolts which hold the poles to the rim of the wheel. To take up the tangential stresses there is a rectangular projection from the botttom of

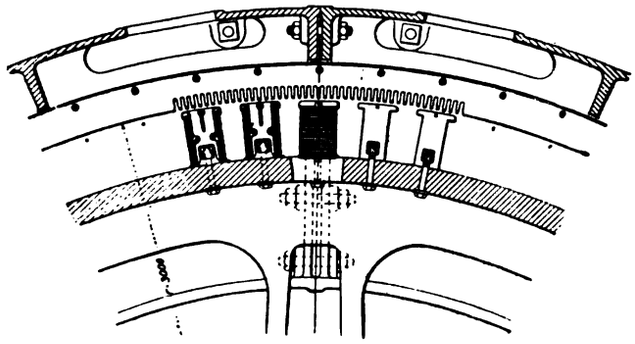

FIG. 36.—DETAILS OF MAGNETS AND ARMATURE OF SIEMENS THREE-PHASE DYNAMO.

the pole which fits into a groove in the rim of the wheel. Each pole has 40 turns of copper strip, 4mm. × 28mm. cross-section, wound on edge. At the two ends, this strip is wound on hollow bronze castings, which allow the air to pass through in a radial direction when the magnet is revolving. To assist ventilation still further a slot is cut in the middle of the pole itself. These details are seen in Fig. 36. The winding alone weighs 5 tons, and its resistance hot is about 1 ohm. A pressure of 210 volts is employed for the excitation, the mean energy required being 28kw., and the maximum 42·5kw. The exciter is a series machine generating 45kw. at 210 volts when running at the speed of the engine.

The armature of the alternator is supported between two annular castings, which are perfectly symmetrical to allow of the armature being turned for repairs. These castings are lightened by 16 holes, or each may be considered as two rings held togeher by 16 radial arms. Each is in four parts, bolted together. The armature core is made up of sheets 0·5mm. thick. The whole armature frame rests on two pairs of rollers beneath the floor, the height of each of which can be adjusted. Thus the whole frame can be lifted by raising both pairs of rollers, or by raising one and lowering the other it can be shifted sideways. Moreover, the armature can be revolved by turning the rollers. The armature casting is further secured by two floor-plates, which must, of course, be removed to turn the armature. There are 648 slots in the armature core, 13mm. wide and 55mm. deep, and the copper bar

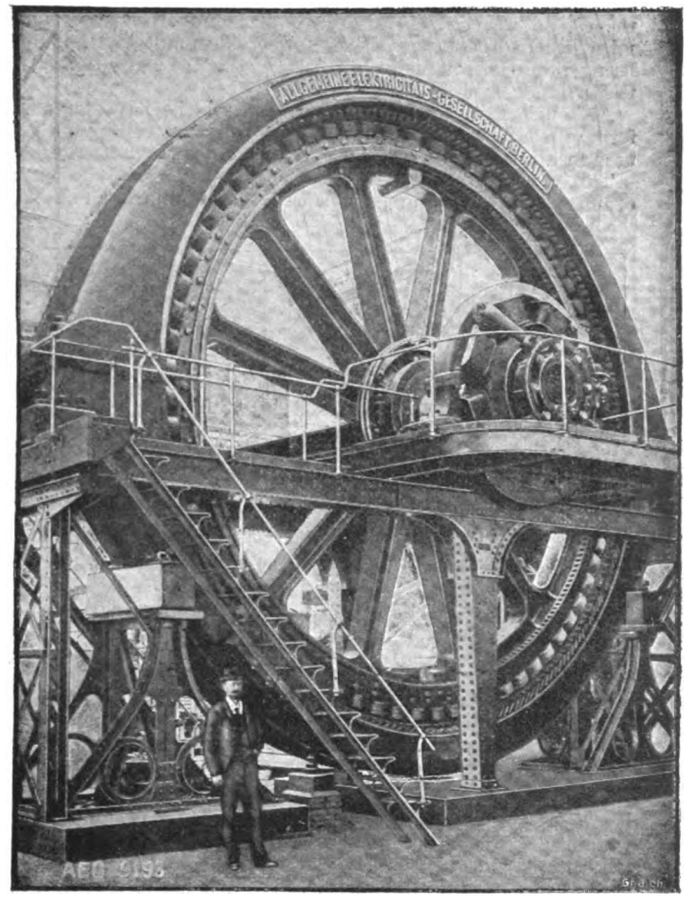

FIG. 37.—3,000KW. 3-PHASE DYNAMO EXHIBITED BY THE ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT.

windings have a section of 7mm. × 44mm. The bars are insulated with mica, which is pressed around them, and when the bar is in position the slot is closed by an insulating piece. The 216 bars joining the winding of each phase are in series, and the windings are star-connected. The weight of copper on the armature is about 2·4 tons, and its C^2R loss is about 15kw.

The enormous dynamo exhibited by the Allgemeine Electricitäts Gesellschaft in the German "annexe" (a building by itself at the Avenue de Suffren end of the electricity palace) may be mentioned here, although the machine is an exhibit pure and simple and does not generate current at the exhibition. This machine is illustrated in Fig. 37. It is designed to furnish 8,000kw. three-phase at 50 ∿ per sec. when running at 83 revs. per min., and is one of eight similar machines that are being erected in the Berlin electricity supply works. Ten others are proposed for projected extensions. Three-phase current will be distributed in some of the

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suburbs, but in Berlin itself it will be converted into continuous current for the existing network. In order to show the machine in rotation at the exhibition, a small continuous current motor is coupled to it. The 72-pole flywheel field-magnet has a diameter of 7·4 metres (24ft. 3in.), and the armature frame a diameter of 8·6 metres (28ft. 9in.). It is interesting to note that the whole machine weighs 160 tons, made up as follows: Armature frame 80 tons, field-magnet 70 tons, bedplates 10 tons; and yet the whole was successfully erected without the assistance of a crane.

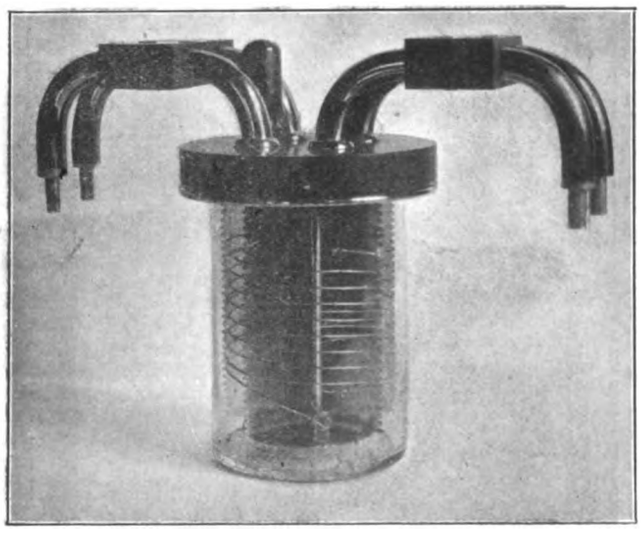
NOTE ON AN IMPROVED STANDARD RESISTANCE COIL.*

BY ROBERT S. WHIPPLE.

In June, 1896, Prof. Burstall read a Paper before the Physical Society "On the Use of Bare Wire for Resistance Coils."—*Phil. Mag.*, September, 1896 pp. 209–224—in which he described a resistance box, the coils of which consisted of bare platinum-silver wire, wound on mica frames, the frames being immersed in an oil with high insulating properties, a method of constructing the coils originally due to Mr. E. H. Griffiths, F.R.S.

Although Prof. Burstall's Paper showed the advantages of this form of resistance coil, it has not, until comparatively recently, been used for standard coils, and only in a few cases for resistance boxes.

This form of coil possesses the following advantage over the ordinary resistance coil: (1) The coils can be annealed to a dull red

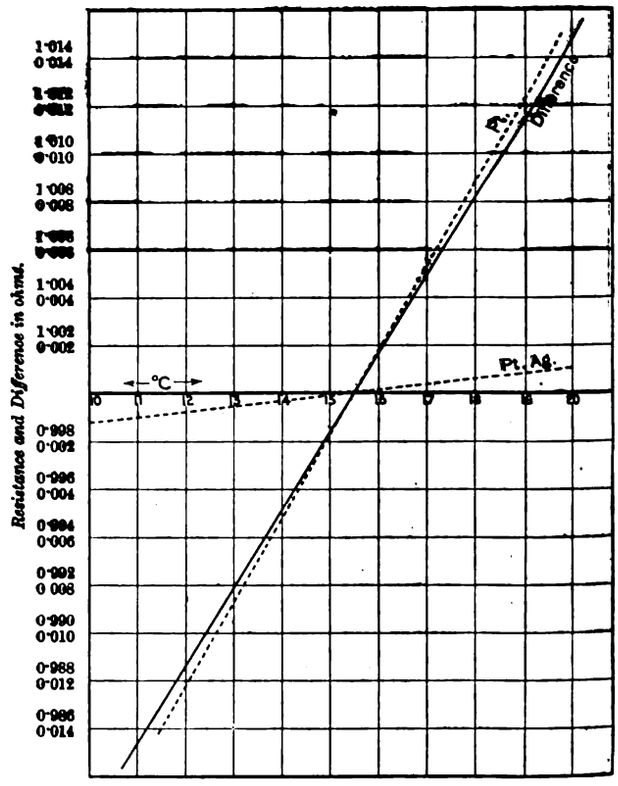


heat *in situ*, thus relieving the wire of any strain caused by the winding. (2) The heating of a wire immersed in oil is less than one silk-covered and varnished. (3) The temperature of the wire can be accurately determined by means of a thermometer placed in the oil surrounding the wire. German physicists have adopted a form of coil in which the wire is silk-covered and varnished and then placed in a metal case perforated with holes. The whole coil is placed in an oil bath when in use. This form of coil is open to the objection that it cannot be annealed above 140°C. without causing injury to the silk covering on the wire, and there is a certain amount of lag in the oil obtaining the temperature of the coil.

By request of the Electrical Standards Department of the Board of Trade the Scientific Instrument Co., Ltd., Cambridge, have designed and made two standard 1 ohm coils, the wires of which are bare and immersed in oil; a modification suggested by Mr. Horace Darwin was also fitted for obtaining the temperature of the coils. The coils proper consist of 0·035in. PtAg wire wound on mica frames, the ends of the wires being attached to stout copper terminals in the usual manner. A 0·008in. platinum wire is wound alternately with the platinum-silver wire, and is attached similarly to stout copper leads. The illustration clearly shows the method of winding. Both coils are adjusted to a resistance of 1 ohm at 15·5°C. Owing to the difference in the temperature coefficient of the two wires (PtAg 0·00024, Pt 0·00350) a small change in the temperature of the coil causes a comparatively large difference between the resistances of the two coils. This difference being known, the temperature in degrees Centigrade is given by the adjoined table. The table is calculated from the difference in the temperature coefficients of the two wires 0·00350 − 0·00024 = 0·00326 for 1°C. The table of differences, together with the values of the Pt and PtAg coils at different temperatures is also shown diagramatically:—

Temperature of Standard Coil.	Difference in resistance of the coils.	
10·0°C.	−0·01793	Platinum coil having a lower resistance than the platinum-silver coil.
11·0	0·01467	
11·9	0·01141	
13·0	0·00815	
14·0	0·00489	
15·0	−0·00163	
15·6	0·00000	
16·0	+0·00163	Platinum coil having a higher resistance than the platinum-silver coil.
17·0	0·00489	
18·0	0·00815	
19·0	0·01141	
20·0	+0·01467	

As the temperature coefficient of platinum is about 15 times as great as that of platinum-silver the resistance of this coil may be measured to one significant figure less than the standard coil without affecting the value for the temperature of this coil. In measuring small resistances the determination of the last figure to 0·00001 ohm requires considerable care, and the advantage of not being compelled to measure to such a high degree of accuracy is apparent. The two



wires being wound on the same frame alternately with each other and immersed in oil are at the same mean temperature. Any temperature gradient in the oil influences both wires similarly, thus doing away with the necessity of a stirrer. The platinum wire is also useful for testing the insulation of the windings of the PtAg coil one from the other. The coils are placed in a glass vessel in order that the behaviour of the insulating oil with time may be studied.

Coal versus Oil Fuel.—Crude petroleum oil has been used extensively in some parts of the United States as fuel for stationary boilers, and efforts have been made to introduce it generally into this country. As our readers are aware, it has already been used here in certain electric supply stations as well as on one or two locomotives on the Great Eastern Railway. A reversal of the situation, however, has taken place in Chicago where, owing to the great rise in the price of crude oil, the Chicago Union Traction Co. has been compelled to convert its originally oil-fired boiler plant to coal firing.

* Paper read before Section A of the British Association at Bradford.

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WIRELESS TELEPHONY.*

BY SIR WILLIAM H. PREECE, K.C.B.

The first experiments in this direction were made in the month of February, 1894, across Loch Ness, in the Highlands. On that occasion, trials were made to determine the laws governing the transmission of Morse signals by my electromagnetic method to wireless telegraphy, which has formed the subject of frequent reports to this section since 1884. Two parallel wires well earthed were taken, one on each side of the lake, and arrangements were made by means of which the wires could be systematically shortened, with a view of ascertaining the minimum length necessary to record satisfactory signals. It occurred to Mr. Gavey, who was experimenting, to compare telephonic with telegraphic signals, *i.e.*, to ascertain whether articulate speech could be maintained under the same conditions as Morse signalling. The trials showed that it was then possible to exchange speech across the loch at an average distance of 1½ miles between the parallel wires, when the length of the wires themselves was reduced to 4 miles on each side of the water. What led to this train of thought was the fact that, although the volume of a telegraphic current was immensely greater than that of a telephonic current, whenever, through want of balance in a loop, disturbance was evident, then telephonic cross talk was also manifest. In other words, a weak telephonic current was apparently as powerful a disturber as a strong telegraphic one. The sensation created in 1897 by Mr. Marconi's application of Hertzian waves distracted attention from the more practical, simpler, and older method. Mr. Evershed and Principal Oliver Lodge had in the meantime much advanced the system by introducing admirable call systems.

In 1899, I conducted some careful experiments on the Menai Straits, which determined the fact that the maximum effects are produced when the parallel wires are terminated by earth plates in the sea itself. It became quite evident that the ordinary inductive effects are much enhanced by conductive effects through the water and that in consequence shorter wires are practical. No special apparatus seems necessary. The ordinary telephonic transmitters and receivers were used. It became desirable to establish communication between the islands or rocks known as the Skerries and the mainland of Anglesey, and it was determined to do this by means of wireless telephony. The lighthouse at the Skerries was wanted to be in communication with the coast-guard station at Cemlyn, which is connected with the Post Office system. The bottom of the Channel is too rough and the currents too violent for a cable. A wire 750 yards in length was, therefore, erected along the Skerries, and on the mainland one of 3½ miles from a point opposite the Skerries to Cemlyn. Each line terminates by an earth plate in the sea. The average distance between the parallel portions of the two wires is 2·8 miles. Telephonic communication is readily maintained, and the service is a good one. Lodge's call system will be used.

Further experiments with wireless telephony have recently been made between Rathlin Island, on the north coast of Ireland, and the mainland. The east and west portion of the island of Rathlin is about 8 miles from the mainland, but a tongue of land projects southward to within a distance of 4 miles. Communication was required between the lighthouse near the north-eastern corner of the island and the mainland, and the question for solution was whether an overhead line running the whole length of the island from east to west was necessary to obtain good communication, or whether a shorter line across the neck of the southern peninsula would serve. The preliminary experiments that have been made proved conclusively that communication, both telegraphic and telephonic, has been readily maintained by means of temporary wires established across the neck of the peninsula along the shorter line. Wireless telephony across the sea is now a practical and commercial system.

No experiments have yet been made with ships, but it would appear simple to speak by telephone between ship and ship, or between ship and shore, to considerable distances across space, by means of a circuit formed of copper wire terminating at each end of the ship in the sea, passing over the topmast and using simple telephones.

* Abstract of a Paper read before Section A of the British Association at Bradford.

ON THE APPARENT EMISSION OF CATHODE RAYS FROM AN ELECTRODE AT ZERO POTENTIAL.*

BY CHARLES E. S. PHILLIPS.

It has been noticed by many people who work with X-ray or other vacuum bulbs that numerous bright green patches occasionally appear upon the inner surface of the glass walls of a bulb while a discharge is passing, especially during the process of exhaustion. These green flecks vary considerably from time to time both in shape as well as in position, and efforts have been made to connect their existence either with want of uniformity in the composition of the glass or with irregularities in the surface of the negative electrode.

I have already, in another place,* given some account of an experiment made with the object of clearing up this uncertainty, and now beg to supplement that work with the following observations as to the cause of the phenomenon. The experiment just referred to consisted in using a pivoted disc of aluminium as the negative electrode in a bulb containing rarefied air, so that when green patches appeared a rotational movement of the disc (actuated by means of an external magnet) would show whether the patches of green moved in a corresponding manner or not. It was seen that they did so move. A distinct feature of the experiment, however, consisted in ascertaining whether those flecks which persisted after the discharge had ceased were still sensitive to movements of the cathode. This also was found to be the case. The proof therefore that the green patches were associated with an emission from the cathode appeared complete. But it was further noticed that subsequent to the passage of a discharge, and even when either or both of the electrodes were connected to earth, still the green flecks were easily visible upon the glass walls of the bulb, and continued to move as before when the cathode was rotated. This was apparently a case in which cathode rays were emitted from an electrode at zero potential.

I do not know that any explanation of this effect has so far been offered, and I therefore venture to bring forward the following suggestions, supported by further experiments. When a piece of metal is placed in a rarefied atmosphere and made the negative pole for an electrical discharge passing across the attenuated gas, innumerable small bright specks of light appear over the surface of the metal. It was found convenient in my particular case to use an *iron* electrode for observations of this effect, because it had the advantage of being readily magnetisable from without. The addition of a similar iron electrode to act as the anode determined the shape of the magnetic field. With such an apparatus it could be seen that the bright spots appeared principally upon the *cathode* while the discharge passed, and that the creation of a magnetic field between the electrodes made visible the individual luminous streams of gas emanating from those tiny points of light. The paths of these luminous streams, becoming bent by the action of the magnetic field, followed the direction of the lines of magnetic force and exhibited a tendency to become spiral in accordance with well-known laws. In this way a fine layer of sodium upon the anode was caused to fluoresce through the action of the negatively electrified particles beating down upon it. One was able, in fact, by this means to cast shadows of objects placed in the paths of the bent streams, and at a pressure considerably higher than that necessary for the production of the well-known cathode shadow effects. In the above case, however, the method served to clearly establish the fact that the bright points of light upon the surface of the cathode indicated the places from which the jets of gas originated. The number of these jets became less as the exhaustion was continued, and individual streams were very clearly seen owing to the action of the magnetic field. When the discharge began to cause fluorescence in the glass of the bulb some green patches made their appearance, and, in some cases, when the cathode was magnetised a bright spot, which was previously judged to indicate the origin of a green patch upon the glass, would shift to a new position upon the electrode. In all such cases the corresponding patch also moved in a similar manner upon the glass. At sufficiently high exhaustions the bright spots upon the electrode disappeared entirely, although green flecks were still visible upon the glass. But a movement as before of the electrode as well as its magnetisation gave results consistent with previous observations. Under these conditions, when the discharge through the bulb was stopped, green flecks were still visible for about ten seconds. A positively-charged body was brought up to the outside of the bulb and the patches brightened considerably. A negative charge similarly placed extinguished the flecks completely. This was also the case when the electrodes were connected to earth. Finally, vacuum bulbs, such as X-ray lamps, &c., exhibiting green flecks while in operation, were generally found to deteriorate if laid aside for a month or two, owing to an increase in the pressure of the contained gas. We see therefore that, in the first place, the bright points of light upon the surface of the cathode are due to the emission of fine jets of gas; also that such jets, if negatively charged, may be made to cast shadows of objects suitably placed in their paths. It is at the same time clear that the green flecks referred to above are due, during the passage of a discharge, to these same jets of gas impinging upon the inner side of the glass walls, and that, under the conditions existing immediately subsequent to the passage of the discharge, it is evident that streams of gas continue to be emitted from the pores of the electrodes. In spite of the fact that with the electrodes connected to earth these streams consist of unelectrified particles, they assume that property of ionisation during their passage across the space within the bulb which appears to be essential to the production of local fluorescence in the glass upon which they impinge.

* *The Electrician*, Vol. XLI., 1898, pp. 425-426.

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This latter effect, while explaining the process by which a cathode emission may appear to originate at an electrode with no electrical charge upon it, is one to which I wish to draw especial attention, for there is reason to believe that the upper limit of speed for the individual particles constituting the jets cannot exceed the rate at which sound is propagated. It is therefore interesting to find that, under such circumstances, fluorescence was produced in the glass upon which the streams impinged. As many of the observations referred to here were made during the course of an investigation into the dis-electrifying action of magnetism now being carried out by myself at the Davy-Faraday Laboratory of the Royal Institution, I desire to express my indebtedness to the managers of that institution for the facilities which they have kindly placed at my disposal.

ON THE SIMILARITY OF EFFECT OF ELECTRICAL STIMULUS ON INORGANIC AND LIVING SUBSTANCES.*

BY PROF. J. CHUNDER BOSE, D.SC.

Molecular Change Produced by Electric Stimulus.

Effect on Muscles.—If we take a piece of living tissue, say a piece of muscle, and subject it to an electric stimulus, there will be produced a contraction; the stimulus causes a re-arrangement of the particles of the living substance by which the form of muscle is changed. On the cessation of stimulus, the muscle recovering from the strain gradually attains its original shape.

Effect on Nerves.—The effect of stimulus on nerves is not apparent; there is no change of form. The molecular disturbance due to stimulus can, however, be detected in an indirect manner from certain electromotive variations that are produced.

Effect on Inorganic Substances.—If we take, for example, a mass of metallic filings and subject them to electric shocks, there is found to be no visible change. The substance appears to be irresponsive or dead to stimulus. Are inorganic substances then really irresponsive? Could this apparent want of response not be due, after all, to our inability to detect the profound molecular changes that may have, nevertheless, taken place in the substance under the action of stimulus? In nerves the molecular changes could only be detected indirectly by an electric method. I shall describe in detail an electric method which will tell us whether, after all, a stimulus does evoke a moleculr thrill even in inorganic substances. First of all let us study the effect of the very quick electric vibration known as light on inorganic matter. If we take a piece of yellow phosphorus and subject it to light, it will be found to be slowly converted into the allotropic red variety; the substance will be strained from one molecular condition to another. But for the fortunate circumstance of the change of colour we could not have detected by sight the change produced. Even if there had been no visible change, we could have still detected the molecular change due to radiation by means of other methods; for it is obvious that any molecular change in a substance must be attended with corresponding physico-chemical changes. In the case of the red variety of phosphorus, in comparison with the yellow variety, it is found to be chemically less active, insoluble in CS_2 and of higher specific gravity. We may also expect its other properties such as elasticity, its position in the voltaic series, its electric conductivity, &c., to be similarly modified. As a matter of fact the conductivity of red phosphorus is greater than that of the yellow variety. We may thus detect the variation produced in the molecular arrangement by measuring the corresponding variation of any of the above properties. The choice of any particular method is one of convenience and of special applicability under the given conditions. I have shown in my Paper "On Electric Touch and the Molecular Changes Produced in Matter by the Action of Electric Waves," *Proc.* Roy. Soc., February, 1900, that the conductivity method of detecting molecular strain is one of very great delicacy; this is the method which will be constantly referred to in the present Paper. Occasional reference will also be made to the electromotive variation method, which will be described in detail on a future occasion.

Conductivity Method of Detecting Molecular Strain.

In the case of phosphorus it would be possible to detect the molecular change due to radiation by interposing it in an electric circuit containing a galvanometer. As the yellow phosphorus is gradually converted into the red variety, on account of the increased conductivity of the latter, there would be produced a corresponding increase in the galvanometer deflection; the increased deflection will thus be a measure of the molecular change produced by radiation. For the most sensitive arrangement a solid lump of the substance is not suitable; the molecular change would then be confined to the thin layer on the surface, the mass in the interior remaining unaffected. For increased action the substance should be spread out in the form of a thin layer of particles accessible to the radiation. This is one of the reasons why it is better to have the substance in the form of powder if the molecular change is to be detected by the conductivity method. There are other additional reasons which will be presently given.

Molecular Change produced by Electric Radiation.—Let us now take a mass of metallic filings interposed in an electric circuit and subject it to the stimulus of much slower electric radiation. As in the last case, the molecular change produced by radiation will be detected by the change of conductivity produced.

Theory of Coherence.—A tube containing a mass of metallic filings is thus a good detector of electric radiation, and is sometimes called a coherer. For reasons given below it is preferable to call such a detector a "molecular receiver." Filings of a number of metals were found to exhibit a diminution of resistance under electric radiation, and this diminution was found to persist until the particles were "decohered" by tapping. Prof. Lodge was thus led to suppose that the effect was produced by minute induction sparks, due to electric radiation, welding the particles together. The theory of coherence leads to the conclusion that *all* sensitive substances should exhibit a diminution of resistance; in other words, the action should be non-discriminative; it also follows from the same theory that there should be no self-recovery.

Theory of Molecular Strain.—But in carrying out a systematic investigation on the action of electric waves on fragments of elementary substances I found that while some substances—*e.g.*, Mg, Fe, Bi, exhibit an increase of conductivity or a positive effect, others—*e.g.*, K, As, I, exhibit a diminution of conductivity or a negative effect; and, further, the effect, positive or negative, is found to be a periodic function of the atomic weight of the substance. This at once shows that the action is one of atoms or of molecules. I have also found that in many cases the change of conductivity is not permanent, but the substance quickly recovers and attains its original conductivity on the cessation of radiation stimulus, as if a force of restitution was called forth to restore the substance to its equilibrium position of original conductivity.

Imagine a small magnetometer needle (with the usual arrangement of mirror and reflected spot of light) suspended by means of a thin wire, and imagine the earth's field neutralised by a controlling magnet. When a second magnet is approached "end on" there would be produced a distorting couple which would twist the wire, the torsion of the wire balancing the magnetic force. This distortion of the wire is measured by the deflection of the spot of light. As the distorting force is increased by the gradual approach of the magnet, there is produced a corresponding increase of distortion as seen in the increased deflection of the spot of light. If the magnet is now removed, the wire will recover from distortion (with the return of light spot to the original equilibrium position); the wire will recover quickly if made of highly elastic steel, slowly if made of viscous lead. I will now describe a parallel experiment, where the radiation-stress produces a molecular strain attended by a corresponding variation of conductivity of the substance, the conductive distortion being measured by the galvanometer deflection.

Proof of Radiation producing Molecular Strain.—I have found that the bromides of several metals exhibit a distortion of conductivity (a diminution of conductivity) under electric radiation, and that on the cessation of radiation the recovery is very quick. Let a small quantity of lead bromide in the form of powder be interposed in an electric circuit, and the pressure on the powder and the E.M.F. properly adjusted till a suitable deflection, which I shall call the normal deflection, is obtained in the galvanometer. The resistance of the galvanometer and the voltaic cell being relatively small in comparison with the resistance of the sensitive powder, the above *normal* deflection represents the conductivity of the substance under the given conditions; the deflection will remain constant as long as the substance is left undisturbed. But any external stimulus producing molecular distortion will be detected and measured by the corresponding *variation* of deflection produced in the galvanometer, just as the distorting magnetic force was measured by the variation of the magnetometer readings.

I now placed an electric radiator at a distance of 125cm. from the "molecular receiver" of lead bromide; the radiation stimulus at once produced a diminution of conductivity, the *normal* deflection being reduced by 44 divisions. If the radiator is now removed, the normal conductivity is at once restored, the deflection attaining its original value. It is thus seen that no permanent change of conductivity is produced, the force of restitution merely balances the distorting force due to radiation. If there is any fluctuation of radiation intensity, there would be produced a corresponding variation of conductivity-strain in the substance. As a matter of fact, it is difficult to keep the intensity of radiation uniform; there is a flicker, and in the experiment just described there is a slight fluctua-

* Paper read before Section A of the British Association at Bradford.

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tion in the deflected spot of light. On the gradual approach of the radiator there was a corresponding increase of deviation. Thus :—

Distance of radiator.	Deviation.
125cm.	44 divisions
100cm.	63 do.
75cm.	74 do.
50cm.	110 do.

Just as the quickness of recovery of a twisted wire depends on its elasticity, so also the rapidity of recovery from the state of conductivity strain is determined by the electric elasticity of the substance. The recovery is, for example, very quick with potassium and slow with magnesium.

On the theory of coherence the above results are without any meaning and absolutely inexplicable. On the theory of strain, the meaning is quite obvious.

Further Proofs.—If the effect of electric radiation on a substance is one of strain, then it follows : (1) That the substance will recover from the strained condition due to radiation, provided the resulting strain is within the limit of the elasticity of the substance ; hence the substance will exhibit self-recovery (*a*) if the stimulus is not excessive, or (*b*) if the electric elasticity of the substance is very great. I find that on careful adjustment a receiver often exhibits self-recovery when the intensity of the incident radiation is feeble. I also find that substances which are, electrically speaking, highly elastic (*e.g.*, potassium), exhibit an automatic recovery even when the stimulus is very strong. (2) But if the substance has a narrow elastic limit and the stimulus is too great, then there would be produced a more or less permanent distortion. This molecular distortion will be attended with a more or less permanent charge of conductivity. In the case just described, owing to molecular friction, the recovery of the substance when left to itself will be very slow. The substance being distorted to the maximum extent will exhibit little sign of response to the further action of stimulus ; the absence of response or "fatigue" is thus due to the overstrained condition of the substance. (3) For the reasons given above, the recovery

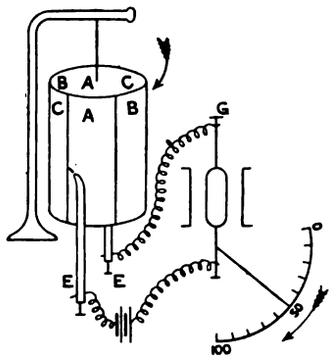

FIG. 1.—Diagram of the Electric Circuit containing the Sensitive Substance.

of a substance from the strained condition should be hastened by molecular vibration. A fatigued receiver should thus be re-sensitised by molecular vibration due either to tapping or to a gentle application of heat. These conclusions are borne out by experiments. (4) The recovery of the substance, either (*a*) slowly, or (*b*) in a "dead beat" manner, or (*c*) after one or more vibrations, will be determined by the viscosity of the substance. In working with sensitive receivers made of various substances, I have obtained indications of the above types. It will thus be seen that the above theoretical deductions, based on the theory of molecular strain, are in all cases experimentally verified.

It is often forgotten that the conductivity of a substance does not simply depend on the chemical nature of the substance. The state of molecular aggregation also plays an important part in determining the conductivity of a substance, and as an illustration we may take the case of carbon, which exhibits wide differences of conductivity in the two allotropic states of graphite and diamond. Imagine a piece of carbon in an intermediate or neutral state between graphite and diamond. Suppose an external force distorts it to a small extent towards the more conducting graphite state. This distortion would be attended with an increase of conductivity from which latter the extent of distortion may be inferred. Now, during the distortion from equilibrium position, a force of restitution will tend to restore the substance to its original neutral condition. If the distortion does not proceed beyond the elastic limit, then, on the cessation of the distorting force, the substance will recover its original state, and this will be evidenced by the restoration of its original conductivity. But if the distortion is of a sub-permanent type, then mechanical vibration or heat will hasten the recovery of the substance to its original condition.

The permanent distortion known as allotropic transformation due to luminous radiation is seen in the production of red phosphorus from the yellow variety and the insoluble from the soluble variety of sulphur.

A substance responds to an external stimulus as long as there is a certain amount of mobility of its molecules. I will, in a future Paper, show that a selenium cell acts in the same way as the molecular receivers described above—that is to say, a molecular strain is produced in it by the stimulus of light. In order to make the selenium cell sensitive, a careful process of annealing is found necessary. The cell ceases to respond or is "killed" when there is a permanent set in its molecules.

A Mechanical Model.—It has been said before that the conductive aspect of a given substance is not definite but variable, the conductivity being dependent on the particular molecular condition of the substance. This peculiarity may be represented in the accompanying model, if we give to the cylinder representing the sensitive substance, three main conducting aspects ABC. The non-conducting aspect is represented by C. With the sensitive substance in this particular condition interposed in an electric circuit, the current in the galvanometer would be zero ; A is the semi-conducting aspect of the substance, and let the corresponding galvanometer deflection be 50 ; B is the highly-conducting aspect, the corresponding galvanometer reading being 100.

The cylindrical piece ABC representing the sensitive substance is divided along the circumference into six parts, the opposite sextants being put in electric communication. The opposite sextants CC are coated with shellac to represent the non-conducting aspect ; the sextants AA are coated with graphite to represent semi-conducting aspect ; and the highly conducting aspect is represented by the sextants BB coated with tinfoil. The three main aspects of the sensitive substance are thus represented in the model ; it is to be understood that with sensitive substances under the action of radiation, the transition from one aspect to the next is gradual and not abrupt, as represented. The sensitive substance is interposed between the two electrodes EE ; the torsion of the suspending wire represents the force of restitution. G is the suspended coil of a D'Arsonval galvanometer in circuit, which by its deflections exhibits indirectly the molecular strain produced in the substance by radiation.

Suppose we start with the substance in its normal state A, with moderate conductivity, and let the corresponding galvanometer deflection be 50 ; let the substance belong to the positive class which exhibits an increase of conductivity under radiation. The radiation stimulus will, therefore, distort the substance to a state of increased conductivity, the increased conductive aspect B being brought opposite the electrodes EE ; the increased current thereby produced causes a deflection of, say, 100 in the galvanometer. If the strain has not been excessive the substance will return to its original position of equilibrium on the cessation of radiation stress, and the galvanometer deflection will fall from 100 to the original value, 50. If the substance belongs to the negative class the distortion will be in the opposite direction, and the effect of stimulus will be a diminution of conductivity.

Method of obtaining Curve of Molecular Response.—The suspended coil of the galvanometer thus moves in perfect response to the varying strain produced in the sensitive substance by the action of stimulus. The invisible molecular distortions are thus revealed by the visible deflections of the galvanometer coil ; the effect on one is merely the reflection of the effect on the other. Curves of molecular effect due to the action of radiation may thus be obtained with the galvanometer deflections as ordinates and the time of exposure (or the time of recovery) as abscissæ. It is thus seen that these curves faithfully represent the invisible molecular strain effect due to the stimulus and the after recovery from the strain.

The Muscle Curve and the Molecular Response Curve.—When a muscle is stimulated there is produced in it a re-arrangement of its particles ; this is attended by a shortening of the muscle. A muscle curve is a graphic record of the contraction due to stimulus and the gradual recovery from the strain after the cessation of the stimulus. A muscle curve thus records the history of the strain effect produced by a stimulus in a living tissue, just as the molecular response curve records a similar effect in an inorganic substance. The two represent the same thing ; in one the strain is detected by the change of conductivity, in the other the same strain is detected by the change of form. We have thus means of studying the molecular response produced in both the inorganic and living substances by electric stimuli of varying frequency, intensity and duration.

In the above are included some of the most difficult problems that underlie both physics and physiology. The subject is very extensive, and our knowledge proportionately inadequate. Very little is definitely known about the influence of ether disturbance on matter. A great gulf separates the phenomena of the living from those of the non-living. But if we are ever to understand the hidden mechanics of the animal machine, attempts have to be made to solve these problems, and many difficulties have to be faced which now appear very formidable.

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Before taking up the comparative study of the effect of electric stimulus on inorganic and living substances, I will say a few words about the continuity of certain phenomena.

Effect of Electric Vibration on Discontinuous Particles and on Continuous Solids.—The variation of conductivity due to electric radiation is very great in discontinuous particles, but is supposed to be wanting in continuous solids. This is not altogether correct, for I have detected such a variation even in a continuous solid, though the variation is small. The following are the probable reasons for the feebleness of action in the latter, specially when the effect is measured by the variation of conductivity method: (*a*) The action of quick electric oscillation on molecules of the solid is only skin deep; the effect cannot pass to any depth. As the action is one of surface, the larger the surface the greater is the effect produced. We see that in loose particles the effective surface is very much enlarged. Again, any effect on the numerous surfaces (which also form points of electric contact for the conduction of current) greatly affects the conduction. When the particles become continuous, the radiation can only affect the layer of molecules on the surface, the inner layers being protected by the outer conducting sheet. The molecular changes produced on the comparatively thin layer on the surface do not affect to any great extent the conductivity of the continuous particles in the interior of the solid. I have, however, succeeded in detecting this skin-effect by the variation of electromotive variation. (*b*) In order that the molecules may undergo a change of aggregation, it is necessary that there should be a certain amount of freedom of movement. The strain effect would take place more easily on the surface than in the constrained position inside a solid mass. (*c*) In addition to the above there is another phenomenon to which the observed feebleness of effect may also be due. I find that the effect feeble radiation is often, if not always, opposite to the action of strong radiation. Thus with the positive class of substances, the effect of strong radiation is produce a *diminution* of resistance. But if the intensity of radiation is decreased till it falls below a critical value, then the effect of the feeble radiation will produce an *increase* of resistance. There is thus produced a sort of polarised action, a positive action on the portion of a sensitive substance on which strong radiation acts, and a negative reaction on another portion of the sensitive substance where the intensity of incident radiation is feeble. Now, in a continuous solid the intensity of radiation will get gradually diminished (by absorption) as it passes inwards, and thus the intensity in the interior soon falls below the critical value. The resultant effect will thus be due to the *difference* of opposite effects on the outer and inner layer of the solid. I have obtained several results in support of this view, and these considerations offer a satisfactory explanation of some obscure reversal effects in certain phenomena of vision.

Continuity of Effect of Electric Vibration of Widely Varying Frequencies.—References have already been made of the molecular change produced by the high-frequency electric vibration of light. It has also been shown how the low-pitched electric radiation produces similar action on metallic particles. Similar molecular change (attended with a variation of conductivity) is also produced by a single electric shock. A variation of current or of E.M.F. produces similar effect. (There is a critical E.M.F. which I find necessary to produce the above change.) It will thus be seen how essentially continuous is the effect of electric stimulus of varying frequencies on matter. I need only add that in considering the effect of electric vibration on matter, the modifying influence of selective absorption should also be borne in mind.

Continuity of Effect on Elementary Substances and on Compounds.—I have found that the molecular effect due to electric stimulus is not only produced (1) in all elementary substances—metals, non-metals and metalloids, but also (2) in metallic compounds, such as the various chlorides, bromides, iodides, oxides and sulphides. There is thus seen a continuity of effect of electric stimulus on different forms of inorganic matter. I will now proceed on the comparative study of the direct and after effect of electric stimulus of (*a*) varying intensity and (*b*) duration on inorganic matter and on living tissues. I have already explained how the response curve for inorganic substances may be obtained with the variation of conductivity (as inferred from galvanometer deflections) as ordinates, and the time as abscissæ. These curves will be compared with the corresponding curves for muscles, as given in well-known text-books on physiology.

On the Comparative Study of the Molecular Response Curve of Inorganic and Living Substances.

Under the subsection (*a*) I will describe the effect of a given stimulus on inorganic substances, and under (*b*) the effect of a similar stimulus on muscles.

1. *Moderate Distortion.*—(*a*) Curve for slightly warmed magnetic oxide of iron. As an instructive example representing the general effect produced by electric stimulus on inorganic substances, I will give a detailed account of the curve for Fe_3O_4. The curves of various inorganic substances differ from each other only in the rapidity of recovery from the effect of stimulus. The specific difference between the positive and negative classes of substance should, however, be borne in mind: in the former the stimulus produces a diminution and in the latter an increase of resistance. The curves for the two classes will still be comparable if the ordinates in the one represent the conductivity and those in the other the resistivity. The advantages of magnetic oxide of iron are (1) that owing to its chemical stability there is no secondary chemical action, (2) that when kept slightly warmed it exhibits self-recovery, and (3) that the direct and after effects of stimulus are not too quick for detailed observation

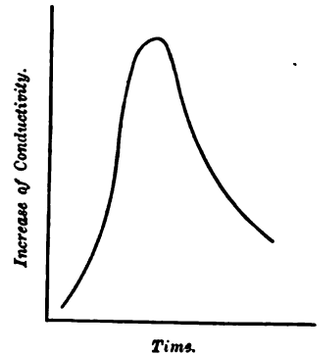

Fig. 2.—Curve for Fe_3O_4.

and study. With this substance it is quite easy to take time observations and obtain quantitative readings from which the curves are easily obtained. The curve given in Fig. 2 represents the effect of a stimulus of short duration (due to an instantaneous flash of electric radiation).

There is a latent period. The response begins to take place a very short time after the action of the stimulus, the molecular effect continues even after the cessation of the stimulus; it attains a maximum, after which the substance recovers with more or less rapidity.

Fig. 3.—The Muscle Curve.

The recovery is rather slow with many substances, but with magnetic oxide of iron the recovery is fairly rapid when the temperature is moderately warm (see below); it is also very rapid at ordinary temperatures with potassium and the bromides of several metals. With certain sensitive substances I have also noticed a tendency to an oscillation or after-vibration. The molecular effect described above is also produced when platinum or any other noble metal is taken as the sensitive substance. This shows that the effect of stimulus does not give rise to any chemical action; the *primary*

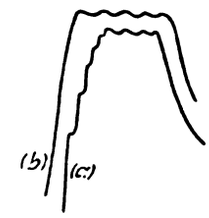

Fig. 4.—Superposition of Effects: (*a*) Effect due to Slow Intermittence. (*b*) Tetanic Effect due to High Frequency Intermittence.

effect is one of molecular strain—the strain which gives rise to the allotropic modification of a substance. If the substance is kept immersed in a medium with which the strained substance can enter into a chemical reaction, it may do so; but such effects are secondary. This aspect of the subject I will treat in detail in a future Paper, "On the Theory of Photographic Action."

(*b*) Muscle curve. In Fig. 3 is given the usual curve for muscles, which will be found to be very similar to the Fe_3O_4 curve given above. There is a phase (1) of a latent period, then (2) a

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phase of increasing action *bd*, and (3) a phase of return to the original condition. Just as in the curve with inorganic substances, the recovery may be either slow or quick, depending on various circumstances. In the muscle curve there is also a very interesting fourth phase known as "Elastic after-vibration." There seems to be some differences of opinion among physiologists as regards the reality of this fourth phase. From some of my experiments, which will be given later on, it would appear that in the retina, at all events, there is an oscillatory after-effect.

2. *Superposition of Stimuli.*—(*a*) As the magnetic oxide of iron when slightly warmed exhibits self-recovery, I tried experiments to find out the effect of superposition of stimuli. Three sets of experiments were carried out—(1) on the effect of the superposition of maximum stimuli; (2) on the summation effects of medium stimuli with slow intermittence; and (3) the summation effect with rapid intermittence. (1) Maximum stimulus: By bringing the radiator sufficiently near a maximum effect was produced on the sensitive substance. The maximum deflection was thus found to be 230 divisions. Before the substance could recover to any extent a second flash of radiation was superposed. This produced no further deflection. But if the second stimulus is applied after recovery, then the second deflection is the same as the first—*i.e.*, 230 divisions. (2) Medium stimulus, slow intermittence: In this set of experiments the radiator was moved farther away, so that the intensity of the stimulus was moderate. The successive flashes of radiation were given out at intervals of 2sec.; the approximate increase of deflection due to the effects of successive flashes (1), (2), (3), &c., are given below :—

	Deflection.		Deflection.		Deflection.
(1)	100	(4)	15	(7)	2
(2)	30	(5)	6	(8)	-2
(3)	20	(6)	4	(9)	3

The self-recovery being not very rapid, the fall during the intervals of 2 sec. was very slight. After the sixth flash the further rise was small; after this there were only slight fluctuations. On the cessation of radiation, the substance gradually recovered. It will be noticed that whereas the successive distorting forces were equal, the corresponding strain effects are less and less, as may be seen in the gradual shortening of the height of the succeeding steps (see Fig. 4 (*a*)). The elasticity undergoes a rapid increase with the increased strain. After the maximum effect has been produced by the summation of stimuli, there is but little further action. The effect is not unlike the successive diminished compressions produced in a spiral spring by the successive additions of equal loads. Again, if a piece of muscle is stretched by a weight, and the stretching force is continuously increased by equal increments, the corresponding elongations are not uniform; the elasticity is found to increase with the increased strain.

3. *Rapid Intermittence.*—When the stimuli follow each other with great rapidity, the intermittent effects are fused together; the rising curve is found to be unbroken, and the effect may be described as "tetanic" (see Fig. 4 (*b*)). When the maximum effect is produced, the force of restitution is very great, and this is just balanced by the radiation stress. In this part of the curve representing a state of rather unstable equilibrium, any fluctuations of either force will be attended with a corresponding fluctuation; as a matter of fact there is a slight fluctuation in this part of the curve. On the cessation of radiation, the elastic rebound being strong, the recovery is rapid and the fall curve very steep, specially in the first part. This is found to be the case only after the maximum strain, but when the strain is moderate, the recovery is comparatively slow, and the slope of fall curve gentle.

(*b*) The curves for muscles under the above conditions are simply the reproductions of those given above. The various effects produced on muscles under intermittent stimulation are absolutely identical with those on the inorganic substance Fe_3O_4. In muscles, too (1) with maximum stimulus, the second stimulus has no further effect on the maximum contraction due to the first; (2) with the moderate stimulus, there is a summation of effect; if the intermittence is slow, the individual effects can be made out (see Fig. 4 (*a*)); (3) with very rapid succession of stimuli there is a fusion of effect known as tetanus (see Fig. 4 (*b*)).

4. *Opposite Effects due to Strong and Feeble Stimulus.*—With many inorganic substances, I found, as previously mentioned, that if a moderately strong intensity of stimulus produces a certain normal or positive effect, then a feeble intensity would produce a negative effect; in other words the effects of the stimulus above and below the critical intensity are opposite. Though this is very curious, yet it is not singular, for we know of other molecular effects whose sign is reversed when the intensity of the force acting exceeds a certain critical value. I believe a similar effect has also been observed in the physiological action of drugs, which act as chemical stimuli, a small "dose" being found to give rise to an effect precisely opposite to that produced by a large dose.

(*To be continued.*)

THE PRODUCTION OF AN ARTIFICIAL LIGHT OF THE SAME CHARACTER AS DAYLIGHT.*

BY A. DUFTON, M.A., B.SC., AND W. M. GARDNER.

It is a matter of common experience that many colours alter in appearance when seen by artificial light. The extent to which colours may vary under different illumination is perhaps not commonly known, but is well illustrated by the range of dyed cloths exhibited. Amongst other patterns, one which is green by daylight becomes red-brown by gaslight; a violet changes to purple; a grey to heliotrope; a shade of tan to a brick red. Particularly striking is a pattern woven from specially dyed yarns, which appears a uniform green colour by daylight, but which is figured by gaslight. Seen by the light of the electric arc, the patterns show similar but less marked changes. It may be of interest to indicate briefly how such peculiar changes of colour arise. The colour of a body depends in the first place on the nature of the incident light. In monochromatic red light a red appears much the same as in daylight, but a yellow changes to red, a green is almost black, while blues and violets become red. Gaslight shows a continuous spectrum from red to violet, but compared to daylight is of a strong orange colour due to an excess of rays in the red, orange, and yellow. It does not, however, necessarily result that all colours appear redder by gaslight. It is, indeed, well known that the majority of colours change little by gaslight. This is due to the adaptability of the eye; if the light becomes redder the eye becomes less sensitive to red; if the light is deficient in green, the eye becomes more sensitive to green. Persons working by gaslight soon cease to notice its intense orange colour. It results that a grey produced by mixture of black and white appears grey under any illumination, and simple colours, such as reds, oranges, and some greens, giving light confined practically to one part of the spectrum, undergo little change.

Generally, however, the colour of a body is due to a mixture of light from different parts of the spectrum. All violet colours are transparent, not only for violet, but also for blue and red light; all blues transmit not only blue, violet, and green light, but also more or less red. Consequently, whenever a blue or violet is used in the production of what is called by artists a "tertiary" colour, the general result is a colour having bright bands in different parts of the spectrum. A mixture of red, blue, and yellow to produce a neutral grey will show bright bands in the red and green—complementary colours, resulting in a proportion of white light. According to the exact position and intensity of these bands the grey will become redder or greener or may even remain unchanged by gaslight. Generally, colours become redder under artificial light. This is due not merely to the redder character of artificial lights as compared with daylight, but to the peculiar transparency of colouring matters for red light. Among reds and yellow we have many theoretically perfect colouring matters—a perfect yellow being one having sharp absorption in the violet and blue, and perfect transparency for green, yellow, orange and red rays. A perfect blue would be transparent for violet, blue and green, and opaque for the rest of the spectrum. Apparently such a blue can only be obtained by means of cupric salts. All other blue dyes and pigments we have examined agree in being more or less transparent for red light. Even greens transmit some red. This peculiar transparency of colours for red light is of primary importance in colour matching. All dyers know how persistent is the tendency to the development of red in the production of compound shades.

The need of an artificial light which should so closely resemble daylight as to show colours in their true relationship has long been felt by workers in colour. At present the electric arc light is largely used for colour work, but, as we have seen, it is far from satisfactory. The peculiar character of daylight is due essentially to the modification produced by the atmosphere in the light from the sun. Light from a north sky as usually adopted for colour work is deficient in red, orange, and yellow rays, and consequently the light from a clear north sky is intensely blue.

Starting with the electric arc light as being nearest daylight in character, we have attempted to imitate by direct absorption the effect produced by scattering in the atmosphere. The light of an arc lamp consists of two distinct parts: (1) The light from the glowing carbons; (2) the light of the arc itself, characterised by its richness in violet rays. In lamps of the enclosed arc type the length of arc is increased, and consequently such lamps give a light richer in violet rays. Although arc lights vary somewhat in the proportion of violet light, they all agree in being richer than daylight in the amount of red, orange, and yellow rays, compared with the amount of green and blue. Owing to the peculiar transparency of colours to red light already noticed, it is of primary importance that the proportion of red light should be carefully adjusted. Small variations in the amount of violet light are of minor importance, owing to the eye being less

* Abstract of a Paper read before Section A of the British Association at Bradford.

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sensitive to such rays, and also because in mixing colours there is not the same tendency to develop a band of violet as we have seen occurs in the red, since yellow colours generally have complete absorption in the violet. The required absorption of the less refrangible rays can be effected by means of blue cupric salts. A solution of copper sulphate shows strong absorption at the extreme red of the spectrum, the absorption extending with diminishing intensity into the green. For practical purposes the light from the arc is modified by passage through pale blue glass coloured by means of copper. This coloured glass may conveniently take the form of a globe replacing the ordinary globe of the arc light.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"Der Rotirende Umformer." By Charles Proteus Steinmetz. (Stuttgart: Ferdinand Enke.) 1.20m.

"The Official Gazette of the United States Patent Office." Published by Authority of Congress. Vol. XCII. Nos. 4, 5, 6, 7, 8 and 9. (Washington: Government Printing Office.)

Transactions of the Royal Society of Edinburgh. Vol. XXXIX., Part II. For the Session 1897-98. 19s. Also Vol. XXXIX., Parts III. and IV. For the Session 1898-99. 43s and 19s. (Edinburgh: Robert Grant & Son; London: Williams and Norgate.)

ELECTRICITY WORKS ACCOUNTS.

Manchester Municipal Electric Supply Works.

Although the accounts of the Manchester undertaking for the year ended at March 31 last show that a material increase in the working expenditure per unit sold has taken place, yet the results in general are most satisfactory.

To have diminished the already low fuel charge of 1898 is a highly creditable achievement, while the item "Wages at Station" presents a figure, at 0·156d. per unit, little over half what it might reasonably have been expected to stand at. Owing to expenditure on mains which had proved defective, the charge in respect of repairs and renewals of mains has risen considerably, and has been the cause of a rise in the works costs in spite of the diminished generating costs. Another item which has seriously risen is that of rents, rates, and taxes. The chief seat of the rise in this item is in the rates, the charge on this account being £4,814 last year, as compared with £1,048 in the preceding year. The result of this increase has been to raise the collective management and property charges to 0·554d. per unit—a value decidedly above what it should be. The total costs, at 1·88d. per unit, are most satisfactory.

During the year the lamp connections rose from the equivalent of 217,457 8 c.p. lamps to 290,284—a rise of 17·3 per cent. The output made a greater stride, having reached 6,355,872 units sold, being an advance of 33·3 per cent. Last year's load factor at 12·9 per cent. was a slight improvement on that of 1898-9, which stood at 12·8 per cent.

In addition to the call made upon the revenue account in respect of renewal of mains a sum of £12,460 was withdrawn from the renewals suspense account to cover similar expenditure, while on account of the unfortunate breakdown at the Dickenson-street station in September of last year, when two 400 H.P. generating sets were wrecked, the reserve fund suffered to the extent of £7,070.

On Sept. 30 last year the price for supply to long-hour consumers was reduced from 1½d. to 1¼d. per unit. This was to the advantage of consumers to the extent of £2,873 in six months.

Glasgow Municipal Electric Supply Works.

Again this year the accounts of the Glasgow undertaking indicate excellent results. It is true that owing to the increased fuel expenditure both the generating and the total works costs have gone up, yet the increase in the latter two items has been but slight and more than neutralised in the total costs by the reduction which has taken place in the management and property charges. These charges have fallen from 0·59d. to 0·44d. per unit, and at the latter figure indicate a most commendable result in view of the low load-factor which obtains at Glasgow. The net result in the aggregate costs has been that they have dropped from 2·04d. to 1·98d. per unit.

As regards the progress in the business done, the lamp connections and the output bear convincing evidence. The former quantity advanced by nearly 26·5 per cent., and the latter by over 50 per cent. The load-factor, which was only 5·28 per cent. in 1898-9, was last year 6·28 per cent.

During the year the buildings at Port Dundas and at the Pollokshaws-road station have been nearly completed. In the former station steam plant to nearly 7,000 H.P. capacity and at the latter station to 2,200 H.P. is being installed, while further extensions of plant to about 5,000 H.P. are on order for the Port Dundas station, and to the extent of 2,200 H.P. for the Pollokshaws-road station.

The undertaking of the Kelvinside Electricity Co. (Ltd.) was acquired by the Corporation in August, 1899, and they are putting in about 1,000 H.P. of new plant.

The tariff for supply during the current year (1900-1901) is as follows:—Under the maximum demand system 6d. per unit for a quantity not exceeding the maximum demand for 365 hours in the year, and thereafter 2½d. per unit to 100-volt consumers, 2d. per unit to 200-volt consumers, and 1½d. to 250-volt consumers.

Under the fixed charge system, a fixed charge of 4s. 6d. per annum for each 8 c.p. lamp, or its equivalent fixed on the consumer's premises (or £7. 0s. 8d. per kw.) for 100-volt supply, 4s. 4d. per lamp for 200-volt supply, and 4s. per lamp for 250-volt supply, this charge being spread uniformly over the 12 months, and in addition a charge of 1½d. per unit by meter.

All consumers taking a supply for the equivalent of five hours or more per day for 365 days per annum to be charged throughout at 2½d. per unit for 100-volt supply, 2d. per unit for 200-volt supply, and 1½d. per unit for 250-volt supply.

There is a special rate of 3d. per unit charged to churches.

For domestic consumption only, a uniform charge of 3½d. per unit for 250-volt supply and 4d. for 100 and 200-volt supply is made without the use of demand indicators, and for motive power only, a uniform charge of 1½d. per unit for 250-volt supply, and 2d. per unit for 200-volt consumers is also applicable—no demand indicator being used.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	July 20, 1900
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, ,,
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	Aug. 3, ,,	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	July 6, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, 1899	Liverpool (Municipal)	June 22, 1900
Blackburn (Municipal)	Jan. 19, 1900	London (Company)	June 8, ,,
Blackpool (Municipal)	Sept. 29, 1899	Londonderry (Municipal)	Feb. 16, ,,
Bournemouth (Company)	Sept. 7, 1900	Manchester (Municipal)	Aug. 11, 1899
Bolton (Municipal)	Nov. 24, 1899	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	June 22, 1900	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 4, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bristol (Municipal)	Aug. 24, ,,	Northampton (Company)	Oct. 20, ,,
Bromley (Kent) (Co.)	June 15, ,,	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, ,,	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	Aug. 24, 1900
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, 1899
Chelsea (London) (Co.)	Mar. 22, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	Aug. 3, 1900	Richmond (Company)	June 29, 1900
City of London (Company)	June 15, ,,	Salford (Municipal)	Feb. 23, ,,
Clerkenwell (Company)	May 18, ,,	Scarborough (Company)	July 13, ,,
Coventry (Municipal)	Feb. 23, ,,	St. Helens (Municipal)	Dec. 8, 1899
Croydon (Municipal)	July 20, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	June 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, 1899
Dover (Company)	April 27, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, ,,	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	May 4, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Aug. 17, 1900
Folkestone (Company)	April 27, 1900	Sunderland (Municipal)	July 28, 1899
Glasgow (Municipal)	Sept. 1, 1899	Taunton (Municipal)	June 16, ,,
Guildford (Company)	May 5, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Halifax (Municipal)	July 21, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hammersmith (Vestry)	June 29, 1900	Walsall (Municipal)	June 23, ,,
Hampstead (Vestry)	Aug. 25, 1899	Wandsworth (Company)	May 12, 1900
Hanley (Municipal)	July 27, 1900	Westminster (Municipal)	Mar. 9, ,,
Harrogate (Municipal)	Oct. 20, 1899	Whitehaven (Municipal)	July 28, 1899
Harrow (Company)	June 16, ,,	Windsor (Company)	Dec. 22, ,,
Hast'gs & St. Leonards (Mun.)	Sept. 7, 1900	Woking (Company)	Dec. 22, ,,
Hove (Company)	July 6, ,,	Wolverhampton (Municipal)	July 27, 1900
Huddersfield (Municipal)	Aug. 17, ,,	Woolwich (Company)	Jan. 12, 1899
Islington (Vestry)	Oct. 27, 1899	Worcester (Municipal)	April 20, 1900
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Yarmouth (Municipal)	Nov. 3, 1899
Kingston-upon-Hull (Mun.)	July 13, ,,		

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	MANCHESTER.		GLASGOW.	
Undertaking Worked by	Manchester Corporation.		Glasgow Corporation.	
Date of Commencement of Supply	August, 1893.		March, 1892.	
System of Supply	Continuous-current 5-wire and 3-wire system.		3-wire continuous-current with batteries.	
Chief Engineer	C. H. Wordingham.		W. A. Chamen.	
YEAR ENDED	MAR. 31, **1899.**	MAR. 31, **1900.**	MAY 31, **1899.**	MAY 31, **1900.**
QUANTITIES—				
Units generated	5,633,534	6,927,396	3,401,731	5,226,818
„ SOLD (TOTAL)	4,773,247	6,355,872	2,824,350	4,250,669
„ sold to consumers	4,726,677	6,312,182	2,566,016	3,788,795
„ sold for public lighting, &c.	46,570	43,690	258,334	461,874
„ used on works	440,974	112,533	67,435	155,294
UNITS SOLD PER 8 C.P. LAMP CAPACITY	31·4	34·6	42·0	21·3
Maximum supply demanded	4,246 kilowatts	5,607 kilowatts	6,114 kilowatts	7,732 kilowatts
Number of public lamps	29	26	227 arc	265 arc
Number of consumers	2,570	3,240	1,858	2,852
Connections to mains in 8-c.p. lamps	247,457	290,284[a]	191,062	241,625
CAPACITY OF PLANT IN 8-C.P. LAMPS	151,800	183,700	67,200	200,000
CAPACITY OF PLANT IN KILOWATTS	4,860	5,880	2,150	6,402
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£490,511 / £101	£694,121 / £118	£700,000 / £325	£700,000 / £109
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	490,511 / 101	694,121 / 118	700,000 / 325	700,000 / 109
RECEIVED (TOTAL)	431,900 / 88·8	605,511 / 103	330,000 / 153	640,000 / 100
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	431,900 / 88·8	605,511 / 103	330,000 / 153	640,000 / 100
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	58,611 / 12·1	88,610 / 15·1	370,000 / 172	60,000 / 9·37
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	58,611 / 12·1	88,610 / 15·1	370,000 / 172	60,000 / 9·37
REPAID (TOTAL)	36,298 / 7·47	49,233 / 8·37	8,000 / 3·72	11,500 / 1·80
RESERVE OR SINKING FUND	nil / —	nil / —	15,729 / 7·32	18,170 / 2·84
DEPRECIATION FUND	35,993[h] / 7·41	13,696[h] / 2·33		4,378 / 0·684
EXPENDED (TOTAL)	493,716 / 102	641,822 / 109	339,783[a] / 158	657,040 / 103
Lands and buildings	125,202 / 25·8	132,368 / 22·5	77,606[a] / 36·1	140,749[d] / 22·0
Plant	138,417 / 28·5	169,225 / 28·8	80,345[a] / 37·3	189,020 / 29·5
Mains	230,097 / 47·3	338,890 / 57·7	181,655[a] / 84·5	326,722 / 51·1
Miscellaneous	— / —	1,333 / 0·227	177[a] / 0·082	550 / 0·086
BALANCE OF CAPITAL ACCOUNT	−61,816[a] / −12·7	−36,311[a] / −6·18	−9,783[b] / −4·55	−17,040[b] / −2·66
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£71,905 / 3·615d.	£86,241 / 3·259d.	£44,141 / 3·750d.	£59,762 / 3·373d.
Revenue from supply	69,246 / 3·483d.	85,589 / 3·233d.	41,639 / 3·539d.	55,471 / 3·132d.
„ meters, &c.	2,235 / 0·112d.	184 / 0·007d.	— / —	— / —
„ public lighting	393[b] / 0·020d.	364 / 0·014d.	2,502 / 0·213d.	4,291 / 0·242d.
„ sale of lamps, &c.	— / —	— / —	— / —	— / —
„ miscellaneous sources	32 / 0·002d.	104 / 0·004d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£30,970 / 1·558d.	£49,848 / 1·832d.	£24,013 / 2·040d.	£35,000 / 1·976d.
WORKS COSTS	22,504 / 1·132d.	35,197 / 1·329d.	17,100 / 1·453d.	27,132 / 1·531d.
Generation of electricity	*19,131 / 0·962d.*	*23,103[i] / 0·873d.*	*13,141 / 1·117d.*	*21,001 / 1·186d.*
Fuel (including cartage, &c.)	8,251 / 0·415d.	10,376 / 0·392d.	6,401 / 0·544d.	12,997 / 0·734d.
Oil, waste, water, stores	3,305 / 0·166d.	3,208 / 0·121d.	701 / 0·060d.	1,073 / 0·061d.
Wages at station	3,295 / 0·166d.	4,127 / 0·156d.	3,384 / 0·288d.	4,859 / 0·274d.
Repairs and maintenance at station	3,774 / 0·190d.	4,303 / 0·162d.	2,656 / 0·226d.	2,073 / 0·117d.
Distribution of electricity	*3,372 / 0·170d.*	*13,094 / 0·457d.*	*2,816 / 0·239d.*	*5,007 / 0·283d.*
Wages, &c.	1,088 / 0·055d.	2,226 / 0·084d.	2,816 / 0·239d.	5,007 / 0·283d.
Repairs, renewals of mains, &c.	2,284 / 0·115d.	9,868 / 0·373d.		
Public lighting	— / —	— / —	*1,143 / 0·097d.*	*1,124 / 0·064d.*
Attendance	— / —	— / —	1,143 / 0·097d.	1,124 / 0·064d.
Renewals	— / —	— / —		
MANAGEMENT AND PROPERTY CHARGES	8,466 / 0·426d.	14,651 / 0·554d.	6,913 / 0·587d.	7,867 / 0·441d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*2,383 / 0·170d.*	*6,564 / 0·248d.*	*4,129 / 0·351d.*	*4,549 / 0·257d.*
Management	*6,083 / 0·306d.*	*8,087 / 0·305d.*	*2,784 / 0·237d.*	*3,318 / 0·187d.*
Salaries	3,653 / 0·184d.	4,856 / 0·183d.	1,158 / 0·093d.	1,564 / 0·088d.
Stationery, &c.	615 / 0·031d.	862 / 0·033d.	460 / 0·040d.	467 / 0·026d.
Establishment charges	991 / 0·050d.	1,093 / 0·041d.	1,160 / 0·099d.	1,287 / 0·073d.
Law charges, &c.	824[c] / 0·041d.	1,276[j] / 0·048d.	— / —	— / —
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£40,935 / 9·61%	£36,393 / 6·41%	£20,128 / 7·63%[f]	£24,762 / 4·76%
Sum carried to Depreciation Fund	6,533 / 1·53%	1,193 / 0·210%	7,521 / 2·85%[f]	3,222 / 0·619%
Sum carried to Reserve or Sinking Fund	10,377 / 2·44%	12,935 / 2·28%	5,161 / 1·95%[f]	6,285 / 1·21%
Net interest on loans (incl. Debenture charges)	10,025 / 2·35%	14,265 / 2·51%	7,445 / 2·82%[f]	15,256 / 2·93%
BALANCE FROM LAST ACCOUNT	nil / —	2,000 / 0·352%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	14,000[d] / 3·29%	10,000[k] / 1·76%	— / —	— / —
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	43·1%	57·8%	51·4%	58·6%
Expenditure per kilowatt capacity	£6. 7s. 6d.	£8. 9s. 7d.	£11. 3s. 2d.	£5. 9s. 5d.
REVENUE PER KILOWATT CAPACITY	£14. 16s. 0d.	£14. 13s. 2d.	£20. 10s. 5d.	£9. 6s. 7d.
Expenditure per 8-c.p. lamp capacity	4s. 1d.	5s. 5d.	7s. 1¾d.	3s. 6d.
REVENUE PER 8-C.P. LAMP CAPACITY	9s. 5½d.	9s. 4½d.	13s. 1½d.	5s. 11½d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 9½d.	5s. 11¼d.	4s. 7½d.	4s. 11¼d.
Price charged for lighting, per unit	5d.[e]	5d.[l]	6d. to 2d.[c]	6d. to 1½d.[c]
Price charged for power, per unit	1½d.[f]	5d.[m]		
Price charged for public lighting	2d. per unit.	2d. per unit.	—	—

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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AN ELECTRICAL HYPOTHESIS OF VITAL FUNCTIONS.

It is several years since Prof. J. CHUNDER BOSE, of Calcutta University, delighted and surprised English physicists, at a meeting of the British Association, by an exhibition of the neat and compact Hertzian wave apparatus which he had designed, and by his rehearsal of the principal experiments in optics with Hertzian waves. What investigators in Europe had been attempting with crude and clumsy apparatus, Prof. BOSE had accomplished in his laboratory at Calcutta with a pretty little set of instruments occupying no more space than an ordinary optical bench. Indeed, he carried the optical analogy experimentally much further than had been attempted in this country; and by his investigation of the properties of various substances in regard to Hertzian waves, he greatly extended the study of optical phenomena in the region of non-luminous long waves to which the Hertzian waves belong. Since that time both the scientific and the practical bearing of the Hertzian wave has been closely studied by numerous workers. Wireless telegraphy has leaped from the laboratory into the arena of public commerce and civilised arts; and the so-called "coherer"—in spite of its unhappy christening—has become an article of everyday use in the physical laboratory, and one of considerable and increasing importance in applied science. Probably on the scientific side no element of wireless telegraph apparatus has received more careful study than has the coherer; while, in the domain of practical wireless telegraphy, it has been, comparatively speaking, neglected. And it is certain that no physicist has devoted more time and attention to this item, nor has anyone educed more systematic and comprehensive information regarding its properties and physical laws, than has Prof. BOSE. The coherer has been the absorbing study of the past few years of his life; and, we may add, we trust he may enjoy many more years in which to push his researches further into the rich fields of still undiscovered truths, and to clear away some of the inspiring mysteries suggested by the extraordinary facts he has already succeeded in establishing. Viewed in the light of Prof. BOSE's researches, recent and of earlier date, physics and chemistry—even,

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perhaps, biology—appear to be on the eve of a generalisation of unusual importance.

From time to time we have acquainted our readers with the progress of Prof. Bose's researches. We have now to invite their attention to an informative and profoundly suggestive Paper read by him at the recent meeting of the British Association at Bradford. In this Paper, which we reprint elsewhere, almost the latest stages in his systematic lines of research are recorded, and hypotheses are advanced and backed up by such apparently weighty evidence as must astonish physicists and biologists alike, and give them pause. Let us not, however, anticipate the astonishment of our readers, but proceed first to summarise the train of reasoning by which Prof. Bose seeks to explain half or more of physico-chemistry and scarcely less of the science of vital functions. Electric stimulus, or, rather, the behaviour of any substance under electric stimulus—is the key to the whole problem. Electric stimulus is the stress; the variously manifested behaviour is the strain which that stress produces. Within limits the ordinary law of elasticity holds, the ratio of stress to strain being constant; but, according to the physical properties of the substance strained, fatigue occurs when the stress is excessive. Recovery, either automatic or induced, may occur in specified conditions. We are to interpret these actions on a scale molecular, or atomic, or perhaps even sub-atomic, in magnitude. The electric stimulus directly actuates matter on this scale, and calls into effect a change of property or function which produces the corresponding outward phenomenon. Thus, in the iron-filings coherer the Hertzian wave generates an electric stimulus within the molecules of iron in the region where the waves act; and if the stimulus is of sufficient strength it will so stress the molecules that a decrease in the electrical resistance will ensue. But it is not essential to have actual filings; the iron may be continuous and homogeneous, and still the action will be the same, in so far as the metal is reached by the external waves. With some materials the stimulus produces a decrease of resistance; with others the change is just the reverse; and in many cases the direction of the change is determined by the vigour of the stimulus. Moreover, some materials under a definite stimulus quickly recover their normal state; others recover slowly, in similar circumstances, but may behave differently under stronger stimuli; others, again, may be "poisoned" by the injection into them of foreign materials, the effect of which is to convert them from quickly-recovering to non-recovering substances. Heat and mechanical vibration are effective in assisting recovery from fatigue, whether of the over-stimulated coherer or of the over-strained muscle or nerve. Indeed, the parallel between the behaviour of a coherer in an electric circuit and the behaviour of living tissue in its ordinary physiological functions is remarkably close; it is so close as to be suggestive of a common explanation. Prof. Bose indicates such an explanation in the electric stress-strain hypothesis, regarding vital functions as merely the manifestations of an electric stimulus in a substance (tissue) acting molecularly or atomically in the same manner as a so-called coherer does. We believe that Profs. Oliver Lodge and F. Gotch were the first to suggest a coherer theory of vision, propounding that the elements of the retina and optic nerve—acting in conjunction with the brain—constitute a number of coherer circuits, the luminous image on the retina corresponding in its action to the impinging Hertzian waves in an ordinary coherer. Prof. Bose carries this hypothesis much further, for he extends it into the domain of every form of differentiated living tissue. If his hypothesis is correct, not merely sight and the rest of our five senses, but also every functional change in every portion of living tissue is explicable in the same manner. It is a stupendous proposition for the physiologist. Will he accept it?

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Standard Polyphase Apparatus and Systems. By Maurice A. Oudin. (London: Sampson Low, Marston & Co. (Ltd.), 1900.)

This is a book well deserving of popularity amongst those who are interested in the electrical transmission of power. The work throughout has the characteristics of over condensation—a good quality merging into a bad; and has evidently been written from a breadth of view and judgment not commonly associated with the essentially practical nature of the information given. Of necessity, in attempting to deal with such a subject in a volume of this size the author has had to limit himself rigidly to descriptions of plant and systems, with the result that the book is rather more a convenient assemblage of facts, and contains information hitherto only available (by those conversant with the theory of the subject) from manufacturers' catalogues and descriptions of transmission plants in periodicals. Chapters XII. and XIV. are exceptions in this respect, however, in that they are devoted, the former to an excellent discussion of the considerations governing the choice of frequency, the latter to the calculation of transmission lines. The title of the book is, therefore, appropriated and naturally in consequence of the condensed nature of the treatment of the subject, its practical nature, but also because its writer is, too frequently we must say, somewhat careless in his terms of expression, it is necessary to warn the student from its perusal until he is perfectly familiar with the principles and theory of alternating and polyphase currents. To the engineering student who has thoroughly mastered the theory relating to this branch of electrical engineering a work like this is invaluable, as it serves to furnish him with a truer practical idea of the proportionate importance of various phenomena, and of the extent to which they enter into and influence practical work.

It is rather a pity that the author did not deal more adequately with the subject of resonance. Notwithstanding that in polyphase and transmission work generally the use of low frequencies is general, yet the E.M F. wave is generally rich in the higher harmonics, and these are apt to assert themselves on long transmission lines in an embarrassing way. To us in this relatively humid climate the author's sanguine remarks about the extended use of glass as the material for line insulators for pressures even up to 40,000 volts seem very strange. We notice, too, that oil insulators for the line are not referred to at all, so completely do they appear to have dropped out of use in America.

We have little but praise for the whole of the book after Chapter I., which deals with the definitions of alternate current terms. Careless expressions, such as "voltage drop due to power factor," rather mar the first two or three chapters, though the *matter* given is most useful and condensed. The author uses the term "shunt" as applied to the field windings of generators, motors and rotary converters in an incorrect and unusual sense. Throughout the book the field windings carrying current supplied by a separate exciter are termed "shunt" windings—a machine separately excited being referred to as "shunt wound." We must also take exception to the definition of the term "regulation" on p. 42, viz., ". . . the now commonly accepted definition is the percentage rise of the voltage when full non-inductive load is thrown off the generator, speed and the field excitation remaining constant."

The subject dealt with is one singularly difficult of intelligible treatment without the constant use of mathematical symbols and expressions. Although, however, there is comparatively little of these, once the student has learnt the author's language he will find some of the more difficult points treated with unusual lucidity of expression.

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THE BRITISH ASSOCIATION MEETING AT BRADFORD.

Thursday, Sept. 6.

The presidential address to Section A was delivered by Dr. Joseph Larmor, F.R.S., Pres. C.P.S. We complete our reprint of it this week. Prof. G. F. FitzGerald then communicated a note on M. Cremieu's experiment in search of a magnetic effect of a moving electric charge. Contrary to Rowland's effect, M. Cremieu's experiments led to negative results. The object of the note was to point out that both results might be correct, since the methods were different, Rowland having looked for a direct effect upon a magnet, whilst Cremieu looked for an induction current in a wire. The absence of any effect in the latter case Prof. FitzGerald suggested might be due to omission of some term in our electro-dynamic equations. Prof. A. Gray stated that he had already commenced a research upon the point in question. A lengthy discussion ensued.

Dr. F. T. Trouton, F.R.S., then read a Paper on "The Creeping of Liquids and the Surface Tension of Mixtures." He said that pure liquids did not creep, but only mixtures. Ether and benzene increased the rate of creeping. The more volatile and higher the surface tension the less ought the effect to be; but he observed that the opposite took place, and that their effect was to increase the creeping. The rate of creeping over zinc is three times as great as that over any other substance.

Prof. FitzGerald then read the report of the Committee on Radiation in a Magnetic Field, and stated that the work in which the late Prof. Thomas Preston was engaged had been taken up by Mr. W. E. Thrift. He proposed that copies of Preston's photographs should be produced on an enlarged scale, especially the iron spectrum, which showed doublets, triplets, quartets, and sextets, and hoped that by more careful analysis they might be more clearly understood.

Mr. H. Ramage read an interesting and important Paper on "A Method of Investigating Correspondences Between Spectra"; which was followed by a Paper by Mr. G. J. Burch, F.R.S., "On an Experiment on Simultaneous Contrast." Mr. J. W. Gifford read a Paper on a "Quartz-Calcite Symmetrical Doublet."

In the afternoon a reception was held at the Technical College, when a Paper was read by Mr. Arthur Dufton and Mr. Walter M. Gardner on the "Production of an Artificial Light of the same character as Sunlight," forming part of the proceedings of Section A. They gave a very pretty exhibition in contrasts of colours.

Friday, Sept. 7.

In Section A the President, Dr. J. Larmor, read a Paper on the "Dynamical Statistics of Gas Theory, illustrated by Meteor Swarms and Optical Rays," which was followed by one on the "Partition of Molecular Energy," by Prof. G. H. Bryan, F.R.S. A lengthy discussion followed, in which Prof. G. F. FitzGerald pointed out that the energy of translation of molecules ought ultimately to be frittered away by their collisions into higher and higher vibrations, and that if they behaved like billiard balls they ought to lose all their energy in 15 minutes. But this does not happen, and the kinetic theory does not explain why. The radiation from radio-active substances may be the result of its happening to some extent in some bodies, but why it should take place only in some bodies and then only very slightly is as great a mystery as if it did not take place at all. No satisfactory explanation has yet been given of how radiant energy is converted into energy of translation of molecules.

Prof. W. B. Morton gave a note on the "Propagation of Electric Waves along Parallel Wires," and Dr. S. H. Burbury, F.R.S., "On the Vector Potential of Electric Currents in a Field where Disturbances are Propagated with Finite Velocity."

Saturday, Sept. 8.

In Section A reports were presented of the Committee on the most suitable Method of Determining the Magnetic Force on Board Ship; and of the Committee on the Size of Pages of Scientific Periodicals. Sir William Preece gave an account of his experiments on wireless telephony, between the islands or rocks known as the Skerries and the mainland of Anglesey; and also more recently between Rathlin Island, on the north coast of Ireland, and the mainland. He explained that wireless telephony across the sea is now a practical and commercial system. The preliminary experiments show that telephonic communication has been maintained under similar conditions as Morse signalling between parallel wires at a distance of 8 miles, and he suggested that signalling between ships may be effected by means of a circuit formed of copper wire terminating at each end of the ship in the sea, and passing over the masts, using simple telephones.

Mr. C. E. S. Phillips read a Paper on "The Apparent Emission of Cathode Rays from an Electrode at Zero Potential." He showed that the green patches which often appear on the surface of the walls of a Röntgen-ray bulb while a discharge is passing are due to irregularities on the surface of the cathode, as they could be made to alter their position when a movable cathode was used, and, moreover, that there was strong evidence for regarding an emission of gas in jets from the electrodes to take place. Prof. F. G. Baily read a Paper on a "Lecture-room Volt-and-Ammeter," which was followed by a Paper by Mr. J. B. B. Burke on "The Phosphorescent Glow in Gases," proving that the glow produced by the passage of a discharge through a gas consisted of unelectrified particles which, as they moved through the gas, produced conductivity, but were quickly destroyed in the ionised gas. The Paper contained an account of a series of experiments to investigate various properties of the glow. A discussion of some length ensued. Prof. J. C. Bose read a Paper "On the Similarity of the Effect of Electrical Stimulus on Inorganic and Living Substances."

Sections B and G did not meet.

Monday, Sept. 10.

Section A divided into two parts—for mathematics and meteorology. There were no Papers read which had any special bearing on electricity.

In Section G several interesting Papers were read. The first was by Mr. J. G. W. Aldridge, "On the Automobile for Electric Street Traction." This was followed by a communication from Mr. A. Mallock, "On Measurement of the Tractive Force, Resistance and Acceleration of Trains," in which he described some experiments recently made on electric and other railways, the object of the experiments being to determine the acceleration, tractive force, and running resistance to which the trains are subject. A short pendulum was used, the free vibrations of which are considerably damped. This is suspended on the moving body. The angle which it makes with the vertical is a measure of the acceleration at any instant, and variations in the angle are recorded on a uniformly moving paper, on which also are recorded the revolutions of one of the wheels of the carriage, by which means a measure is obtained of the speed and acceleration of the carriage. From the speed and power supplied, together with the pendulum observations, the resistance to and efficiency of electric and other motor vehicles can be easily obtained.

Sir W. H. Preece, F.R.S., read a Paper on "The Manchester and Liverpool Express Railway." It dealt with the mono-rail line which has been projected by Mr. Behr between Manchester and Liverpool for express passenger accommodation. Mr. F. J. Behr then read a Paper on "Brakes and Signals," which was a continuation of the last. Mr. Alfred H. Gibbings read a Paper on "The Design and Location of Electric Generating Stations," and Mr. T. Barker made a communication on a "Combination Integrating Wattmeter and Maximum Demand Indicator." Abstracts of all these Papers will appear in our columns.

Tuesday, Sept. 11.

In Section A a lengthy discussion on "Ions" was opened by Prof. G. F. FitzGerald. He considered that "conductivity" was a better word than "ionisation." The "conductivity" in liquids was different from that in gases, for in gases there is

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evidence of masses smaller than atoms, whereas there is no evidence of such in liquids. Then conductivity of liquids is connected with many other properties—their solution, chemical affinity, the power of coagulation, osmotic pressure (which is related to the freezing point and boiling point). We have no satisfactory theory of what is going on in ionisation. There are many difficulties in the ordinary theories of ionisation, and there is no consistent explanation of (1) the instability of ions; (2) the source of energy of ions for dissociation; (3) the migration of ions with different velocities—some move faster than others. Prof. FitzGerald said these were difficulties which required to be removed. German physicists were contented with the term "ionisation." But hydrogen and chlorine when separated wander about without any tendency to re-combine. This is a state dynamically impossible, and until we get a dynamical explanation it is better to acknowledge our ignorance. As regards the conductivity of gases very little was known until the conductivity of gases produced by X-rays, &c., was studied. For a long time it was supposed that dust played an important part in the conductivity of gases, but this has now been refuted.

The term "ionisation" should, he thought, be used only to denote the presence of charged atoms, and he suggested the word "electronisation" for the conducting state of a gas in which there were five electrons. Lenard rays, Becquerel rays, Röntgen rays, and strong currents, give electronisation. But it is probable that both electronisation and ionisation take place in a gas, and that there are electrons, atoms and groups of molecules with a charge which co-operates in the conductivity of a gas. An electron appears to possess the power of carrying a group of molecules after it, like a mother with a dozen children as she tries to make her way through a crowded thoroughfare. Prof. FitzGerald then maintained that the small carriers of electricity or corpuscles, smaller than atoms, which Prof. J. J. Thomson had found to exist in a conducting gas, were electrons, as they have the same mass as the oscillating changes in an atom to which the vibrations of light are due, as is shown by the Zeeman effect, and the fact that the mass of these free carriers of electricity is the same in all conducting gases. He maintained, however, that there was very little evidence to justify the assumption that atoms are made up of electrons, but the best evidence in its favour is that it accounts for the change in the size of objects moving through the ether, which he believed was the correct explanation of Michelson's experiments, according to which the earth's diameter is altered by 4cm. in consequence of its motion through the ether.

The following points require an answer:—

1. What is the cause of ionisation, and what is its nature? Why do not ions exist in pairs?
2. What is the source of the energy that keeps ions apart?
3. Ionisation does not obey the law of dissociation. With sufficient dilution the law does not hold.
4. Different ions move with different velocities.
5. What is the nature of the double layer? Why do some substances attract positive electricity and others negative?
6. Ionisation in gases and liquids not the same.
7. Do electrons gravitate, and have they a material nucleus?
8. The theory of magnetism and nature of paramagnetism.

The President, Dr. J. Larmor, suggested that the high specific inductive capacity of water might be due to a large electric moment in the molecules as the positive and negative ions may be far apart. He also remarked that he thought atoms could not be broken up, but that what happened during conductivity is an interchange of electrons, and that the same effect took place at the electrodes, whether in gases or in liquids.

Prof. H. E. Armstrong said that the chemist regarded an atom as a sacred structure, and would not admit that it could be broken up, but he was ready to admit that the displacement of electrons was quite possible. Stability is what marks an atom; it has an assymetric structure and a definite combining power. He regarded conductivity in gases as being due to the same process as in liquids. He believed that the conductivity of gases was dependent on the presence of vapours; for Dewar had shown that cooling a vacuum tube destroyed the conductivity of the gas within, showing conclusively, he thought, that the vapour thus removed was essential to the passage of electricity through the gas. Neither is a liquid *per se* an electrolyte. Oxidation does not take place except in the presence of conducting water.

A manuscript was read from Mr. Whetham in which he maintained that ions are handed on from molecule to molecule.

Principal Oliver Lodge pointed out that Faraday's law for liquids implied that electrons were not separated from ions. In gases, he thought, there were two processes, but whether a gas conducted electrolytically or not he considered had not yet been proved. He remarked further that though ions move with different velocities, electricity goes at the same rate. He added that he hoped the electric theory of matter would turn out correct.

Principal Glazebrook asked what produced the first electron which led to the interchange in atoms. Mr. W. J. Pope also made some suggestive remarks.

Dr. H. C. Pocklington then read a Paper on "The Radiation of a Black Body on the Electromagnetic Theory of Light."

Wednesday, Sept. 12.

In Section A, the report of the Electrical Standards committee was read by Mr. R. T. Glazebrook. The question of the selection of a wire for the construction of the standards is still under the consideration of the committee. During the year the resistance coils and other apparatus belonging to the committee have been removed to Richmond. It is interesting to note that the case containing the original coils of the Association bears the words, "To be deposited at Kew." After many wanderings these coils, of memorable fame, have at last reached their home and resting place—the National Physical Laboratory. Mr. E. H. Griffiths, F.R.S., described a form of Wheatstone Bridge, and Mr. R. S. Whipple gave a note on "An Improved Standard Resistance Coil," after which Mr. G. E. Petavel described some experiments on the explosive pressures of gaseous mixtures, which were an extension of the work originally done by Bunsen at atmospheric pressures to initial pressures of 100 or 200 atmospheres. It was proved that compressed gases had a very high *thermal* conductivity. Mr. Petavel proposes to investigate the phenomenon of dissociation at very high pressures.

The President (Dr. J. Larmor) then read a Paper "On the Relation of Radiation to Temperature," and emphasised the fact that Balfour-Stewart was the co-discoverer with Kirchhoff of the law of the equality of the radiation and absorption of bodies surrounded by others at the same temperature, and therefore in a steady state.

A Paper, by Dr. S. P. Langley, "On the Infra-red Solar Spectrum," was then read by the recorder (Prof. W. Watson). It was a continuation of a communication made six years ago by Dr. Langley himself to the British Association at Oxford. That elegant piece of research has since been diligently pursued at the Smithsonian Institute. Only the results obtained were given. The apparatus used in this as in the preceding investigation had not, it was stated, as yet been fully described.

The monumental work which Dr. Langley has, without either haste or pause, like all true scientists, successfully carried out during the last 10 years with the bolometer, beginning—if our memory serves us rightly—in that beautiful investigation of the radiation from glow-worms and fire-flies, which proved that all the energy that such creatures emit, small though it be, is always luminous, and then, leading up as that research has done, like a stepping-stone to the careful study of the invisible spectrum of the sun in the infra-red, has we believe, though it came last, not been the least important, but possibly the most lasting, of the many valuable contributions which have helped, some to a greater others to a less degree, to maintain that high standard which Section A has always held amongst its sister sections. But it is to the President, Dr. Larmor, however, that the particularly brilliant success of this section is chiefly

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due. We can call to mind many accomplished presidents and many successful meetings, but we cannot recall one that has left more pleasing memories than the one over which Dr. Larmor has presided with so much ability, with so much grace and dignity. Throughout the whole proceedings one quality shone out before every other, great as no doubt these were—his mind was sincere and open.

LIST OF THE ELECTRICAL PAPERS READ AT THE BRITISH ASSOCIATION MEETING AT BRADFORD.

The following is a complete list of the electrical Papers read and reports presented at the Bradford meeting of the British Association, September 6 to September 13, 1900:—

SECTION A.—*Mathematical and Physical Science.*

"Note on M. Cremieu's Experiment," by Prof. G. F. Fitzgerald, F.R.S.
"On the Creeping of Liquids and the Surface Tension of Mixtures," by Dr. F. T. Trouton, F.R.S.
"An Experiment on Simultaneous Contrast," by G. J. Burch, F.R.S.
"The Production of an Artificial Light of the same Character as Daylight," by A. Dufton and W. M. Gardner.
"On the Partition of Molecular Energy," by Prof. G. H. Bryan, F.R.S.
Note "On the Propagation of Electric Waves along Parallel Wires," by Prof. W. B. Morton.
"On the Vector Potential of Electric Currents in a Field where Disturbances are propagated with Finite Velocity," by Dr. S. H. Burbury, F.R.S.
"On the Application of the Electric Telegraph to the Furtherance of Eclipse Research," by Prof. David P. Todd.
"On the Similarity of the Effect of Electrical Stimulus on Inorganic and on Living Substances," by Prof. J. C. Bose.
"Wireless Telegraphy," by Sir William Preece, F.R.S.
"On the Apparent Emission of Cathode Rays from an Electrode at Zero Potential," by C. E. S. Phillips.
"On Volta-Electromotive Force of Alloys," by Dr. G. Gore, F.R.S.
"On a Lecture Room Volt-and-Ammeter," by Prof. F. G. Baily.
"On the Phosphorescent Glow in Gases," by J. B. B. Burke.
"A Form of Wheatstone Bridge," by E. H. Griffiths, F.R.S.
"Note on an Improved Standard Resistance Coil," by R. S. Whipple.
"Note on the Explosive Pressures of Gases," by G. E. Petavel.
"On the Relation of Radiation to Temperature," by Dr. J. Larmor, F.R.S.
Report of Committee on Radiation in a Magnetic Field.
Report of the Committee on the most suitable Method of Determining the Magnetic Force on board ship.
Report of the Committee on the Sizes of Pages of Scientific Periodicals.
Report of the Electrical Standards Committee.

SECTION B.—*Chemistry.*

"On the Specific Heat of Gases at Temperatures up to 400deg.," by H. B. Dixon, F.R.S., and F. W. Rixon, B.Sc.
"On the Crystalline Structure of Metals," by Prof. J. A. Ewing, F.R.S., and W. Rosenhain, B.A.
"On the Electric Conductivity of the Alloys of Iron," by Prof. Barrett, F.R.S.
"On some New Chemical Compounds discovered by the Use of the Electric Furnace," by C. S. Bradley.
Report of the Committee on the Teaching of Science in Elementary Schools.
Report of the Committee on the Nature of Alloys.
Report of the Committee on the Electrolytic Methods of Quantitative Analysis.

SECTION G.—*Mechanical Science.*

"Resistance of Road Vehicles to Traction," by Prof. Hele Shaw, F.R.S.
"Power Generation—Comparative cost by the Steam Engine, Water Turbine, and Gas Engine," by J. B. C. Kershaw.
"The Automobile for Electric Street Traction," by J. G. W. Aldridge.
"The Manchester and Liverpool Express Railway," by Sir W. H. Preece, F.R.S.
"The Manchester and Liverpool Express Railway—Signals and Brakes," by F. J. Behr.
"The Construction of Large Dynamos, as exemplified at the Paris Exhibition," by Prof. S. P. Thompson, F.R.S.
"Recent Tramway Construction," by W. Dawson.
"Measurement of the Tractive Force, Resistance, and Acceleration of Trains," by A. Mallock.
"On a Combination Integrating Wattmeter and Maximum Demand Indicator," by T. Barker and Prof. Ewing, F.R.S.
"The Design and Location of Electric Generating Stations," by A. H. Gibbings.

MISCELLANEOUS SECTIONS.

"Electrical Changes in Mammalian Nerve" (Report) (Section D), by Dr. McDonald.
"Municipal Trading," by Arthur Priestman. (Section F.)
"Recent Changes affecting the Legal and Financial Position of Local Authorities in England," by F. W. Hirst. (Section F.)

DR. JOSEPH LARMOR'S PRESIDENTIAL ADDRESS TO SECTION A OF THE BRITISH ASSOCIATION AT BRADFORD.*

(*Concluded from page 736*).

Let us now return to the general question whether our definition of a dynamical system may not be too wide. As a case in point, the single principle of action has been shown to provide a definite and sufficient basis for electro-dynamics; yet when, for example, one armature of an electric motor pulls the other after it without material contact, and so transmits mechanical power, no connection between them is indicated by the principle such as could by virtue of internal stress transmit the pull. The essential feature of the transmission of a pull by stress across a medium is that each element of volume of the medium acts by itself, independently of the other elements. The stress excited in any element depends on the strain or other displacement occurring in that element alone; and the mechanical effect that is transmitted is considered as an extraneous force applied at one place in the medium, and passed on from element to element through these internal pressures and tractions until it reaches another place. We have, however, to consider two atomic electric charges as being themselves some kind of strain configurations in the æther; each of them already involves an atmosphere of strain in the surrounding æther which is part of its essence, and cannot be considered apart from it; each of them essentially pervades the entire space, though on account of its invariable character we consider it as a unit. Thus we appear to be debarred from imagining the æther to act as an elastic connection which is merely the agent of transmission of a pull from the one nucleus to the other, because there are already stresses belonging to and constituting an intrinsic part of the terminal electrons, which are distributed all along the medium. Our action criterion of a dynamical system, in fact, allows us to reason about an electron as a single thing, notwithstanding that its field of energy is spread over the whole medium; it is only in material solid bodies, and in problems in which the actual sphere of physical action of the molecule is small compared with the smallest element of volume that our analysis considers, that the familiar idea of transmission of force by simple stress can apply. Whatever view may ultimately commend itself, this question is one that urgently demands decision. A very large amount of effort has been expended by Maxwell, Helmholtz, Heaviside, Hertz, and other authorities in the attempt to express the mechanical phenomena of electrical action in terms of a transmitting stress. The analytical results up to a certain point have been promising, most strikingly so at the beginning, when Maxwell established the mathematical validity of the way in which Faraday was accustomed to represent to himself the mechanical interactions across space, in terms of a tension along the lines of force equilibrated by an equal pressure preventing their expansion sideways. According to the views here developed, that ideal is an impossible one; if this could be established to general satisfaction the field of theoretical discussion would be much simplified.

This view that the atom of matter is, so far as regards physical actions of the nature of a structure in the æther involving an atmosphere of æthereal strain all around it, not a small body which exerts direct actions at a distance on other atoms according to extraneous laws of force, was practically foreign to the eighteenth century, when mathematical physics was modelled on the Newtonian astronomy and dominated by its splendid success. The scheme of material dynamics, as finally compactly systematised by Lagrange, had therefore no direct relation to such a view, although it has proved wide enough to include it. The remark has often been made that it is probably owing to Faraday's mathematical instinct, combined with his want of acquaintance with the existing analysis, that the modern theory of the æther obtained a start from the electric side. Through his teaching and the weight of his authority, the notion of two electric currents exerting their mutual forces by means of an intervening medium, instead of by direct attraction across space, was at an early period firmly grasped in this country. In 1845 Lord Kelvin was already mathematically formulating, with most suggestive success, continuous elastic connections, by whose strain the fields of activity of electric currents or of electric distributions could be illustrated; while the exposition of Maxwell's interconnected scheme, in the earlier form in which it relied on concrete models of the electric action, goes back almost to 1860. Corresponding to the two physical ideals of isolated atoms exerting attraction at a distance, and atoms operating by atmospheres of æthereal strain, there are, as already indicated, two different developments of dynamical theory. The original Newtonian equations of motion determined the course of a system by expressing the rates at which the velocity of each of its small parts or elements is changing. This method is still fully applicable to those problems of gravitational astronomy in which dynamical explanation was first successful on a grand scale, the planets being treated as point-masses, each subject to the gravitational attraction of the other bodies. But the more recent development of the dynamics of complex systems depends on

* Delivered September 6, 1900.

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the fact that analysis has been able to reduce within manageable limits the number of varying quantities whose course is to be explicitly traced, through taking advantage of those internal relations of the parts of the system that are invariable, either geometrically or dynamically. Thus, to take the simplest case, the dynamics of a solid body can be confined to a discussion of its three components of translation and its three components of rotation, instead of the motion of each element of its mass. With the number of independent co-ordinates thus diminished, when the initial state of the motion is specified the subsequent course of the complete system can be traced; but the course of the changes in any part of it can only be treated in relation to the motion of the system as a whole. It is just this mode of treatment of a system as a whole that is the main characteristic of modern physical analysis. The way in which Maxwell analysed the interactions of a system of linear electric currents, previously treated as if each were made up of small independent pieces or elements, and accumulated the evidence that they formed a single dynamical system, is a trenchant example. The interactions of vortices in fluid form a very similar problem, which is of special note, in that the constitution of the system is there completely known in advance, so that the two modes of dynamical exposition can be compared. In this case the older method forms independent equations for the motion of each material element of the fluid, and so requires the introduction of the stress—here the fluid pressure—by which dynamical effect is passed on to it from the surrounding elements: it corresponds to a method of contact action. But Helmholtz opened up new ground in the abstract dynamics of continuous media when he recognised (after Stokes) that, if the distribution of the velocity of spin at those places in the fluid where the motion is vortical be assigned, the motion in every part of the fluid is therein kinematically involved. This, combined with the theorem of Laggrange and Cauchy, that the spin is always confined to the same portions of the fluid, formed a starting point for his theory of vortices, which shows how the subsequent course of the motion can be ascertained without consideration of pressure or other stress.

The recognition of the permanent state of motion constituting a vortex ring as a determining agent as regards the future course of the system was in fact justly considered by Helmholtz as one of his greatest achievements. The principle had entirely eluded the attention of Lagrange and Cauchy and Stokes, who were the pioneers in this fundamental branch of dynamics, and had virtually prepared all the necessary analytical material for Helmholtz's use. The main import of this advance lay, not in the assistance which it afforded to the development of the complete solution of special problems in fluid motion, but in the fact that it constituted the discovery of the types of permanent motion of the system, which could combine and interact with each other without losing their individuality,* though each of them pervaded the whole field. This rendered possible an entirely new mode of treatment; and mathematicians who were accustomed, as in astronomy, to aim directly at the determination of all the details of the special case of motion, were occasionally slow to apprehend the advantages of a procedure which stopped at formulating a description of the nature of the interaction between various typical groups of motions into which the whole disturbance could be resolved.

The new train of ideas introduced into physics by Faraday was thus consolidated and emphasised by Helmholtz's investigations of 1858 in the special domain of hydro-dynamics. In illustration let us consider the fluid medium to be pervaded by permanent vortices circulating round solid rings as cores: the older method of analysis would form equations of motion for each element of the fluid, involving the fluid pressure, and by their integration would determine the distribution of pressure on each solid ring, and thence the way it moves. This method is hardly feasible even in the simplest cases. The natural plan is to make use of existing simplifications by regarding each vortex as a permanent reality, and directly attacking the problem of its interactions with the other vortices. The energy of the fluid arising from the vortex motion can be expressed in terms of the positions and strengths of the vortices alone; and then the principle of action, in the generalised form which includes steady motional configurations as well as constant material configurations, affords a method of deducing the motions of the cores and the interactions between them. If the cores are thin they in fact interact mechanically, as Lord Kelvin and Kirchhoff proved, in the same manner as linear electric currents would do, though the impulse thence derived towards a direct hydro-kinetic explanation of electromagnetics was damped by the fact that repulsion and attraction have to be interchanged in the analogy. The conception of vortices, once it has been arrived at, forms the natural physical basis of investigation, although the older method of determining a distribution of pressure-stress throughout the fluid and examining how it affects the cores is still possible; that stress, however, is not simply transmitted, as it has to maintain the changes of velocity of the various portion of the fluid. But if the vortices have no solid cores we are at a loss to know where even this pressure can be considered as applied to them; if we follow up the stress we lose the vortex; yet a fluid vortex can, nevertheless, illustrate an atom of matter, and we can consider such atoms as exerting mutual forces, only these forces cannot be considered as transmitted through the agency of fluid pressure. The reason is that the vortex cannot now be identified with a mere core bounded by a definite surface, but is essentially a configuration of motion extending throughout the medium.

Thus we are again in face of the fundamental question whether all attempts to represent the mechanical interactions of electro-dynamic systems, as transmitted from point to point by means of simple stress, are not doomed to failure; whether they do not, in fact, introduce unnecessary and insurmountable difficulty into the theory. The idea of identifying an atom with a state of strain or motion, pervading the region of the æther around its nucleus, appears to demand wider views as to what constitutes dynamical transmission. The idea that any small portion of the primordial medium can be isolated, by merely introducing tractions acting over its surface and transmitted from the surrounding parts, is no longer appropriate or consistent: a part of the dynamical disturbance in that element of the medium is on this hypothesis already classified as belonging to, and carried along with, atoms that are outside it but in its neighbourhood—and this part must not be counted twice over. The law of Poynting relating to the paths of the transmission of energy is known to hold in its simple form only when the electric charges or currents are in a steady state; when they are changing their positions or configurations their own fields of intrinsic energy are carried along with them.

It is not surprising, considering the previous British familiarity with this order of ideas, that the significance for general physics of Helmholtz's doctrine of vortices was eagerly developed in this country, in the form in which it became embodied through Lord Kelvin's famous illustration of the constitution of the matter, as consisting of atoms with separate existence and mutual interactions. This vortex-atom theory has been a main source of physical suggestion because it presents, on a simple basis, a dynamical picture of an ideal material system, atomically constituted, which could go on automatically without extraneous support. The value of such a picture may be held to lie, not in any supposition that this is the mechanism of the actual world laid bare, but in the vivid illustration it affords of the fundamental postulate of physical science, that mechanical phenomena are not parts of a scheme too involved for us to explore, but rather present themselves in definite and consistent correlations, which we are able to disentangle and apprehend with continually increasing precision.

It would be an interesting question to trace the origin of our preference for a theory of transmission of physical action over one of direct action at a distance. It may be held that it rests on the same order of ideas as supplies our conception of force; that the notion of effort which we associate with change of the motion of a body involves the idea of a mechanical connection through which that effort is applied. The mere idea of a transmitting medium would then be no more an ultimate foundation for physical explanation than that of force itself. Our choice between direct distance action and mediate transmission would thus be dictated by the relative simplicity and coherence of the accounts they give of the phenomena: this is, in fact, the basis on which Maxwell's theory had to be judged until Hertz detected the actual working of the medium. Instantaneous transmission is to all intents action at a distance, except in so far as the law of action may be more easily formulated in terms of the medium than in a direct geometrical statement.

In connection with these questions it may be permitted to refer to the eloquent and weighty address recently delivered by M. Poincaré to the International Congress of Physics. M. Poincaré accepts the principle of least action as a reliable basis for the formulation of physical theory, but he imposes the condition that the results must satisfy the Newtonian law of equality of action and reaction between each pair of bodies concerned, considered by themselves; this, however, he would allow to be satisfied indirectly, if the effects could be traced across the intervening æther by stress, so that the tractions on the two sides of each ideal interface are equal and opposite.* As above argued, this view appears to exclude *ab initio* all atomic theories of the general type of vortex atoms, in which the energy of the atom is distributed throughout the medium instead of being concentrated in a nucleus; and this remark seems to go to the root of the question. On the other hand, the position here asserted is that recent dynamical developments have permitted the extension of the principle of action to systems involving permanent motions, whether obvious or latent, as part of their constitution; that on this wider basis the atom may itself involve a state of steady disturbance extending through the medium, instead of being only a local structure acting by push and pull. The possibilities of

* We may compare G. W. Hill's more recent introduction of the idea of permanent orbits into physical astronomy.

* *Cf.* also Hertz on the electromagnetic equations, § 12, *Wied. Ann.*, 1890. The problem of merely replacing a system of forces by a statical stress is widely indeterminate, and therefore by itself unreal; the actual question is whether any such representation can be co-ordinated with existing dynamics,

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mical explanation are thus enlarged. The most definite type odel yet imagined of the physical interaction of atoms through ether is, perhaps, that which takes the æther to be a rotationally ic medium after the manner of MacCullagh and Rankine, and s the ultimate atom include the nucleus of a permanent rota-l strain-configuration, which as a whole may be called an ron. The question how far this is a legitimate and effective l stands by itself, apart from the dynamics which it illustrates ; all representations it can only cover a limited ground. For nce, it cannot claim to include the internal structure of the eus of an atom or even of an electron ; for purposes of physical y that problem can be put aside, it may even be treated as utable. All that is needed is a postulate of free mobility of this eus through the æther. This is definitely hypothetical, but it t an unreasonable postulate because a rotational æther has the erties of a perfect fluid medium except where differentially ional motions are concerned, and so would not react on the on of any structure moving through it except after the manner apparent change of inertia. It thus seems possible to hold uch a model forms an allowable representation of the dynamical ty of the æther, as distinguished from the complete constitution e material nuclei between which that medium establishes ection.

any rate, models of this nature have certainly been most helpful axwell's hands towards the effective intuitive grasp of a scheme ations as a whole, which might have proved too complex for act unravelment in detail. When a physical model of concealed mical processes has served this kind of purpose, when its con- has been explored and estimated, and has become familiar gh the introduction of new terms and ideas, then the ladder by 1 we have ascended may be kicked away, and the scheme of relations 1 the model embodied can stand forth in severely abstract form. d many of the most fruitful branches of abstract mathematical sis itself have owed their start in this way to concrete physical ptions. This gradual transition into abstract statement of cal relations in fact amounts to retaining the essentials of our ing models while eliminating the accidental elements involved em ; elements of the latter kind must always be present because wise the model would be identical with the thing which it sents, whereas we cannot expect to mentally grasp all aspects of ontent of even the simplest phenomena. Yet the abstract stand- is always attained through the concrete ; and for purposes of iction such models, properly guarded, do not perhaps ever lose value ; they are just as legitimate aids as geometrical diagrams, hey have the same kind of limitations. In Maxwell's words, the sake of persons of these different types scientific truth d be presented in different forms, and should be regarded as ly scientific whether it appear in the robust form and the vivid ring of a physical illustration, or in the tenuity and paleness of bolical expression." The other side of the picture, the neces- incompleteness of even our legitimate images and modes of sentation, comes out in the despairing opinion of Young romatics," 1817), at a time when his faith in the undulatory of light had been eclipsed by Malus's discovery of the mena of polarisatian by reflection, that this difficulty "will bly long remain, to mortify the vanity of an ambitious philo- , completely unresolved by any theory": not many years ards the mystery was solved by Fresnel.

is process of removing the intellectual scaffolding by which our ledge is reached, and preserving only the final formulæ which s the correlations of the directly observable things, may more- eadily be pushed too far. It asserts the conception that the rse is like an enclosed clock that is wound up to go, and that lingly we can observe that it is going, and can see some of its superficial movements, but not much of them ; that thus, by t observation and use of analogy, we can compile, in merely tabular information as to the manner in which it works and is likely on working, at any rate for some time to come ; but that any pt to probe the underlying connection is illusory or illegimate. heoretical precept this is admirable. It minimises the danger ignoring or forgetting the limitations of human faculty, which ly utilise the imperfect representations that the external world sses on our senses. On the other hand such a reminder has been required by the master minds of modern science, from rtes and Newton onwards, whatever their theories may have Its danger as a dogma lies in its application. Who is to , without risk of error, what is essential fact and what is ctual scaffolding ? To which class does the atomic theory of r belong ? That is, indeed, one of the intangible things which uggested may be thrown overboard in sorting out and classify- ur scientific possessions. Is the mental idea or image, which sts, and alone can suggest, the experiment that adds to our ete knowledge, less real than the bare phenomenal uniformity it has revealed ? Is it not, perhaps, more real in that the mities might not have been there in the absence of the mind to ve them ?

time is now left for review of the methods of molecular dynamics. Here our knowledge is entirely confined to steady states of the molecular system : it is purely statical. In ordinary statics and the dynamics of undisturbed steady motions, the form of the energy function is the sufficient basis of the whole subject. This method is extended to thermo-dynamics by making use of the mechanically available energy of Rankine and Kelvin, which is a function of the bodily configuration and chemical constitution and temperature of the system, whose value cannot under any circumstances spontaneously increase, while it will diminish in any operation which is not reversible. In the statics of systems in equilibrium or in steady motion, this method of energy is a particular case of the method of action ; but in its extension to thermal statics it is made to include chemical as well as configurational changes, and a new point appears to arise. Whether we do or do not take it to be possible to trace the application of the principle of action throughout the process of chemical combination of two molecules, we certainly here postulate that the static case of that principle, which applies to steady systems, can be extended across chemical combinations. The question is suggested whether extension would also be valid to transformations which involve vital processes. This seems to be still considered an open question by the best authorities. If it be decided in the negative a distinction is involved between vital and merely chemical processes.

It is now taken as established that vital activity cannot create energy, at any rate in the long run, which is all that can from the nature of the case to be tested. It seems not unreasonable to follow the analogy of chemical actions, and assert that it cannot in the long run increase the mechanical availability of energy—that is, considering the organism as an apparatus for transforming energy without being itself in the long run changed. But we cannot establish a Carnot cycle for a portion of an organism, nor can we do so for a limited period of time ; there might be creation of availability accompanied by changes in the organism itself, but compensated by destruction and the inverse changes a long time afterwards. This amounts to asserting that where, as in a vital system or even in a simple molecular combination, we are unable to trace or even assert complete dynamical sequence, exact thermo-dynamic statements should be mainly confined to the activity of the existing organism as a whole ; it may transform inorganic material without change of energy and without gain of availability, although any such statements would be inappropriate and unmeaning as regards the details of the processes that take place inside the organism itself.

In any case it would appear that there is small chance of reducing these questions to direct dynamics ; we should rather regard Carnot's principle, which includes the law of uniformity of temperature and is the basis of the whole theory, as a property of statistical type confined to stable or permanent aggregations of matter. Thus no dynamical proof from molecular considerations could be regarded as valid unless it explicitly restricted the argument to permanent systems ; yet the conditions of permanency are unknown except in the simpler cases. The only mode of discussion that is yet possible is the method of dynamical statistics of molecules introduced by Maxwell. Now statistics is a method of arrangement rather than of demonstration. Every statistical argument requires to be verified by comparison with the facts, because it is of the essence of this method to take things as fortuitously distributed except in so far as we know the contrary ; and we simply may not know essential facts to the contrary. For example, if the interaction of the æther or other cause produces no influence to the contrary, the presumption would be that the kinetic energy acquired by a molecule is, on the average, equally distributed among its various independent modes of motion, whether vibrational or translational. Assuming this type of distribution to be once established in a gaseous system, the dynamics of Boltzmann and Maxwell show that it must be permanent. But its assumption in the first instance is a result rather of the absence than of the presence of knowledge of the circumstances, and can be accepted only so far as it agrees with the facts ; our knowledge of the facts of specific heat shows that it must be restricted to modes of motion that are homologous. In the words of Maxwell, when he first discovered in 1860, to his great surprise, that in a system of colliding rigid atoms the energy would always be equally divided between translatory and rotatory motions, it is only necessary to assume, in order to evade this unwelcome conclusion, that "something essential to the complete statement of the physical theory of molecular encounters must have hitherto escaped us."

Our survey thus tends to the result, that as regards the simple and uniform phenomena which involve activity of finite regions of the universal æther, theoretical physics can lay claim to constructive functions, and can build up a definite scheme ; but in the domain of matter the most that it can do is to accept the existence of such permanent molecular systems as present themselves to our notice, and fit together an outline plan of the more general and universal features in their activity. Our well-founded belief in the rationality of natural processes asserts the possibility of this, while admitting that the intimate details of atomic constitution are beyond our scrutiny and provide plenty of room for processes that transcend finite dynamical correlation.

SIR GEORGE S. ROBE
ADDRESS TO THE GEO
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ORGE S. ROBERTSON'S PRESIDENTIAL ESS TO THE GEOGRAPHICAL SECTION OF BRITISH ASSOCIATION AT BRADFORD.*

ness of the occasion led me to believe that the British elf was a very proper subject for such reflections as could ssed within the limits of an inaugural presidential address. ; with the important practical application of our science to of national life—political geography—I feel that perhaps explanation is necessary. Pure geography, with its placid nd its far-stretching outlook, combined sometimes with a evotion to the facts and conclusions of strict geographical s apt to incline many scientific minds to an admirable quiet- opolitanism—the cosmopolitanism of the cloistered college ture theatre. It perhaps also at times has a tendency to purely academic students a feeling of half disdain or irritability against those who love the science for its and social suggestiveness and elucidations. Thus there is a danger that geographers of high intellectual calibre, with sms entirely scholarly, may come to underrate nationality ook upon the world and mankind as the units, and upon and confederacies and amalgamations merely as specific s of the general type. We know that geography is often pon as the science of foreign countries more especially. Such confusion is undoubtedly less common than it was, yet it luences, unconsciously, the minds of many people. It is well forget this curious fact, and to point out, as if it required ising, that there is nothing foreign to geographical thought association of geography and patriotism, and that the home y is worthy of careful study, particularly when, as with us, me country is not Yorkshire, nor England, nor the United om, but the whole British Empire. Every true man loves his ountry the best in the world. To love mankind one must by loving individuals ; before attaining to true cosmopolitanism ust first be patriotic.

e British Empire is equal in size to four Europes, while its lation approximates four hundred millions. Although that may a somewhat grandiloquent method of description, it is a fairly ate statement of fact. Still more interesting to us is another —that outside of these islands we have some ten millions of e-skinned, English-speaking fellow-subjects. These islands are ely more than one-hundredth part of the whole empire, ugh we count as four-fifths of its white population ; of the total ber of the Queen's subjects we are, however, no more than a h. *British Empire* is somewhat of a misnomer, just as the North erican and Australian Colonies were never colonies at all in the sical sense of the word. For the colonies are not independent he mother country. An empire again really means a number subject peoples brought together, and at first held together, by ce. India is an empire, for instance. Happily, however, there no need now for any novel designation. The style *British pire* has become in time of stress a rallying cry for all the ueen's subjects, and the term has been sanctified by the noble ger devotion shown to her Majesty, both as a beloved and vene- ted constitutional sovereign, and as the common bond of unity tween those great self-governing daughter-nations which we in e past were accustomed to speak of as "our colonies." Con- erning the British Empire, and comparing it with other empires, ncient, recent, or now existing, its two most remarkable features re its prodigious and long-continued growth and the persistency of s power. It cannot to all seeming grow much larger, from lack of xpansive possibility. But it is unprofitable to predict. Every step which has been taken in the way of extension, particularly of late years, has been against the wishes and in almost passionate opposition to the views of large sections of the people. Yet the process of enlargement has gone on continually. In short, the British Empire, in spite of its seemingly reckless out- spread, its sometimes cloudy boundaries, its almost vague and appa- rently meaningless growth, is at the present day more braced together, more manageable, and more vigorous as a complete organi- sation than it was 60 years ago. The difference between its actual extent in the last year of the century and its size at the date of the Queen's accession can be estimated by a glance at a remarkable series of maps published in the "Statesman's Year Book for 1897," while since 1897, and at this instant, as we all know well, its mighty bulk is being still further increased.

The world as a whole has strangely contracted owing to a bewil- dering increase in lines of communication, to our more detailed geographical knowledge, to the formation of new harbours, the extension of railways, the increased speed and the increased number of steamships, and the greatly augmented carrying power of great sailing vessels built of steel. Then, hardly second in importance to these influences are the great land lines and the sea cables, the postal improvements, the telephones, and, perhaps, we may soon add, the proved commercial utility of wireless telegraphy.

* Abstract. Delivered September 6, 1900.

This universal time-diminution in verbal and personal contact has brought the colonies, our dependencies, protectorates, and our dependencies of dependencies, closer to each other and all of them nearer still to us. Measured by *time-distance*, which is the controller of the merchant and the cabinet minister just as much as of the soldier, the world has indeed wonderfully contracted, and with this lessening the dominions of the Queen have been rapidly consoli- dating. Nor is this powerful influence by any means exhausted. In the near future we may anticipate equally remarkable improve- ments of a like kind, especially in railways, telegraph lines and deep-sea cables, and in other scientific discoveries for transmitting man's messages through water, in the air, or perhaps by the vibra- tions of the earth. For us particularly, railway schemes of expansion must be mainly relied upon to open up and to connect distant parts of the empire. Our true and only trustworthy road of intercommu- nication between the heart of the empire and its limits must always be the sea. For general trade purposes, such as the convenience of business travellers, all Continental lines and all the great projected railways will be helpful, whatever nation controls them ; but our certain security is the sea, the sea which protects us, which has taught us to be an imperial people. If we ever forget that, there may be a calamitous awakening. We must not be persuaded to build—or at any rate to place reliance upon—land roads or railways through regions inhabited by tribes and peoples over whom we have not complete military as well as political control. Persian, Arabian, North African railway projects are happily rarely heard of now. As national enterprises they never were and never could be practicable, or otherwise than dangerous mistakes. In the future we shall remain a world-power only so long as we hold command of the sea in the fullest sense of the term, not merely by the force and efficiency of the fighting Navy, but by the excellence and the perfecting of our mercantile marine, by increasing its magnitude, carrying power, and speed, and by anxiously attending to its recruit- ment by British sailors.

And what has been said about railways applies, with obvious modifications, to telegraph lines and to maritime cables. The more general the extension of these, and the more numerous they become, the greater benefit will there be to this country in its double capacity as the greatest trader and the greatest carrier of merchandise in the world ; while the actual equivalent to a diminution of time-distance in travelling is to be found in the instantaneous verbal message which can be despatched to the most distant point of the empire. But we ought certainly to join all the shores of the Queen's dominions by sea cables completely controlled by British authority. To rely upon connection between our own cables through telegraph systems stretching across foreign countries, however friendly, or to permit the ends of these sentient nerves of the empire to emerge upon shores which might possibly become an enemy's country, is dangerous to the point of recklessness, that parent of disaster. As a melancholy instance of my meaning it is only necessary for us to remember the Pekin catastrophe—how we suffered from those dreadful intervals of dead silence, when we could not even communi- cate directly with our own naval officers at Taku, or with anyone beyond Shanghai, although we have in our possession a place of arms at Wei-hai-Wei, upon the Gulf of Pechili. It is obvious that we ought to have an all-British cable for pure strategic reasons as far as Wei-hai-Wei, our permanent military outpost on the mainland.

Now to give some suggestion of the increased facilities for carrying merchandise, for conveying passengers quickly about the world, and for the sending of messages to all parts of the earth, a few, a very few, salient facts may be quoted about ships—sailing ships and steam vessels—and about telegraphs and cables. In 1870 there were no more than 10 British sailing ships which exceeded or reached 2,000 tons burden. In 1892 the yards on the Clyde alone launched 46 steel sailing ships which averaged 2,000 tons each. In 1895 the number of large steel sailing ships being built in the United Kingdom was down to 23, and, speaking generally, it is inevitable that sailing vessels must give way to ocean steamships for most kinds of cargo—cattle, coals, wool, grain, oil, and everything else. . . . It is not too bold to predict that the Atlantic, from Queenstown to New York, will, before long, be steamed in less than four days. The question has now resolved itself simply into this—will it pay shipowners to burn so much coal as to ensure these rushing journeys before a cheaper substitute for coal is found ? We know that a torpedo-destroyer has been driven through the water at the rate of 43 miles an hour by the use of the turbo-motor instead of reciprocating engines. Consequently an enormous increase in the present speed of the great Atlantic liners is certain if the new system can be applied to large vessels. By such very swift steamers, and by the example they will set to all established and competing steamship companies, the journey to Canada and subsequently to all other parts of the Empire will be continually quickened, until predictions which would now sound extravagant will in a few years be simple everyday facts.

We must turn next to the subject of telegraphic communication, especially as it relates to the British Empire. The mazes of land- lines and of sea and ocean cables are too numerous and intricate to be described in detail. Also the general effect of this means of bringing

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distant peoples together, and its transcendent importance for political, strategic, and trading purposes, need not be too much insisted upon in this place, so obvious must they be to everyone. Yet, great as has been its power and advantage in all of those directions in the past, it is certain that still greater development and still greater service to the world will follow in the future even from existing systems, not to speak of their certain and enormous possibilities of growth. In the celerity of the actual despatch of a message we need not ask for much improvement. Lightning speed will be probably sufficient for our go-ahead children of the twentieth century. But where we may expect and shall undoubtedly get increased success is in multiplied facilities for sending telegrams all over the earth and in widening their usefulness and convenience to all ranks and sections of the community. To obtain these necessary advantages there are two requisites—first a great and general cheapening of tariffs and, as a certain consequence of such reduced charges, a duplication or even a quadrupling of many of the present cables to prevent blocking; and, secondly, an indefinite extension of both lines and cables everywhere. Progress in submarine telegraphy undoubtedly means a lessening in the price of service and a firmer control by the State, as an obvious corollary to the large help to the companies already given by the general taxpayer, quite as much as it means those scientific inventions and scientific discoveries which the coming years have in store for us. At the present time the charges are far too high, ridiculously so as regards India, and the use of the great cables is therefore very often beyond the power of the small capitalist and the trader of the middle sort. Yet certain and early news is of supreme importance to large numbers of both classes. Its absence hampers or stops business, while its price is too severe a tax upon average profits. This fact has led to the invention of ingenious and elaborate codes. They might possibly have been devised in any case; but there is no doubt that messages by code would be certainly expanded so as to prevent all possible ambiguity if telegraphing to distant countries were not so costly. The spreading of land lines and sea cables about the earth has gone on rapidly since 1870; to the extent that those already completed would seem even to be in advance of their requirement, if that requirement were to be measured by their full employment. Nevertheless it is to be wished that new companies could be formed and new lines laid down to excite competition and thereby to cheapen rates; or else that our Government should step in and regulate charges over subsidised British lines. For the power of the great telegraph corporations by reason of their monetary resources enables them to overcome ordinary rivalry and to treat public opinion with indifference. A general cheapening of rates has constantly been followed by increased profits, earned by the resulting augmentation of traffic, but it needs an enterprising directorate to face the necessary initial expenditure, except under pressure. Boldness and foresight in finance are naturally less prominent features in the management of the great telegraph companies than contentment with a high rate of interest on invested capital. All their energy and watchfulness are employed to crush competition rather than to extend their activities indefinitely. Moreover, money making is their business, not Imperial statesmanship. If it were a question of the added security or the close coupling-up of the Empire (which are probably synonymous) on the one hand and a loss of profit (however splendid the dividends might still remain) on the other, we know what would be the result of their deliberations.

Important as are the sea cables for statesmen, for strategy, and for commerce, they are or will be equally important socially to keep up intimacy and swift intercourse between families half in Britain and half in India for instance, or between friends and relations in these islands and in the great colonies. They might be made to give the sensation almost of actual contact, of holding the hand of your friend, of speaking directly to his heart. It is this interchange of personal news and private wishes, quite as much as the profound political and commercial aspects of lightning communication with all parts of the empire, which will bind the empire in bonds stronger than steel, easy as affection, to hold it together with unassailable power. Consequently the health and strength of the empire depends very greatly upon a cheapening of telegraph charges. Doubtless a time will come when all our main cables of the first importance will be in the hands of Government, when they will only touch upon British territory, and when they will be all adequately protected from an enemy. Those are truly imperialistic and patriotic aspirations. But we must never forget the grand part in bringing together, within whispering distance as it were, the different parts of the world, and consequently of our world-wide empire, which has been taken in the past by such Napoleonic organisers as the late Sir John Pender. It is to him and to such men as he that we owe those splendid beginnings which by means of vital reflexes from the nerve centre of the empire have helped to fire our white fellow-subjects all over the globe with a loftier patriotism and with new, brave, and broader ideals of nationality.

It was coincident with the opening of the Suez Canal, in 1869, that the liveliest interest began to be taken in sea cables, and a master mind perceived their commercial possibilities. Before that time the success of the constructing companies had not been great. Sir John Pender then founded the famous Eastern Telegraph Co. by the amalgamation of four existing lines, which had together laid down 8,500 miles of sea cables, besides erecting land-lines also. A year later, in 1873, from three other companies he formed the Eastern Extension, Australasia and China Telegraph Co., which jointly possessed 5,200 miles of submarine lines. From that date the extension of electric communication to all parts of the earth, over wild as well as other civilised countries, and beneath the salt water, has only been equalled by their average remunerativeness. Now there are 175,000 miles of submerged cables alone, of which this country owns no less than 113,000 miles. The history of some of these cables is full of interest and might attract the delighted attention of the lover of picturesque romance no less than of the student of commercial geography. It also supplies suggestions and many facts, both to the physical geographer and to the student of seismic phenomena. Science has taught the companies to economise time, labour, and material in cable-laying operations, as well as how to improve the working instruments. Human ingenuity, business perception, and organising power have shown once more their startling possibilities when directed and controlled by cool, clear-eyed intelligence combined with general mental capacity. It is only necessary to re-affirm, for the reasons already given, the national, the imperial, the commonwealth requirement for cheap telegraphy, and the profound necessity there is, both strategically and politically, for complete government control by purchase, guarantee, or other equitable means over main cables which connect Great Britain with her daughter states, her Indian Empire, and her dependencies. Our communications with our own folk must be independent of private companies and completely independent of all foreign nations.

The general considerations which I have named might lead to the inference that actual geographical disadvantages, in trade competition for instance, may sometimes be conquered by man's resourcefulness and energy. Within obvious limitations that is certainly true. At places, as we know, the borderland between geography and many of the natural sciences is often vague and confusedly interlaced. So perhaps also with mechanical and economic science our boundaries at certain spots overlap. Quick steamers, far-reaching telegraph lines, and the piercing of isthmuses by ship canals may at the first glance appear outside the purview of the geographer. Yet from that particular aspect of geography which I have already spoken of as the science of distances we perceive how relevant they are, how worthy of study. Truly ours is a very catholic science. Our success as an empire will probably depend for its continuance upon a high level of national sagacity, watchfulness, and resource, to make up for certain disadvantages, as I think, of our geographical position since the cutting of the Suez Canal; and it will also depend upon the comprehensive and intelligent study of all branches of geography, not the least important of which to my view is the science of distances—the science of the merchant, the statesman, and the strategist.

REPORT OF THE NEW YORK RAILROAD COMMISSION ON BRAKE TESTS.*

The report of the competitive tests of street car brakes, held by the Board of Railroad Commissioners of the State of New York, has been issued, and contains a large amount of valuable information for electric railway men. The technical part of the report is made by Charles R. Barnes, electrical expert of the commission. It is very complete, and gives a history of the work from its beginning. On March 29, 1899, circulars were sent out inviting all makers of street car brakes to enter application for the tests, which were to take place on the tracks and cars of the Metropolitan Street Railway Co. of New York City. Twenty-six applications were filled out, and 25 were accepted. The results of tests were recorded by an automatic attachment, so that no complaint could be made as to unfair treatment by any of the contestants. This device was built and carefully calibrated by Mr. Barnes and Mr. W. A. Pierson, electrical engineer of the Metropolitan Street Railway Co. On each car 14 official speed records were taken—three at 8 miles an hour, three at 12 miles an hour, three at 15 miles an hour, three at 16 miles an hour, and two at 16 miles an hour with sand on the track. Air brakes were submitted to test by the following-named companies: Magann Air Brake Co., Christensen Engineering Co., Standard Air Brake Co., John E. Reyburn. Electric brakes were tested from the General Electric Co.; Columbia Electric Light and Brake Co.; Price, Darling & Co.; Electric Selector and Signal Co. Hand-power brakes were submitted by Sterling Supply and Manufacturing Co., M. H. Vogel, Sauvage Street Car Brake Co. Brakes classified as friction brakes were entered by the Peckham Motor Truck and Wheel Co., and the J. G. Brill Co. Track and wheel brakes tested were from the Devlin Street Car Brake Co., Philip Bach and Bernard

* From the *Western Electrician* of Chicago.

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No. I.—*Showing average stops made with all brakes tested at* 8, 12, 15 *and* 16 *miles per hour, and at* 16 *miles per hour with sand.*

Name of brake.	8 miles per hour.		12 miles per hour.		15 miles per hour.		16 miles per hour.		16 miles per hour, with sand.	
	Feet.	Seconds.	Feet.	Seconds.	Feet.	Seconds.	Feet.	Seconds.	Feet.	Seconds.
Motor, Truck and Wheel Co.	42·41	7·03	59·52	6·44	70·50	6·87	81·25	7·43	79·91	7·51
reet Car Brake Co.	54·08	7·38	65·80	8·86	92·36	9·58	93·63	9·51	84 91	7·98
en Air Brake Co.	56·86	6·20	88·25	7·88	113·80	8·60	130·75	9·74	93·70	6·63
Air Brake Co.	54·19	5·79	76·08	5·48	86·83	7·32	104·47	8·48	93·04	6·58
lectric Co.	45·00	5·34	111·02	8·95	114·86	8·32	134·72	8·62	116·66	6·58
Car, Light and Brake Co.	65·86	6·16	99·94	5·46	139·50	7·30	155·08	7·70	203·66	7·55
Street Car Brake Co.	46·11	4·00	78·58	5·67	129·16	8·50	138·27	8·60	143·25	7·31
l Co.	35·11	3·16	67·83	6·12	121·88	7·50	108·44	6·22	127·16	7·47
ppliance Co.	40·27	3·15	68·36	4·54	135·11	5·92	140·69	6·07	†	†
ake Co.	50·86	7·56	72·85	7·86	92·11	9·62	119·91	10·56	105·58	9·35
gann Air Brake Co.	42·72	6·75	56·80	7·33	81·80	9·12	95·66	9·17	89·16	8·70
arling Co.	45·27	7·23	...	...	...	...	...	...	...	...
Supply and Manufacturing Co.	41·50	6·99	57·00	7·91	75·27	9·59	81·41	9·35	90·66	9·45
Selector and Signal Co.	38·75	7·71	50·00	7·95	60·02	8·28	72·33	9·35	73·08	8·92
nd Schlegel	...	...	...	...	...	...	...	...	...	...
Reyburn	66·80	7·17	94·00	8·55	...	...	...	...	...	...

* No tests after 8 miles per hour. † No test. ‡ No tests after 12 miles per hour.

ble No. II.—*Showing comparative average stops at all speeds.*

Name of company.	Feet.
lectric Selector and Signal Co.	58·83
eckham Motor, Truck, and Wheel Co.	66·71
terling Supply and Manufacturing Co.	69·16
. P. Magann Air Brake Co.	73·22
evlin-street Car Brake Co.	78·15
Standard Air Brake Co.	82·92
Vogel Brake Co.	88·46
J. G. Brill Co.	92 08
Christensen Air Brake Co.	96 67
General Electric Co.	104·45
Sauvage Brake Co.	107·07
Columbia Car, Light and Brake Co.	132 80
*J. E. Reyburn	—
*Price-Darling Brake	—
*Safety Appliance Brake	—
*Batch and Schlegel	—

* Not tested on all speeds.

chlegel. A system of brake levers entered by the Safety Appliance o. was also tested.

The air brakes were all of the "straight-air" type, the differences eing in methods of compression and details of apparatus. Among lectric brakes the General Electric and Electric Selector were the nly ones that met the requirements of the test. The latter is a magnetic brake, attached to the regular brake rigging, and operated by the trolley current. Among hand-power brakes the Sterling is that used by the Metropolitan Street Railway Co. of New York City, and consists of gear wheels applied to the ordinary spindle, which multiply the force applied to the brake. The Vogel brake uses eccentric gear wheels on the ordinary brake spindle, so that the leverage is increased the nearer the brakes are set, while at first the slack is quickly taken up at a reduced leverage. The Sauvage brake system is constructed on the principle of a wedge working against a wheel. The Peckham brake was the brake known as the "Price Momentum," which originated on the Chicago City Railway. The Brill Company also presented a friction or momentum brake.

Table No. I., from the report, gives the averages of all the tests in feet and seconds required to stop the car at different speeds.

The comparative average stops at all speeds are shown in Table No. II.

It should be stated that the cars used were double truck, mounted on Brill maximum-traction trucks, with 30in. and 20in. wheels. The weight of the car in each case was 20,816lb., except the General Electric, which was 24,000lb.

Table No. III shows the result of a test made with a car equipped with the ordinary spindle hand brake, such as is in common use. This test was made on the same car (with same brake levers) that was tested with the Sterling brake, the results of which are given in Table No. IV. This test was made for comparing the efficiency of the ordinary brake now generally used with one of the improved brakes. The comparison was made with the Sterling brake because the change from the ordinary handle to the Sterling brake could be made more conveniently than any other.

Tests were also made to ascertain the comparative amount of force exerted by a motorman with the Sterling brake and the common brake. An 18in. hand-wheel was used in these tests. The average of all stops made by the Sterling brake, with this equipment, was 58·73ft., and the average of the power applied 77·08lb. With the common brake, the average stop was made in 56·87ft. and the average of the power applied 92·51b.

Table No. III.—*Showing result of curves and other information in reference to test of car equipped with single chain spindle brake, same brake leverage as used on test of Sterling brake, car equipped with ordinary brake handle,* 14*in. sweep, tested Nov.* 23, 1899.

Initial speed. Miles per hour.	Stop. Ft.	In.	Sec.	Direction of car.	Number of passengers.	Average stop. Ft.	Sec.	Remarks.
8	44	6	6·45	Down	12	...	...	...
8	49	..	6·40	do.	12	...	...	Did not skid
8	35	6	5·30	do.	12	43·00	6 05	ditto
12	60	5	7·20	do.	12	...	...	ditto
12	64	...	7·60	do.	12	...	...	ditto
12	61	5	6·50	do.	12	61·94	7·10	ditto
15	77	...	7 85	do.	12	.....	...	ditto
15	76	5	7 70	do.	12	...	...	ditto
15	73	4	6·88	do.	12	75 58	7·47	ditto
16	86	6	8·90	Up	12	...	...	ditto
16	86	8	8·45	do.	12	...	...	ditto
16	89	6	8·70	do.	12	87·55	8·68	ditto

Sun shining, track dry.

Table No. IV.—*Showing result of curves and also number of pounds exerted by motorman on brake wheel in test of car equipped with Sterling brake with* 18*in. brake wheel in place of brake handle, car tested Nov.* 24, 1899.

Initial speed. Miles per hour.	Stop. Ft.	In.	Sec.	Direction of car.	No. of passengers	Average stop. Ft.	Sec.	No. of lb. exerted on brake wheel.	Remarks.
8	32	10	5 15	Down	12	...	...	80	Did not skid.
8	27	7	4 60	do.	12	...	...	80	ditto
8	28	2	4·83	do.	12	29·52	4·86	75	ditto
12	49	...	6·75	do.	12	...	...	85	ditto
12	48	6	6·48	do.	12	...	...	65	ditto
12	46	6	6·25	do.	12	48·00	6·49	70	ditto
15	87	2	9·45	do.	12	...	...	75	ditto
15	81	...	8·70	Up	12	...	...	80	ditto
15	80	...	8·80	do.	12	82·72	8·98	80	Skid rear wheel, 6ft.
16	75	9	8·40	do.	12	...	...	80	Did not skid.
16	75	...	7·87	do.	12	...	...	75	ditto
16	75	6	7·95	do.	12	75·41	8·07	80	Skid rear wheel, 6ft.

Clear, track dry.

Three stops were made from 15 miles an hour with a car equipped with the Electric Selector and Signal Co.'s electric brake on rails that had just been flooded. This test on the wet rail was made to compare it with the same equipment on a dry rail. The rails were wet by running a sprinkling cart over them three times. The result shows that the average stop on the wet rail was 71·73ft., and on the dry rail 60ft.

In conclusion, the board expresses its thanks to the officers of the Metropolitan Street Railway Co. for furnishing cars, tracks, and men free to the State for the tests and other valuable aid and co-operation.

The report of the commission is a valuable addition to technical literature, and is the first thorough investigation of street car braking ever made the results of which are public.

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ELECTRIC SUPPLY MAINS CONTRACTS.

The following circular and Table of Conductors is being sent to Electrical Engineers by the Cable Makers' Association :—

September 13, 1900.

The terms and conditions in contracts for electric mains and details of conductors have varied so much in different specifications that, with a view to standardisation, the undermentioned cable makers have drawn up the following, which they suggest as a basis for tenders :—

1. Conductors.—The sizes and combinations of conductors shown on the accompanying Table to be adopted.

2. Guarantee.—If a guarantee be required for cables supplied and laid by the contractors, such guarantee to be in the form of an undertaking to make good any fault due to defective material or workmanship, and to be free for a period not exceeding twelve months after the cables are laid. In case it should be desired that this guarantee be extended beyond twelve months, an annual charge to be made.

In cases where cables are supplied by the contractor, but are not laid by him, the term of guarantee (if any) to date from the time of delivery of the cables.

Should the contractor be required under the guarantee to locate and repair any defect which may occur in the cables, a charge for such work to be made by the contractors in all cases where there is no proof that the defect was caused by bad material or workmanship,

A contract for maintenance when required to be considered as a separate matter from the guarantee and to be charged for accordingly.

3. Quantities.—In the case of a yearly supply of cable, the approximate quantities are to be stated, and the contractor shall not be called upon to deliver more than 25 per cent. in excess of these quantities, or less than 25 per cent. below them without special arrangements as to price being made.

4. Disputes.—The engineer's decision shall not be considered as final, but there shall be an arbitration clause.

5. Duplicates of Specifications.—Specifications shall be supplied in duplicate to all firms tendering.

6. Suspension of Works.—The purchaser shall pay to the contractor all reasonable expenses arising from suspension of works by the engineer, unless such suspension be due to any fault on the part of the contractor.

7. Payment.—In contracts for the supply and laying of cables, payment to be made on terms not less favourable to the contractor than 80 per cent. on monthly certificates, 10 per cent. on completion or putting to work (the completion or putting to work not to be dependent on any other contractor), the remaining 10 per cent. twelve months after completion.

In the case of cables supplied by the contractor but not laid by him, payment in full to be made within one month from date of engineer's certificate of each delivery.

8. Engineer's Certificates.—The engineer shall certify for payment within fourteen days of presentation of the account, and the purchaser shall make payment within one month from date of certificate.

In the event of there being any dispute as to the account, or any claim in connection with the work, the engineer may deduct from the account rendered such reasonable sum as may be necessary to cover the work in dispute; but the issuing of the certificate shall not be delayed in consequence.

Failing payments as specified in Clause 7, and this clause, the purchaser shall pay interest at the rate of not less than 5 per cent. per annum.

9. Tests.—Current for tests on site shall be supplied free to the contractor at the tension of the ordinary supply.

10. Extras.—The contractor shall not be called upon to supply without payment any materials or work not detailed in the specification.

11. Packages.—Where cables are supplied but not laid by the makers, the drums containing them shall be charged for, and allowed for in full when returned, carriage paid, in good condition within three months. If returned later, not more than two-thirds to be allowed.

The following cable makers have agreed to these terms and sizes of conductors to take effect on and after October 1st, 1900 : –

British Insulated Wire Co., Ltd.
Callender's Cable & Construction Co., Ltd.
Connolly Bros., Ltd.
W. T. Henley's Telegraph Works Co., Ltd.
Indiarubber, Guttapercha & Telegraph Works Co., Ltd.
Johnson & Phillips.
London Electric Wire Co., Ltd.
Siemens Bros. & Co., Ltd.
Telegraph Manufacturing Co., Ltd.
Western Electric Co.
W. T. Glover & Co., Ltd.

Standard Sizes of Conductors for Electric Supply Mains, to become operative on Oct. 1, 1900.

Nominal size of conduct'rs in square inches.	No. and diameter of strands.	Resistance in standard ohms per 1,000 yards.			Weight in lbs. per 1,000 yards.	
		Calculated.	Maximum allowable.	Maximum allowable for tinned wires.	Calculated.	Minimum allowable.
·05	7/·095	·490	·499	·504	580·	568·
·05	19/·058	·488	·498	·503	591·	580·
·1	19/·082	·244	·249	·252	1182·	1158·
·125	19/·092	·194	·198	·200	1488·	1458·
·15	19/·101	·160	·163	·165	1781·	1745·
·15	37/·072	·163	·166	·168	1776·	1740·
·2	37/·082	·125	·128	·129	2303·	2257·
·25	37/·092	·0997	·102	·103	2900·	2842·
·3	37/·101	·0827	·0843	·0852	3494·	3424·
·35	37/·110	·0697	·0711	·0715	4145·	4062·
·4	37/·118	·0606	·0618	·0621	4772·	4677·
·4	61/·092	·0605	·0617	·0623	4781·	4685·
·5	61/·101	·0502	·0512	·0517	5762·	5647·
·6	61/·110	·0423	·0431	·0433	6836·	6699·
·6	91/·092	·0405	·413	·0417	7134·	6991·
·7	91/·098	·0357	·0364	·0368	8094·	7932·
·75	91/·101	·0336	·0343	·0346	8597·	8425·
·8	91/·104	·0317	·0323	·0327	9115·	8933·
·9	91/·110	·0283	·0289	·0290	10200·	9996·
1·0	91/·118	·0246	·0251	·0252	11740·	11510·
1·0	127/·101	·0239	·0244	·0246	11910·	11680·

In concentric cables the outer conductors will have the resistance corresponding to the areas as given above.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberdeen.—In connection with the accounts of the Aberdeen electricity station referred to in our last issue, it is of interest to note that the past year has been a record one in connection with electricity supply in this city both in regard to connections and output, and that there is every indication that the current year will be quite as satisfactory. One point in favour of the electricity undertaking is that gas has been raised 2d. per thousand, while it has been decided to keep the charge for electric current at the existing figure. The Gas and Electric Lighting committee recommend the Corporation to increase the salary of the city electrical engineer (Mr. J. Alex. Bell) from £300 to £350, rising by yearly increments to £500 per annum.

Alfreton.—The Council have formally decided to obtain a provisional electric lighting order.

Alnwick.—The Council have consented to the application of the Northern Counties Electricity Supply Co. for a provisional electric lighting order.

Ardrossan.—Proposals for the erection of electricity supply works, estimated to cost about £16,000, are before the Burgh Commissioners.

Asylum Lighting.—Prof. F. G. Baily has reported on the proposal to light the Fife and Kinross Asylum electrically. The initial capital outlay is estimated at £2,800, including buildings, and the annual maintenance charges are put at £400. Tenders are being invited for the work.

Ayr.—The annual report of the burgh electrical engineer (Mr. A. J. Fuller) was presented on Monday. During the past year 3½ miles of cable were laid and 72 new connections made, the number of consumers being now 372. The annual output had increased from 297,420 units to 425,639 units, or 43 per cent. The cost of production had been reduced from 2·03d. to 1·80d. per unit. The revenue amounted to £5,244, and after paying interest on capital (£1,530) there was a surplus of £235 to meet the sinking fund.

Bath.—The electric lighting mains are to be extended into the area of the Bath Rural District Council.

Birkenhead.—A special meeting of the Council was held on Wednesday to consider a report of the tramways sub-committee recommending the adoption of granite setts for the paving of the new electric tramway tracks. After considerable discussion the report was referred back.

Blairgowrie.—The proposed application by the North British Electric Supply Co. for a provisional order will be opposed by the Police Commission.

Brechin (N.B.).—The Angus Electric Lighting Co. has submitted a scheme for the electric lighting of the streets in which mains are to be laid. The company propose to substitute 16 c.p. incandescent electric lamps in place of the present lamps, and to provide lamps, connections, &c., the present lamp posts to be adapted for electric lighting. The company would also undertake the lighting and extinguishing of the lamps at the rate of £1 per 1,000 hours per lamp, which would be at the same rate as paid for gas lighting. The matter has been referred to a committee.

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orne.—Negotiations have been opened with the Camborne lruth Tramway Co. for the supply of electric current for ighting.

iff.—At the meeting of the Electrical and Lighting committee ek a letter was read from Mr. W. H. Illingworth, mains tendent, which stated that when working in Charles-street one of the workmen received a severe shock. The accident sed by seizing a cable that was supposed to have been "dead." rer to questions, the chief engineer (Mr. N. Appelbee) said was on his holidays at the time, and had not had time to into the case. From the report it appeared to him that ingworth should have known that the cable was not "dead." quiry is to be held into the matter.

mbers of Commerce Congress.—At the Congress of British bers of Commerce, held in Paris last week, a motion by Mr. H. ard (Dover) proposing that arrangements should be made ut delay for connecting all lightships and isolated lighthouses he shore by means of wireless telegraphy was adopted. On otion of Mr. Hemelryk (Liverpool) the support of the Associa- was given to the Imperial Telegraphs Committee of the House mmons in their efforts to promote an inquiry into the whole ct. Mr. Plummer proposed that representations should be made e Postmaster-General on the great importance of underground s between the chief commercial towns and seaports, so that the serious losses arising from the interruption of the present system torms might be avoided. This course was approved.

leethorpes.—The District Council have resolved to take the essary steps to purchase and extend the electric lighting plant to erected by the Great Grimsby Tramways Co., as they propose to at the town electrically. The cost of the scheme is estimated at 0,000.

Devonport.—The Council have received sanction to the borrow- g of £67,947 for electric lighting purposes, being £15,250 for the urchase of land, repayable in 50 years, and £52,697 for generating ant, &c., payable in 25 years.

Dover.—It is stated that further powerful electric search-lights re to be erected on the heights to the east and west of the Admiralty Harbour, Dover. A power-house has already been constructed.

Driffield.—The application of the Northern Counties Electricity Supply Co. for a provisional order is to be opposed.

Dumfries (N.B.).—The Council has decided by 20 votes to 2 not to lease their provisional electric lighting order, but to establish municipal electricity works.

Electric Traction at Cape Breton.—The Cape Breton Tramway and Electric Co., which has a capital of £100,000, has decided to construct an electric railway in Sydney and suburbs. The advisability of continuing the line to Glace Bay is also under consideration.

Electric Traction in Holland.—A company, entitled the Zuid-Hollandsche Elektrische Spoorweg Maatschappij, has been formed for constructing an electric railway between Rotterdam and the Hague and Scheveningen. The authorised capital is 3,000,000fl. in ordinary shares and 4,000,000fl. in obligations. It is estimated that the cost of the line, which it is anticipated will be completed by 1903, will be 7,800,000fl. The whole of the plant will be supplied by the Siemens and Halske Aktiengesellschaft of Berlin.

Electric Tramways in Surrey.—The London United Tramways (Ltd) will apply next session for powers to make considerable extensions of its tramway system in the county of Surrey. The company propose to construct electric tramways from Hammersmith to Hampton Wick, via Putney-hill, Kingston-hill, and Kingston-bridge; from New Malden to Kingston; from the Kingston entrance of Richmond Park to Surbiton and Tolworth; from Surbiton to Long Ditton, Thames Ditton, and Esher; from Surbiton to Hook; and from Thames Ditton to Hampton Court. Richmond Council have referred the matter to their Tramways Committee for report.

Fraud.—A man, named William Neal, formerly a labourer in the employ of the National Telephone Co., was charged at Marlborough-street, London, last week, for obtaining money under fraudulent pretences. Neal appears to have described himself as still in the employ of the National Company, to have called upon a large number of telephone subscribers, and on the plea that the employés of the company were about to hold a "beanfeast" to have collected considerable sums of money on that account. The prisoner seemed to have experienced little difficulty in convincing subscribers of his bona fides, and the total amount collected during two months is known to have reached not less than £22. Neal was yesterday sentenced by Mr. Fenwick to one month's hard labour.

Hampstead (London.)—In the annual report of the electricity department, just issued, the total capital expenditure is given as £162,212. The total receipts for the past year amounted to £30,661, an increase of £6,283 on the previous year. The gross profit was £16,325, of which repayment of principal and interest absorbed £6,619. The total net profit since the commencement of the undertaking has been £20,586.

Hastings.—The work of constructing the electric tramways, powers for which were obtained last session, is about to be commenced.

Imports of Electrical Goods into the United Kingdom.—The value of electrical goods and apparatus imported into this country during August was £148,317, against £129,022 in the preceding month. The total for the eight months ended August 31 was £697,592.

Inverness.—A company has offered to take a transfer of the Council's provisional order and to reimburse all expenses incurred by the latter in connection with electric lighting matters, to erect electricity works and lay mains in the compulsory area, and to supply electric current for private lighting at 6d. and for public lighting at 3d. per unit. The Council would have the right to purchase at 14 years or any subsequent period of seven years. The offer has been referred to the Electric Lighting committee.

Irvine.—Bailie Kirkland has given notice of his intention to move: "That it be remitted to a small committee to secure a civil engineer who will consider the capabilities of our coalfields for electric light and traction"; and "That it be remitted to a small committee to secure a civil engineer who will consider the capabilities of the water power developed by the water in flow from the waterworks for electric light and traction."

Kirkcaldy.—The Council decided on Tuesday to adopt the recommendation of the Tramway and Electric Lighting committee in favour of carrying out their electric lighting and tramway scheme.

Lake District Electric Tramway Scheme.—At a public meeting at Windermere a resolution was unanimously passed against the proposal to construct an electric tramway from Windermere to Ambleside. A committee was appointed to organise opposition to the scheme.

Leigh.—Customers of the electric lighting department are to have the option of taking current at a uniform price of 5d. per unit or at the existing figures, viz., 7d. per unit for the first hour's maximum demand and 2½d. after. A tramways committee was appointed at Tuesday's meeting of the Council. The mayor (Ald. Fairclough) said that members were aware that the South Lancashire Tramways Co. had obtained their bill last session giving them power to construct a line from Lowton to Atherton through Leigh, and that the Council had agreed to that. They also obtained power to construct tramways to the outlying districts of Leigh, but the latter powers could not be exercised without the consent of the Council. It would never do to let the company come into the town and construct tramways right and left, as it would interfere with any scheme that the Council might deem it advisable to adopt. That being so, the Council could not block the company, but must do one of three things themselves—(1) either seek powers under a bill for the construction and the working of tramways in their own district, or (2) get an order for construction only, and then lease the lines, or (3) make arrangements with the company to construct those lines. The mayor, Ald. Greenough, Cowburn and Pennington, and Messrs. Shaw, Horrocks, Sims, Wood, and Speakman constitute the new committee.

Light Railways.—The Board of Trade have confirmed the following 1900 light railway orders: (1) South Staffordshire, authorising the construction of light railways in Wolverhampton, Wednesbury, Willenhall, Darlaston, Coseley, and Bilston; (2) Barnsley and District, for Barnsley, Worsborough and Monk Bretton; (3) Gateshead and District, for Gateshead and Whickham; (4) South Staffordshire (Extensions), for Bilston, Willenhall, and Coseley; (5) Bromsgrove, for Worcestershire (between Bromsgrove railway station and Lickey End); (6) Peterborough and District, for Peterborough and district.

The Blackburn Corporation have decided to grant facilities for the construction of a light (electric) railway between Blackburn, Whalley and Burnley, but reserve the right to purchase so much of the railway as is situate in Rishton in the event of the Blackburn borough being extended so as to include that district.

Llandaff.—The Council have resolved to apply for a provisional order.

Longton.—An inquiry was held here on Wednesday into the application of the Town Council to borrow money for electric lighting. The town clerk (Mr. G. C. Kent) appeared in support of the application, and said the provisional order was obtained in 1899, and the electricity works were being erected to the plans and specification of the consulting engineer (Mr. Robert Hammond). The staple trade in the town was the manufacture of china and earthenware, and apart altogether from the question of lighting business premises and residences, there was another important question. Recently there had been a considerable agitation with reference to lead poisoning and poisoning in other forms by the dust emanating from various processes, and a great amount of motive power was required for driving fans and other mechanical appliances. The Corporation anticipated a large demand for electric current for motive

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r from those trades. It was proposed to adopt the continuous-nt three-wire system of distribution, and the approval of the l of Trade had already been received. There was no opposition.

idstone.—In a report just prepared by Mr. S. Sellon the cil are advised to apply for powers to construct electric tram- in the district. Mr. Sellon starts on the assumption that in own having a population of 30,000 electric tramways would be nerative, and he suggests the construction of four routes of a length of 4⅛ miles. The total cost of construction, equipment, ead work, feeders, generating station, and rolling stock is esti- at £40,721. The gross earning capacity would be fairly ented by £7,200 per annum at the outset, with a tendency to se. The working expenses would be about 50 per cent., which, allowing for depreciation and repairs, would leave a gross of £2,900, or a net profit for the first year of £457, after ting interest and sinking fund. The estimates provide for inute service.

ccclesfield.—The Council has received from time to time ations from companies for consent to provisional orders, but ision has yet been come to in the matter. At its last meeting neral Purposes committee discussed a communication from the ical Power-Distribution Co. announcing intention to apply for visional order and asking the Council's consent. An interview en representatives of the company and the Council (Mr. George appearing for the former) took place last week. The Council's lecision will be given later.

nchester and Liverpool Express Electric Railway.—The oters of this scheme, which was rejected by a Select Committee House of Commons (see *The Electrician*, May 18 and May 25), decided to renew their application for parliamentary powers session. Certain modifications have been made which, it is , will disarm opposition. The bill was thrown out principally objection of the Salford Corporation and the Dock Board, m intimation that if these could be removed the bill would a good chance of becoming law. The revised plans show a ion of the original line outside Liverpool so as not uch the land of the Dock Board, and the new it is stated, will be 20yds. shorter than the old. gards Salford, the viaduct cannot be dispensed with altogether, compromise is offered which the promoters think ought to e the objections of Salford. It is stated that the promotion ses this year amounted to nearly £10,000. On Thursday last gineers, Mr. F. B. Behr (the inventor) and Mr. Elliot Cooper consultation with the local directors to discuss alterations in &c. The local directors are Mr. W. Mather, M.P., Mr. Mac-, and Mr. T. Broadhurst, of Manchester, and Mr. D. ngham, of Liverpool.

nchester Municipal Technical School and School of Art.—labus, running into 360 pp., and interleaved with a large r of excellent illustrations of the buildings, interiors, &c., of nchester Technical School and School of Art is just issued Session 1900-1901 by Mr. John Heywood, Manchester and n, price 6d. (by post 9d.). The syllabus gives very full ulars of the numerous classes, and a careful perusal will show ending student how fully his requirements are met in this, the most completely equipped technical training establish- in the kingdom. Very full courses are provided for day and g classes. The session for evening students begins on Monday, 17, and that for day students on Tuesday, Sept. 18.

chant Venturers' Technical College.—We referred on of our last issue to the calendar issued for the session 901. We may add that amongst the recent improvements at lege are the provision of a much larger physical laboratory s equipment, an additional special laboratory for heat and nical physics, and the introduction of special courses of even- asses at reduced composition fees for electrical engineers, nical engineers, pattern makers, &c.

dlesbrough.—The consulting engineer (Mr. Robert Ham- has reported to the Electric Lighting committee that a ary supply of electric current will be available about October. ggested that a list of firms requiring temporary supply should pplied. As the supply was only to be temporary it would be lent upon one set of plant. Mr. Hammond further reported miles of mains suitable for arc lighting had been laid. He s that 30 or 40 arc lights be erected in the principal at a cost of from £1,200 to £1,500. Mr. Hammond's mendations were approved.

ssey (Surrey).—The East and West Molesey Council has l to engage an electrical expert to advise on the proposal of dson's Electricity Corporation to establish electricity works district.

mouth.—At the Council meeting last week the Electric g committee's report referred to a serious accident to the ce at the electricity generating station. On the morning of the 27th ult. the water suddenly ran short and it was found that the steam had forced a hole through the masonry under the sill of the weir and allowed the whole of the water to escape along another course. This had necessitated the dynamos being run by steam, entailing heavy expenditure, and the repair of the weir would probably cost several hundred pounds.

Municipal Telephony.—The question of the erection and equipment of a municipal telephone exchange occupied the attention of the members of the Portsmouth Council on Tuesday, and a formal resolution was passed authorising the Telephone committee on receiving applications from 400 intending subscribers, to apply to the Postmaster-General for a municipal telephone licence. It was announced that a number of applications had already been received.

Musselburgh.—The Council are anxious that the Drake and Gorham Electric Power and Traction Co., who this year obtained a provisional order to construct electric tramways in the district, should proceed with the work of construction, and at the Council meeting on Tuesday a letter was received from the promoters, in which, after expressing surprise at the Council's anxiety, stated that they had every intention of proceeding with the tramway and electric lighting scheme upon the earliest possible opportunity. It would, however, be necessary to mature their plans for financing that and other schemes, which they hoped would be conducted either in the coming autumn or the early spring of 1901.

Newport (Mon.).—The discussion by the Council of a proposal to erect an independent tramway power station has been postponed until after the November meeting.

Nottingham.—The City Council are erecting a refuse destructor at Eastcroft at a cost of about £21,000, and another at Radford costing £10,000. Ald. Mutch explained at the meeting on Monday that they anticipated that by utilising the heat which was generated by the destructor cells they would obtain from 450 H.P. to 500 H.P., which they would utilise in the generation of electric current. The value of the steam to the Electrical committee would be something like £4,000 per year.

Obituary.—We learn with regret of the death of Mr. John Robert Jefferies, a member of the well-known firm of Ransomes, Sims and Jefferies, of Ipswich. Mr. Jefferies had been ailing for some time, but his death was unexpected. He died on Wednesday morning, aged 60. Mr. Jefferies had been associated with the famous Orwell Works since 1856, when he joined the staff as a premium apprentice, and he had been one of the managing directors since the firm was converted into a limited liability company in 1884.

Pocklington (Yorks).—A report is being prepared for the District Council as to the relative cost of electric and gas lighting.

Presentation.—Last week, at Bolton, the employés of the electric lighting and tramway departments presented Mr. Arthur Ellis, electrical engineer and manager of the electric tramway system, with a solid silver tea and coffee service, on the occasion of his leaving Bolton to take up the position of electric tramway engineer to the Cardiff Corporation. In addition, members of the Tramway committee presented Mr. Ellis with a secretaire and fruit stand. Mr. Ellis leaves behind him at Bolton numerous friends who will watch his future advance in his profession with interest.

Rosario (Argentina).—Mr. H. S. Chappell has obtained a 40 years' concession from the municipality for establishing a telephone system in this city. The wires are to be underground, and the concessionaire is to pay the municipality 5 per cent of the gross receipts in lieu of all taxation.

Scarborough.—St. Nicholas Gardens are to be lighted by arc lamps.

Sheffield.—A portion of the Nether Edge depôt is to be set aside for the construction of new tramcars. At the Corporation meeting on Wednesday the chairman of the Tramways committee (Ald. Clegg) said he felt strongly that when the tramway system developed it would be necessary for the committee to be their own car builders and repairers. It was not intended to move very fast in construction, but they wanted power to construct more than one car, for the sake of cheapness. Their desire was to build three or four cars. There was room at Nether Edge, and the temporary workshop would not be costly.

The Electric Light committee recommend the following increases in salary: Mr. A. Cuthill (station superintendent) from £209 to £233, rising by annual increments of £35 to £283; Mr. A. Doxey (chief electrician) from £187. 4s. to £208, increasing by annual increments to £250. The increases to take effect from Jan. 1, and a three years' agreement to be entered into in each case. The salary of Mr. J. T. Ballard, mains superintendent, is to be advanced from £250 to £275 per annum, and on Dec. 31, 1901, from £275 to £300 per annum.

The Electric Lighting department has been asked to submit terms for the electric lighting of the sewage works.

Skipton.—A provisional electric lighting order is to be applied for by the Council.

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South Africa.—Having got over the effects of the siege, the Town Council of Ladysmith are turning their attention to public improvements. At present the question of public lighting is under consideration, and tenders will shortly be invited. It is probable that electric lighting will be decided upon.

The *British and South African Export Gazette* announces that an expenditure of £50,000 is about to be incurred in the installation of additional generating plant at the Capetown tramway power station.

South Shields.—From Oct. 1 the charge for electric current is to be increased 1d. a unit for the first hour's maximum demand, making the price 7d. and 1d. per unit.

Southport.—The charge for electric current for power has been reduced from 6d. per unit for the first hour's maximum demand and 2d. afterwards to 4d. and 2d. respectively.

Swansea.—The Corporation have decided to formulate a scheme for wiring premises in the district on the "easy payment" system.

Swinton and Pendlebury.—A special meeting of the Council has been summoned for Oct. 8 to consider the purchase of the tramways in the district from the Manchester Carriage and Tramways Co. and to introduce electric traction.

Telegraph to the Klondike.—It is reported that direct telegraphic communication with Yukon will be opened on Oct. 1.

Telephone Communicaton with Mid-Wales.—Recently Col. Pryce-Jones, M.P., asked the Postmaster-General to afford further facilities for telephonic communication with Newtown, Welshpool, Aberystwith, and other towns in Mid-Wales, but in reply the Postmaster-General states that he has made inquiries locally, and judging from the replies received, there was little probability that sufficient support would be forthcoming from any of the towns or districts named to justify the expenditure involved. Col. Pryce-Jones now proposes to ascertain the minimum number of subscribers necessary to justify the extension of the system to Newtown.

Tiverton.—The consulting engineer (Mr. W. P. Adams) has presented a report on the proposal to erect electricity works, and three schemes are submitted for the consideration of the Lighting committee, viz., steam, gas, or turbine-driven plant. The water power scheme was the only one which would yield a profit from the outset, and the committee have decided, before reporting fully to the Council, to ascertain if this scheme is practicable. In the event of water power being employed, it would be necessary to obtain the sanction of the Board of Trade to the construction of a weir across the River Exe, and particulars have been submitted to the Board.

Truro.—The consulting engineer (Mr. F. H. Headley) is to report on the suitability of the Carvedras Smelting Works as a site for an electricity generating station.

Workhouse Lighting.—It appears from correspondence which has passed between the West Ham Guardians and the Local Government Board on the subject of the acceptance of certain tenders for the supply and erection of plant for the lighting by electricity of the West Ham Workhouse, that the Board is disposed to prefer an arrangement by which current is to be taken from the mains of the West Ham Town Council. It will be remembered that the tender of Messrs. Frank Suter & Co. for carrying out certain works in connection with the proposed lighting at the workhouse had been provisionally accepted by the Guardians. The Local Government Board point out that the estimated cost of the proposed installation based upon this provisionally accepted tender is 40 per cent. in excess of the original estimate, and the Board advise the Guardians to abandon the proposal to provide independent generating plant, and to either continue to use gas for lighting or, as above mentioned, to arrange with the Town Council for the supply of current from the mains. With regard to this alternative proposal the communication from the Board states:—

> The Board is advised that wherever there is a public supply of electricity available it is preferable for a Board of Guardians to use that supply for the workhouse rather than to themselves put down independent generating plant and apparatus, thereby incurring all the responsibility and cost of increased labour, repairs to machinery, consumption of coal, &c., besides the risk of requiring increased boiler power.

Worksop.—The four tenders received for electricity generating plant have been returned unopened, and it has been decided to invite fresh tenders.

Yeadon.—The Board of Trade are to be again invited to postpone the question of the revocation of the Yeadon provisional order, which was obtained in 1894. The Council are of opinion that, "owing to the depressed condition of trade and the undeveloped condition of the town, it is undesirable to put down electric lighting plant at present." Offers have been made to the Council by private companies to establish electricity works but the Council will not consent to electric lighting powers being obtained.

York.—Owing to the exceptional demand for current no more connections can be made until the new plant on order has been delivered. This is expected to be available in about a month's time.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Submarine Cable-Laying and Repairing.—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"Armature Winding of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

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"TEMPERATURE COEFFICIENTS OF 'CONDUCTIVITY' COPPER." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 84·9°F. Printed on strong cardboard, 6d. net.

"LABORATORY NOTES AND FORMS."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]

TENDERS INVITED.

Walthamstow District Council invite tenders for the supply and erection of electric lighting plant and apparatus, including gas plant, gas engines, dynamos, switchboard, boosters, balancer and measuring instruments. Specifications may be obtained from the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., after Sept. 4. Further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m. Sept. 25.

Hackney (London) Electric Lighting committee invite tenders for electricity supply mains. Specifications may be obtained from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, S.W., after 12th inst., and further particulars are given in an advertisement. Tenders must be delivered to the vestry clerk (Mr. George Grocott), Town Hall, Hackney, by 5 p.m. on Oct. 3.

Devonport Corporation invite tenders for two vertical engines, two 300kw. generators, balancer, battery, booster and motor, switchboard for lighting and traction, storage battery, and a 10-ton travelling crane. An advertisement gives further particulars, and specifications may be obtained from the borough electrical engineer (Mr. Charles Furness), Technical School, Devonport. Tenders to town clerk (Mr. A. B. Pilling), Municipal-buildings, Ker-street, Plymouth, by 5 p.m. 26th inst.

Sheffield Corporation invite tenders for: (*a*) Two 600kw. two-phase steam alternators and exciters, and (*b*) alteration of present single-phase plant to two-phase. An advertisement gives further particulars, and specifications can be obtained from the chief engineer and manager of the electric supply department (Mr. S. E. Fedden), Commercial-street, Sheffield, where tenders must be delivered by Oct. 6.

Fulham (London) Vestry invite tenders for the supply and erection of coal handling plant at their electricity works. Specifications may be obtained at the office of the consulting engineer (Mr. F. H. Medhurst), and tenders must be delivered at the offices of the clerk (Mr. W. J. H. Denselow), Town Hall, Walham Green, S.W., by 6 p.m. of 25th inst. An advertisement contains further particulars.

Salford Electric Light committee invite tenders for the supply and delivery of seven iron transformer chambers. Specification may be obtained from the borough electrical engineer *pro tem.* (Mr. F. A. Wilkinson), and tenders (addressed to chairman of committee) must be delivered to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by 10 a.m. 24th inst. See advertisement.

Salford Corporation also invite tenders for two cast-iron water storage tanks for their Strawberry-road electricity works. Tenders to town clerk by 17th inst.

London County Council invite tenders for mains for the electric lighting of Victoria Embankment and Westminster Bridge. Tenders to clerk, Spring Gardens, before noon Sept. 24.

London County Council Asylums committee invite tenders for boilers, engines, dynamos, &c., at Horton Estate, Epsom, Surrey. Tenders to committee, 6, Waterloo-place, S.W., by 10 a.m. Sept. 22.

Dublin Corporation also invite tenders for supply and erection of power machinery at Ringsend, including pumping engines and pumps, boilers, electric motors and pumps. Tenders to town clerk by noon Oct. 3.

Dublin Electric Lighting committee invite tenders for electricity supply mains and accessories. Tenders to town clerk, City Hall, Dublin, by 4 p.m. Oct. 4.

Eastbourne Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, feed pumps, &c.; 400kw. steam alternator, with exciter (vertical enclosed high-speed engine); and main switchboard and connections. Tenders to town clerk by noon Oct. 4.

Aberdeen Electric Lighting committee invite tenders for two 200kw. direct-coupled continuous-current generators and one 120kw. balancing set; also for one 420kw. direct-coupled continuous generator. Willans engines in both cases. Tenders to city electrical engineer by Sept. 29.

Manchester Tramways committee invite tenders for two steel boilers, cast-iron pipes, rubber rings, bolts and nuts, steel stanchions, &c., and 100 car trucks. Tenders (addressed chairman of committee), to the town clerk by 18th inst.

The Vestry of St. John, *Hampstead* (London), invite tenders for eight dry-back marine boilers, steam and water pipes, feed pumps, &c. Tenders to vestry clerk, Vestry Hall, Hampstead, N.W., by 4 p.m. Sept. 27.

Tenders are invited for wiring the *Suffolk* County Asylum, Melton, for the electric light. Tenders to Mr. A. T. Cobbold, County Hall, Ipswich, by Oct. 5.

Sunderland Corporation invite tenders for triple expansion high-speed direct-current steam dynamos, Lancashire boilers, and feed pumps. Tenders to town clerk by noon Sept. 21.

Dundalk District Council invite offers for the transfer of their provisional electric lighting order. Tenders to town clerk, Town Hall, Dundalk, before 1 p.m. Sept. 18.

Brighton Corporation invite tenders for 25 electric motor-car bodies, trucks, and electric-motor equipments, and also for steel girder tramway rails, fishplates, and joints. Tenders by Oct. 1.

Hull Electric Lighting committee invite tenders for steam and water pipes, feed-pumps, &c. Tenders (addressed chairman of committee) to town clerk's office by noon Sept. 27.

Tenders are invited for wiring *Wrexham* Corporation baths. Particulars from Messrs. Trentham and Peers, 96, Deansgate, Manchester, before 15th inst.

Middleton Town Council require tenders for erecting electricity station buildings. Tenders to town clerk by Oct. 11.

Glasgow Corporation invite tenders for the power station piping required at Pinkston. Tenders to town clerk by 5 p.m. Sept. 28.

Tunbridge Wells Corporation invite tenders for high and low-tension cables. Tenders to town clerk by Sept. 29.

Whitehaven Corporation invite tenders for a switchboard. Tenders by Oct. 13.

Rathmines and Rathgar (Dublin) Council require tenders for electric lighting stores, coal, &c. Tenders by 24th inst.

Tenders are invited for erecting and equipping a telephone exchange in *Santiago de Compostella* (Spain). Tenders to the Civil Administration of Corunna Province, or to the Registro del Direccion Generale de Correos y Telégrafos, Madrid, by 13th prox.

Tenders are invited for the electric lighting of *Azuaga* (Spain). The lighting is to be effected by 10 c.p. or 16 c.p. incandescent lamps, and the equivalent of about 3,000 will be required. Tenders by 11th prox.

Cienfuegos (Cuba) Municipal Council invite tenders for public electric lighting. Tenders to secretary by Oct. 26.

The Director-General of Works and Communications of the Brazilian Ministry of Industry, *Rio de Janeiro*, invite tenders for the supply and erection of electric (or hydraulic) cranes on the new quay at Recife.

TENDERS RECEIVED AND ACCEPTED.

Portsmouth Corporation have received the following tenders for the complete equipment of the proposed tramway power station:—

Dick, Kerr & Co. (*accepted*)	£29,656	0	0	Brit. W'stingh'use Co.	£29,390	0	0
Elec. Constructn. Co.	30,262	0	0	Brush Co.	29,351	10	0
Siemens Bros. & Co.	29,858	0	0	Brit. Schuckert Co.	29,130	0	0
R. W. Blackwell & Co.	29,568	17	0	Combe, Barbour & Combe	27,137	12	6

The special sub-committee, to whom these tenders were referred, reported that only three firms (Messrs. R. W. Blackwell & Co., Dick, Kerr & Co., and the Electric Construction Co.) would complete the work before next summer, and they submitted for consideration the alternative offer of R. W. Blackwell & Co. on engines of British make (made by Yates and Thom) for £29,875. 17s., and the offer of

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Messrs. Dick, Kerr & Co. for £29,656. The first-named firm would complete the work in eight months, while Messrs. Dick, Kerr & Co. would undertake to run one or two sets in six to seven months, and complete the whole in nine months. The offer of Messrs. Blackwell was for American electrical apparatus. The generators varied slightly from specification in having a lower efficiency. Messrs. Dick, Kerr & Co.'s tender provided for British-made plant, &c., throughout, and the whole of the apparatus was entirely in accordance with specification. This tender was also superior to Messrs. Blackwell's in other respects, notably with regard to the pipe work. Both were experienced firms, and practically agreed to the conditions of contract, excepting for an objection on the part of Messrs. Blackwell to clauses 15 and 24. They therefore recommended the acceptance of the tender of Messrs. Dick, Kerr & Co., and this recommendation was adopted.

The contract for the erection of the station building has been let to Mr. J. W. Perkins at £10,515. 8s.

In our last issue we announced that the tender of E. Lace & Son had been recommended for acceptance by the Cardiff Electric Light committee for the supply of sundry pipes, feed water heater, &c, for the electricity works at £1,379. This recommendation has been adopted by the Corporation, and we give below a list of the tenders received :—

E. Lace & Son (*accepted*)	£1,379 0 0	J. Williams & Son	£1,760 0 0
E. Danks & Co.	2,500 7 6	Babcock & Wilcox	1,525 0 0
Edwards & Barnes	2,159 0 0	Aiton & Co.	1,442 0 0
D. B. McCallum	1,953 0 0	Crompton & Co.	1,173 0 0

The City of London Guardians have received the following tenders for wiring the Board's offices, 61, Bartholomew-close, E.C. :—

Newsome, Pinching & Co. (*accepted*)	£430 0	E. H. Leaf	£545 10
Wm. Heath	624 0	J. O. Grant	542 7

Messrs. Richard Johnson & Nephew submitted the lowest tender to the Roumanian Post and Telegraph authorities, Budapest, for the supply of 40 tons of galvanised steel wire, 2mm. diameter, quoting 699·8fr. per metrical ton.

Aberdeen Corporation have accepted the tender of Messrs. Macartney, McElroy & Co. for steel poles, bases and brackets, for extensions of the overhead tramway system. Tenders were also submitted by Messrs. Robt. W. Blackwell & Co., McDowall, Steven & Co., Lowdon Bros. & Co., J. Russell & Sons, and the Walsall Electrical Co.

The Hart Accumulator Co. have secured the contract for the supply of the storage battery required by the Nuneaton and Chilvers Coton Council for the extension of their electricity supply works.

Middlesbrough Town Council have accepted the tender of Messrs. Tadsall and Smith for wiring the electricity works at £231. 15s.

Belfast Electric committee have accepted the tender of Messrs. Edwards and Barnes for feed-water heaters for the electricity supply station.

Southport Corporation have accepted the tender of Messrs. S. Z. de Ferranti (Ltd.) for a rectifier and switchboard at £400, and that of Messrs. Gwynne & Co. for motors and pumps at £710.

Morecambe Council have accepted the tender of Messrs. C. A. Parsons & Co. for condensing plant for the electricity works at £490. The tender of Messrs. E. Green & Son has also been accepted for additional economiser pipes.

APPOINTMENTS VACANT AND FILLED.

Crewe Corporation require the services of an electrical engineer for their new electric lighting and traction works. Salary £200 per annum. Applications to be sent in to the town clerk (Mr. Frederick Cooke) before 19th inst. See advertisement.

A shift engineer is required for the Rathmines electricity works. An advertisement gives further particulars, and applications must be sent in to the resident engineer (Mr. G. F. Pilditch), electricity works, Rathmines, Co. Dublin, by Monday, 24th inst.

Brighton Corporation require a junior assistant in their meter and testing room. Applications to manager, electricity works, North-road, Brighton. See advertisement.

Birmingham Small Arms Co. require an assistant electrician. See advertisement.

An assistant electrical engineer and fitter is required for the City of London Asylum, near Dartford, Kent. Applications to medical superintendent. See advertisement.

An engineer to look after electric lighting plant is required for the Park Fever Hospital, Hither Green, S.E. Applications to Metropolitan Asylums Board, London, E.C., by 24th inst.

Eccles Corporation require a consulting electrical engineer to advise on the extension of the electricity supply undertaking. Applications to town clerk by 17th inst.

Lowestoft Corporation invite applications for the position of resident electrical engineer. Applications to town clerk before 21st inst.

A lecturer and demonstrator in physics is required at University College, Nottingham. Applications to secretary by 25th inst.

There is a vacancy for a pupil at the Rathmines electricity works. Particulars from the resident engineer (Mr. G. F. Pilditch).

Mr. A. J. Margetson, associate of the Merchant Venturers' Technical College, has been appointed assistant in the Mechanical Engineering Department of that institution. Mr. Margetson entered the electrical engineering department of the college as a City of Bristol senior scholar, and completed his course of study in 1894. Since then he has been employed in the works of the Bristol Wagon and Carriage Co.

BUSINESS NOTICES.

We are asked to state that the business relations between Messrs. Pritchetts and Gold and Messrs. Venner & Co., by which the latter firm have acted as sole selling agents for the Pritchett accumulator, have been dissolved by mutual consent. Firms who have previously dealt with Messrs. Venner & Co. for Pritchett accumulators are requested in future to communicate direct with Messrs. Pritchetts and Gold.

Messrs. Ward and Goldstone have taken more extensive premises at 45, Dutton-street, Strangeways, Manchester.

Messrs. Everett, Edgcumbe & Co. inform us that they have taken over the instrument making business of the Edwards Electrical Co., Ltd, of Bow, London, E. Some advance sheets of the new catalogue now in preparation are forwarded, and illustrate and describe "Harrison" direct-coupled recording voltmeters of several types, dial ammeters for alternating or direct current, charge and discharge ammeters, "Swinburne" wattmeters, &c. Copies of these advance sheets can be obtained on application from the offices, 22, Charterhouse-square, London, E.C.

The British Thomson-Houston Co. have opened a branch office in Manchester at Trevelyan-buildings, Corporation-street, where local inquiries should be sent.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against E. J. Paterson and C. F. Cooper (trading as Paterson and Cooper), European Works, Pownall-road, Dalston, and 3, Prince's Mansions, Victoria-street, London, and 137, West Regent-street, Glasgow, must be in by 22nd inst. Mr. E. C. Moore, 3, Crosby-square, London, E.C., in trustee.

F. L. L. Lindsay, electrical and mechanical engineer, Gorphwysfa, Llandegfan, Anglesey (lately trading at 216, High-street, Bangor), has been adjudicated bankrupt. The first meeting of creditors will take place on 18th inst., at the Ship Hotel, Bangor, and the public examination on Oct. 4 at the Magistrates' Room, Bangor.

R. Foster and W. Baker (trading as Robert Foster & Co., and as the Nelson Electrical Engineering Company, at Burnley and Nelson, Lancs.) have been adjudicated bankrupts.

Easton, Anderson and Goolden (Ltd.).—A meeting of the shareholders and creditors of this company was held at the Guildhall Tavern, London, on Wednesday, presided over by Mr. Peat, official liquidator.

The CHAIRMAN said he was authorised in April, 1899, to dispose of the business as a going concern, but up to December last he had not succeeded in doing so, although several tenders had been made, with resulting negotiations involving much correspondence, but nothing definite had accrued. The firm was still going on and carrying out contracts given by the Admiralty, and their trade *clientèle* was, in fact, of the highest character. There had been a good deal of litigation in connection with the firm's contracts, but on the whole much very satisfactory—indeed, profitable—business had been done, and they had a large amount of work still to do. No accounts had been made up from last December to the present month, and he could not say anything definite on that subject. They had been in litigation over one matter, and judgment was given in their favour, but an appeal was still *sub judice*, so he could say nothing as to that. The creditors had been brought together solely because Mr. Hooley had been unsuccessful in floating the company, and a claim was pending against the trustees of Mr. Hooley's estate. They had been met in a very fair spirit. Since the last meeting attempts had been made to sell the business, and the negotiations up to the present time had been embodied in the form of an agreement, which the Court had sanctioned, and this meeting of debenture-holders, shareholders and creditors had been called together to confirm the agreement. In effect the agreement provided, as was set out in the circular calling the meeting, for the purchase of the entire concern for £252,000—£27,000 in cash, £150,000 debentures, £30,000 preference shares, and £45,000 ordinary shares. He (Mr. Peat) had advanced £10,000 to continue the business, and £17,000 would be applied to pay arrears of interest. This disposes of the £27,000 in cash they were to receive, and the debenture stock to be received would go to satisfy the existing debenture shareholders. Mr. Wilson had agreed to take new preference shares in lieu of his present holding. The 45,000 ordinary shares were to be retained under the control of the liquidator for two years, and the proceeds arising from them as the proposed new company progressed would go to the creditors. The dividend on the old estate was about £10,000. He had already received about £5,000, and there was cash at bank £3,000. They anticipated about

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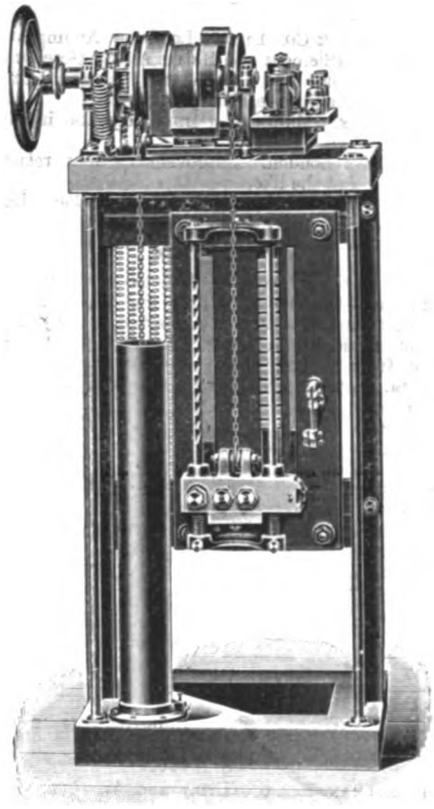
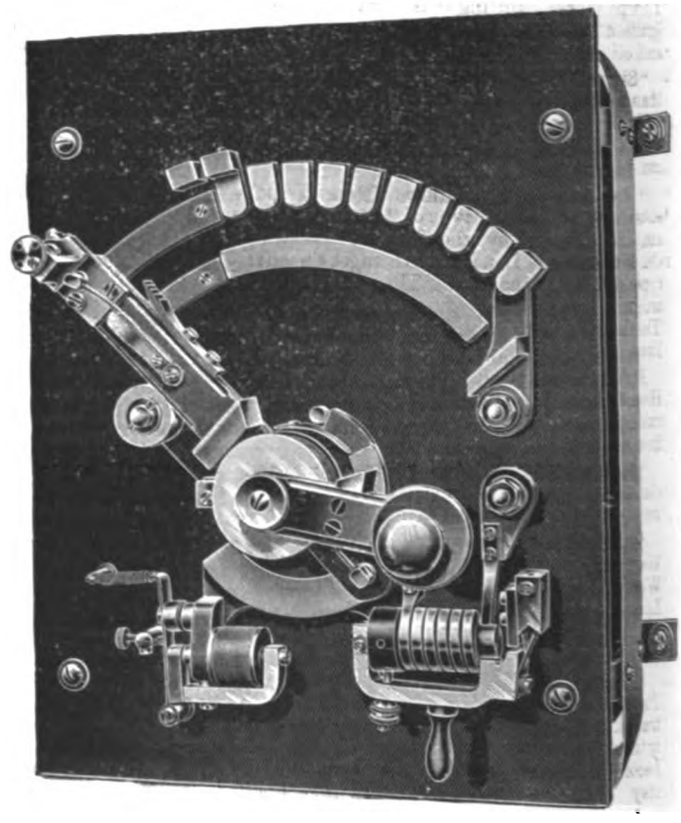
£3,000 as the result of the pending lawsuit to which he had referred. The cash assets of the company he estimated at between £10,000 and £15,000 plus the £3,000 from the lawsuit and £45,000 in ordinary shares. Against this the claims of creditors amounted to £59,743, or, after certain reductions had been made, to, say, £56,000. No promotion was being paid to anyone in connection with the new company, but Mr. Wilson was to receive £2,500 in ordinary shares in consideration of making over certain valuable patents in connection with a new machine. The new company was practically a reconstruction plus an amalgamation which Mr. Wilson was hoping to bring about in a certain direction. This would involve the bringing of £50,000 fresh capital into the firm and the creation of a fresh debenture stock, but that was a question of the future, and more could not be said thereon at present.

After Mr. Wilson had made a few remarks concerning the new machine, a resolution that the meeting, having heard the statement of affairs, approve the sale of the business set out in the agreement mentioned, and authorised the receiver to see same carried into effect, was carried unanimously.

Patent Automatic Switches.—We illustrate below the A and B types of automatic switch manufactured by the Electrical Transmission Co., Albert Works, Beavor-lane, Hammersmith, London, under the patents of Mr. Walter F. Jones, the manager of the company. For the A type it is claimed that it is practically impossible for an unskilled operator to damage either the motor or the switch, as it switches on automatically at a slow speed out of the operator's control after the motor-field magnets are well excited. It switches off automatically if the motor is overloaded, or if the current exceed the given quantity, or if supply fails. When the case is on there is nothing outside but the operating hand wheel, the whole of the mechanism being enclosed. In general practice, the switch is the same as the B type, the arrangement of the parts being, however, different. The chief claim made for the A type over the B type is that it takes the starting-up entirely out of the operator's control and switches on at the speed for which it is adjusted. The switch-arm stops when full on each contact, and proceeds with a "quick make" to the next when cutting out the resistance switching-on, thus avoiding a fault which has prevented the satisfactory continuous working of many other slow-moving switches. The switch operation is performed as under: When starting up the operator winds up a heavy weight in a dash-pot by means of a spring bolt, and when fully wound the hand wheel sheers out of engagement with the weight by compressing the spring bolt. This locks the hand wheel and prevents further forward movement. The weight then descends into the dash-pot, drawing the switch-arm over the contacts, and the step-by-step motion is secured by a spring detent which acts at each contact. Moving the hand wheel backwards, the switch-off causes the short-circuiting of the clutch and releases the switch-arm. The B switch, on the other hand, cannot be switched on until the motor field magnets are well excited. It automatically switches off if the operator attempts to switch on too quickly, if the current exceeds a given amount, or if supply fail. The chief novel feature of this switch is that the handle is not directly attached to the switch-arm, but is held to it by electro-magnetic means when the conditions are suitable. The switch-arm and handle lever are of iron, and have pole-pieces attached extending across the face of a coil mounted to surround the iron spindle of the switch, and together they constitute an electro-magnetic clutch. The switch also has a temporary contact (shown just above the clutch coil in the illustration), a non-sparking arrangement (shown at the bottom left in the illustration), and a maximum cutout and hand switching-off handle (shown at the bottom right in the illustration). The illustration shows the switch in the "off" position. The action of switching-on is as follows: The handle is brought towards the switch-arm, so as to bring the pole-pieces together; this causes the circuit at the temporary contact to energise the clutch coil and also excite the motor magnets, as the clutch coil is in series with the motor field-magnet coils. It is then necessary to pause for a short period, depending on the size of the motor, until the current in the field magnets has risen to about its proper amount, as otherwise the clutch will not be sufficiently powerful for the switch handle to draw the switch-arm against the spring which has brought it to the "off" position. The switch-arm can then be drawn slowly from contact to contact until the full "on" position is reached, when the switch handle is held by a spring detent. The gradual rise of the current in the field magnets of a motor, especially those of large size, can be easily noted by placing an ammeter in the circuit, and where it is not taken into account serious excessive flushing of current with damage to switch contacts and sparking at the motor brushes results through the only partial excitation of the magnets. Should the operator switch on too fast the maximum cutout acts, short-circuiting the clutch coil, so releasing the switch-arm from the handle, when it springs back to the "off" position, inserting the resistances as it does so. The object of the "non-sparking" arrangement is to temporarily close the circuit while the switch-arm is travelling to the first contact of the switch, when it is cut out of circuit. Open-type switches are provided in all cases with wire guards, so that the action of the apparatus cannot be interfered with, and the maximum cutout handles are arranged so that they cannot be held down.



A type Switch (on special frame).



B type Switch.

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Electrical Engineering Business for Sale.—The business of P. C. Middleton & Co. (Ltd.), electric light and power engineers, of Aberdeen, Edinburgh, Inverness, &c., is for sale as a going concern. Further particulars are given in an advertisement. The business includes the electricity supply plant and mains at Cults, Aberdeen. The liquidators offer the business for sale as a whole, but are prepared to consider separate tenders for the various branches. Offers to either Mr. W. R. Reid, advocate, 46A, Union-street, Aberdeen, or to Mr. S. Easton Simmers, C.A., 58, Bath-street, Glasgow, joint liquidators; or to their law agents, Messrs. Wilsone and Duffus, advocates, 146, Union-street, Aberdeen, who will supply all further information.

Engineering Works for Sale.—Our advertisement columns contain particulars of engineering works in the city of Dublin which are offered for sale by tender as a going concern owing to the death of the late proprietor. The works are centrally situated and have a suitable set of offices, pattern shop, machine shop and foundry, and smith's shop, together with a number of tools which are all of modern type, many of them being new. Tenders are to be addressed to Mr. A. Basil Wilson, M.I.C.E., Maryville, Malone, Belfast, from whom further particulars can be obtained.

For Sale.—In an advertisement an English patent of an electromotor is offered for sale by Mr. P. F. C. Iserloth, of Hamburg.

"Sunbeam" Lamps—A useful little pocket price list of "Sunbeam" lamps, lampholders, &c., is to hand, of which copies can be obtained by the trade on application to the company's office, Park-road, Gateshead-on-Tyne, or at the London offices, 141, Fenchurch-street, E.C., and at the company's numerous depôts.

Ignition Batteries.—Messrs. C. A. Vandervell & Co., of Thorpe Works, Notting Hill, London, W., issue a handy list of electric ignition batteries for motor cars, cycles, &c., and for stationary gas and oil engines.

"Sirius" Exhaust Steam Injector.—Messrs. Holden and Brooke, Manchester, issue a neat pamphlet of testimonials from users of the "Sirius" exhaust steam injector manufactured by the firm, particulars of which are published in pocket list No. 25. Both publications can be obtained on application.

"Stewart" Arc Lamps (New Type).—Price lists are now obtainable of the new type of "Stewart" alternating-current enclosed arc lamp made by the Stewart Electrical Syndicate, 57, New Compton-street, London. Amongst the advantages claimed for this type of lamp is that it is "The shortest in the market, will strike an arc on a lower voltage than any other lamp, and makes less noise." The lamp is only 25in. in length including the outer globe. The list illustrates a number of designs, both plain and ornamental.

B.T.H. Plant.—Pamphlet No. 74 issued by the British Thomson-Houston Co., deals with small direct-current motors, type C.A., examples being shown driving sewing machines, ice-cream freezers, &c.

"General" Electric Plant.—Leaflet No. 28 issued by the General Electric Co. illustrates and describes, amongst other matters, overhead trolley line material, suspensions, &c.

Worthington Pumping Plant.—A well-illustrated souvenir of Worthington pumping plant and apparatus is sent out by the Worthington Pumping Engine Co., 153, Queen Victoria-street, London, E.C., illustrating the company's exhibit at Paris and a number of machines erected in various parts of the world. The souvenir can be obtained on application.

"Petroleum."—We have received a copy (No. 3, Vol. I.) of *Petroleum*, the representative organ of the petroleum and allied trades. The new journal has everything to recommend it to those interested in what is already a large industry and promises to become a still larger one. *Petroleum* looks as though it had come to stay. The annual subscription is 10s, single copies 6d.

Argentina Electrical Imports.—The *Review of the River Plate* gives the following figures relating to the imports of electrical goods and appliances into Argentina for the first half of the current year:—

Galvanised iron wire (10,463 tons)	$753,616 gold.
Dynamos (434)	57,231
General material (2,784 cases)	125,687
Cables and wires (629 tons)	277,984
Fittings, including gas fittings (48 tons)	70,280
Electric bells (3,570)	1,785
Porcelain insulators (85 tons)	10,679
Glass insulators (7 tons)	401
Arc lamps, carbon (60 tons)	9,012
Incandescent lamps (18,613 dozen)	53,025
Telephone material (364 cases)	18,672
Telegraph do. (187 do.)	11,884

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 5 to Sept. 11, with the ports of destination:—

Africa—Alexandria, £170; Cape Town, £179; Durban, £966; East London, £67 (including £44 telegraph material). *Argentina*—Buenos Ayres, £367. *Australasia*—Adelaide, £75; Auckland, £75; Brisbane, £20; Launceston, £35; Lyttleton, £158; Melbourne, £1,142; Perth, £785; Sydney, £1,155; Wellington, £4,256 (including £4,180 telegraph material). *Belgium*—Ostend, £340. *Burma*—Rangoon, £12. *Ceylon*—Colombo, £44. *China*—Shanghai, £184. *Germany*—Emden, £308 (telegraph apparatus); Essen, £60 (telegraph material); Hamburg, £200 (telegraph material). *Holland*—Amsterdam, £70; Flushing, £28. *India*—Bombay, £98; Calcutta, £220. *Malta*—£32. *Portugal*—Lisbon, £105 (telegraph material). *Siam*—Bangkok, £149. *Straits Settlements*—Singapore, £277. Total £12,523, against £5,878 in the corresponding week last year (Sept. 6 to Sept. 12).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

July 4, 1900.

12,054. P. H. Frost-Smith. London. The electric lighting of motor-driven vehicles.

12,074. Siemens Bros. & Co. (Ltd.). London. An improvement in static voltmeters. (Siemens and Halske Aktien Gesellschaft, Germany.)

12,086. A. W. Baxter and C. Baxter. Sussex. Improvements in electrical storage or secondary batteries.

12,089. C. E. Grove. Middlesex. Improvements in dynamo electric machinery.

12,100. E. B. Viles. London. Improvements in or relating to electrical tramways and the like.

12,111. J. Szczepanik and L. Kleinberg. London. Improvements in electrical Jacquards and dobbies.*

July 5, 1900.

12,128. G. S. Holmes. Liverpool. A device for shielding fallen wires from overhead electrical conductors.

12,139. J. Collis and T. J. Kelly. London. "Backing up machine" for mechanically backing up "electro" and "half tone work" either for books, periodicals, or trade work.*

12,152. C. Heim. London. Improved method for the practical application of lead secondary batteries.

12,160. V. Thomas. London. Improvements in the manufacture of filaments for electric incandescence lamps.

12,170. P. Mandowsky. London. Electric meter.*

12,175. The Thomson-Davis Telephone System (Ltd.) and A. T. M. Thomson. London. Improvements in electrical relays.

12,177. W. Walker, jun. London. Improvements in the holders of electrical, incandescent, or glow lamps.

12,179. H. Hirst. London. Improvements in or connected with electrical tramways or railways.

July 6, 1900.

12,249. H. H. Lake. London. Improvements relating to thermo-electric cells. (L. S. Langville, United States.)*

12,256. C. A. M. Bärner. London. Improvements in and relating to electric arc lamps.*

12,267. V. de Robinsky. London. Improvements in electric accumulators.

July 7, 1900.

12,276. Cope, Allman & Co. (Ltd.) and W. Allman. Birmingham. Improvements in hooks or clips for gas and water pipes, electric wire conduits, picture rods and the like.

12,296. B. Russell. London. Improved turbine fan or air propeller, driven electrically or by mechanical power.

12,315. G. Blanck, J. W. Hudson, and W. J. Downs. London. Improvements relating to electrical signalling and communicating apparatus.

12,321. F. Kaeferle. Liverpool. An improved collector for electrical machines and the like.*

12,331. E. Schellbach. London. Improvements in blocks for electric conduits.

July 9, 1900.

12,388. A. J. Boult. London. Improvements in or relating to mechanical motive devices for the controlling drums or switches of electrically propelled vehicles. (E. R. Gill, United States.)

12,391. G. P. Harding. London. Improvements in electric traction.

12,392. Callender's Cable and Construction Co. (Ltd.) and J. C. A. Ward. London. Improvements in clamps for holding the ends of electric fuses or links acting as electrical conductors.

12,393. A. Groves. London. An improved case or cover for electric bell pushes and the like.

July 10, 1900.

12,401. N. E. G. Little. Bolton. Safety fender or life guard to attach to electric cars or other mechanically propelled vehicles.

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12,434. H. H. LAKE. London. Improvements relating to the manufacture of conducting material for electrical and other purposes. (W. J. Burke, H. A. Kaufhold and T. Russell, United States.)*
12,436. H. H. LAKE. London. Improvements relating to fire alarm apparatus or signals. (J. D. Gould, United States.)*
12,466. G. G. M. HARDINGHAM. London. Improvements in the construction of rail-bonds for electric railways, and in the mode of applying the same. (Felten and Guilleaume Carlswerk, Actien-Gesellschaft, Germany.)

July 11, 1900.

12,469. S. COWPER-COLES. London. Improvements in vessels for containing fused salts during electrolysis.
12,485. R. KRAYN. Manchester. Improvements in chromoscopes.*
12,495. V. I. FEENY. London. Improvements in and relating to frit apparatus. (Allgemeine Elektricitäts Gesellschaft, Germany.)*
12,499. F. VON MADALER, S. BASEL, S. ROSNER, and W. A. GROS. London. Improvements in phonographs.
12,531. C. VON SEDNEFF. London. Positive electrode for accumulators.
12,532. C. VON SEDNEFF. London. Improvements in switches for accumulator electrodes.
12,537. P. F. RIBBE. London. Improvements in and relating to accumulator plates.*

July 12, 1900.

12,554. W. SUNTER. Edinburgh. Appliance for generating electricity to be utilised for propelling machinery and for other useful purposes.
12,591. C. C. T. SOHRMANN and C. M. O. FEIST. London. Improved device for setting fuses or cutouts in electric circuits.
12,598. C. CONTAL. London. Improvements relating to driving axles for electric and other vehicles. (Date applied for under Patents, &c., Act, 1883, sec. 103, Jan. 6, 1900, being date of application in France.)
12,603. ENTWISLE AND STEPHENS (LTD.) and H. J. STEPHENS. London. Improvements in or relating to shades for incandescent electric lamps.
12,609. W. B. BURNIE. London. Improvements in testing sets for measuring insulation resistances.

July 13, 1900.

12,624. E. M. PARSONS. Hull. The Parsons automatic storage battery switch.
12,672. A. VOELKER. London. Improved manufacture of glass by electrical heating, and apparatus therefor.*
12,673. A. VOELKER. London. An improvement in the manufacture of glass by electrical heating.*
12,709. F. M. LEWIS. London. Improvements in electric arc lamps.

July 14, 1900.

12,716. W. B. DALE. Keighley. Improvements in electric switches.
12,733. M. I. PUPIN. London. Art of producing attenuation of electrical waves and apparatus therefor. (Date applied for under Patents, &c., Act 1883, sec. 103, Dec. 14, 1899, being date of application in United States.)*
12,735. H. J. EVERATT. London. Improved electrical railway fog and danger signal apparatus.
12,737. H. OPPENHEIMER. London. Improvements in and connected with keys or switches in lampholders. (Actiengesellschaft Mix and Genest, Germany.)
12,739. J. F. P. RINGSDORFF. London. An improved dynamo brush.
12,743. H. BEHRENDT. London. An improved method of and apparatus for the local application of electrical treatment to the human body.

July 16, 1900.

12,772. J. T. PEARSON. Burnley. Improvements in and relating to arms and trolley for overhead electrically-driven tramcars.

July 17, 1900.

12,837. E. E. BARTLETT and J. E. ROBINSON. Liverpool. Improvements in electrical switches.
12,838. J. W. FERRIER. London. A "safety" carbon holder and carbon economiser for use in electric arc lamps.
12,843. H. E. FRIESE. London. Electric bell.
12,846. J. GLASMACHERS and C. MÜLLER. Germany. Improvements in portable electrical safety lamps.*
12,855. C. JUNGE. London. Improvements relating to the manufacture of bulbs for electric incandescent lamps. (The Oberlausitzer Glashüttenwerke Otto Hirsch, Germany.)
12,874. G. BLANCK. London. Improvements in and relating to telephonic apparatus.
12,876. E. G. JOHNSON, F. D. PALMER, and C. COENEN. London. An improved trolley for overhead electric traction.*
12,893. T. ROSATI. London. Underground wires for transmitting electric energy.*

July 18, 1900.

12,922. Sir W. H. PREECE, K.C.B., and P. CARDEW. London. Improvements in electrical tramways and trains.
12,944. H. F. CLAYTON, T. BELL, and S. S. BERRY. Manchester. An improved electrical switch.
12,950. P. GARUTI and R. POMPILI. Birmingham. Improvements in voltameters for the electrolysis of the water system Garuti.*
12,971. D. R. BRUCE. London. Improvements in electric switches.*
12,973. SIEMENS BROS. & CO. (LTD.). London. An indicator for high electrical tensions. (Siemens and Halske Aktiengesellschaft, Germany.)
12,977. P. E. FRANCKEN. London. Improved electric battery.
12,992. W. J. DAVY. London. Improvements in or connected with electric traction.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

16,198. OPPENHEIMER (Actien Gesellschaft Mix and Genest). Multiple switchboards.
16,200. OPPENHEIMER. (Actien Gesellschaft Mix and Genest). Holders for electric incandescent lamps.
16,225. NICHOLS and W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.). Conduits for laying electrical cables.
16,295. PEARMAIN. Plugs for telephone switchboards.
16,300. GOSLIN. Safety fuses for electric circuits.
16,311. SAVAGE and W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.). Dry core electrical cables.
16,410. ECKSTEIN and ANGOLD. Electric arc lamps.
16,600. NISBETT. Manufacture of earthenware troughs for carrying electric cables and analogous purposes.
16,628. ANDREWS. Arc lamps.
16,820. MILLS (David and David). Electrically controlled design reading apparatus for punching jacquard and like cards.
16,956. BATE. Conduits for electric conductors.
17,262. WINTER and FÜTTER. Arrangements of connections and conductors for railways worked by electricity.
17,410. HADDAN (Goldstein). Electric accumulators.
17,719. LORRAIN. (Macdonald). Variable-rate electric meters.
18,040. CUTMORE. Telephone speaking tube and like receivers.
18,064. LITTLE and IRELAND. Electric trolley standards.
18,200. KENNEDY. Ships' telegraphs.
18,335. BREMER. Electrodes for arc lamps.

1900.

559. WISE (Aktiengesellschaft Elektricitäts-werke vorm. O. L. Kummer & Co.) Transformers.
956. WILSON. Telephone apparatus and induction coils for use therewith.
2,703. SCHLOMANN and DE CASTRO. Process and apparatus for electrolytically treating ropes, hose, cork, asbestos, and textile fabrics of all kinds.
3,174. MENGIS. Long distance telephony.
3,203. LECARME and LECARME. Interrupters for electric circuits.
5,088. THOMSON (Brown). Bonding for iron or steel electrical conductors.
8,465. BOULT (Collins). Electric motors.
8,486. EDISON. Apparatus for duplicating phonograph records.
9,458. EGLIN. Space telegraphy.
9,730. WORSLEY and GREEN. Electric switches.
10,137. KRAYN. Electric lamps.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC INCANDESCENT LAMP REGENERATING SYNDICATE (LTD.) This company was registered on Sept. 8, with a capital of £7,500, in £1 shares, to acquire certain patents and to carry on the business of electrical and general engineers, electricians, contractors, &c.

LIQUID AIR POWER AND AUTOMOBILE CO. OF GREAT BRITAIN (LTD.) This company was registered on Sept. 5, with a capital of £200,000 in £1 shares, to enter into an agreement with Mr. T. J. T. Huteson and to carry on the business of producers of and dealers in liquid air, manufacturers of apparatus for use in connection with its production, storage and utilisation of liquid air, cycle, motor car and carriage builders, &c., and electrical, mechanical and general engineers, &c.

SHERARD COWPER-COLES & CO. (LTD.) — This company was registered on Sept. 4, with a capital of £25,000 in £1 shares, to acquire the business now carried on by Mr. Sherard Cowper-Coles, and to carry on business as electricians, electrical and consulting engineers, metallurgists, suppliers of electricity, chemists, chemical manufacturers, machinists, &c. The subscribers are: H. R. Braid, electrical engineer; E. G. Woodridge; H. Sayer, metallurgical chemist; H. Groome, electrical engineer; M. A. Hankey, electro-metallurgist; F. S. Spiers, electro-chemist; and C. E. Peczenik, engineer. The first directors are: The Marquis of Queensbury (chairman), Messrs. W. B. Cowper-Coles (deputy-chairman), J. Day, R. Steele and S. H. Cowper-Coles.

BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.)—The annual return to Aug. 17 has been filed. The capital is £500,000, in 200,000 vendors' and 30,000 ordinary shares of £1 each, of which 20,000 vendors' and 20,000 ordinary have been taken up. £1 per share has been called up and paid on the ordinary shares. The 20,000 vendors' shares are considered as fully paid.

CHILI TELEPHONE CO. (LTD.)—The annual return to Aug. 24 gives the capital as £250,000, in £5 shares, 44,000 of which have been taken up and paid for in full.

COLUMN PRINTING TELEGRAPH CO. (LTD.)—According to the annual return to Aug. 13 the capital is £25,000, in £50 shares, 289 of which have been taken up. £50 has been called up on 189 shares, and £8,940 has been received, leaving £510 in arrears. £5,000 is considered as paid on 100 shares.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The annual return to Aug. 15 gives the capital as £350,000, in £1 shares, 204,000 of which have been taken up. 5s. has been called up on each of 99,000 shares, and £24,349 has been received. The remaining 105,000 shares are considered as fully paid.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28⅛d. per oz. (Sept. 13). Consols (2¾ per cent.) 98½—98⅝ for money, 98⅝—98¾ for account; 2½ per cent. 97½—97¾ (Sept. 13). Stocks and Shares Continuation Days, Sept. 26 and Oct. 10; Ticket Day, Sept. 27; Pay Days, Sept. 14 and 28; Mining Share Carry-over Days, Sept. 25 and Oct. 9.

BRITISH ELECTRIC WORKS CO. (LTD.).—The directors' report for the past 16½ months has been issued, and states that, after payment of debenture interest, there was a loss of £12,803 on working.

COMPAGNIE D'ELECTRICITE THOMSON-HOUSTON DE LA MEDITERRANEE.—The capital of this company, whose area of operations includes Greece, Italy, Spain and Portugal, has been increased from 10,000,000fr. to 20,000,000fr. (from about £400,000 to £800,000.)

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., tax free, on the ordinary shares, both for the half-year ended June 30, 1900, and payable on Oct. 1, next.

ELECTRICAL PROGRESS IN RUSSIA.—An extraordinary meeting of the Russische Elektricitäts Aktien-gesellschaft Union of St. Petersburg will be held on 25th prox. to consider a proposal to issue a loan for increasing the working capital, and also to purchase a site for electricity supply works at Kiew, and to form a company for erecting and operating the works.

W. T. GLOVER & CO. (LTD.)—The preference share transfer books will be closed from 17th inst. to 29th inst. inclusive.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—In the recent issue of ordinary and preference shares both classes were, we are informed, largely over-subscribed.

WESTERN UNION TELEGRAPH CO. (LTD.)—The executive committee recommend the payment of the usual quarterly dividend of 1¼ per cent. The statement for the quarter ending Sept. 30 (partly estimated) shows: Net earnings, $1,600,000 (decrease $77,000); balance after charges, $1,361,000 (decrease, $81,000); surplus after dividend, $144,000 (decrease, $81,000); total book surplus, $8,602,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Sept. 8	4,636	+ 137	9	41,034	+ 1,616
Blackpool Corporation...	„ 6	1,403	+ 352	23	20,588	+ 4,709
Blackpool and Fleetwood	„ 8	1,395	+ 60	10	14,520	− 28
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 9	679	+ 216	23	11,721	+ 2,186
Brisbane Trams	July 25	1,495	+ 117	3	4,795	+ 719
*Bristol Trams & Carriage	Sept. 7	3,629	− 68	10	35,630	− 705
*Buenos Ayres & Belgrano	Aug. 12	2,390	+ 371	6	12,786	− 797
Central London Railway	Sept. 8	4,647	...	6	27,475	...
City & South London Ry.	„ 9	1,487	+ 601	10	15,023	+ 5,584
Cork Elec. Trams	„ 6	547	+ 49	36	14,743	+ 1,223
Dover Corporation	„ 8	292	...	23	5,547	+ 318
Dublin & Lucan Rly. ...	...	...	...	...	..	..
Dublin United	„ 7	4,097	+ 587	10	39,221	} +4177
Dublin Southern Dist....	„ 7	1,134	+ 83	10	11,766	}
*Glasgow Corporation ...	„ 8	9,664	+ 209	...	...	...
Hull Corporation	„ 8	1,285	+ 627	10	13,325	+ 7,422
*Liverpool Corporation...	„ 1	8,778	+1,094	35	268,081	+30,201
Liverpool Overhead Rly.	„ 9	1,792	+ 178	10	17,487	+ 218
*Sheffield Tramways	„ 9	2,641	+ 958	36	78,414	+27,860

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, Sept. 5.		Price Wednesday, Sept. 12.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 12. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£96,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July......	...	...
25,000	10	...	Amazon Telegraph........................	...		...		...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	58	61	58	61	6 0 11	Feb., May, Aug., Nov.	...	...
£3,088,640	Stock	30/0	Do. Preferred	110½	111½	110½	111½	5 7 7	„ „	111½	110½
£3,088,640	Stock	27/0	Do. Deferred	12¼	12¾	11¾	12¼	11 0 5	„ „	12¼	11 11/16
$13,333,300	$100	$1¾	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101	103	101	103	3 17 0	„ „	103	103¼
16,000	10	6/0	Cuba Submarine Ordinary	6½	7½	6½	7½	10 0 0	February and August	7½	...
6,000	10	10/0	Do. Preference 10 per Cent.	15	16	15	16	6 5 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October......	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100%	104%	100%	104%	4 6 7	January and July......	...	...
60,710	20	5/0	Direct United States Cable	11	11½	10¾	11¼	6 4 5	Jan., Apr., July, Oct.	11	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	146	151	149	154	4 11 6	Jan., Apr., July, Oct.	150½	148
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	97	100	99	102	3 9 0	„ „	100½	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	112	117	114	119	3 8 1	May and November ...	115¾	114¼
250,000	10	2/6	Eastern Extension	14¾	15¼	15	15½	4 10 4	Jan., Apr., July, Oct.	14⅞	...
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	111	116	115	118	3 8 6	February and August	115	114
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) ...	100%	103%	100%	103%	3 17 8	May and November ...	...	...
180,227	10	4/6	Globe Telegraph and Trust	11	11½	11	11½	4 11 10	Jan., Apr., July, Oct.	11 1/16	...
180,042	10	3/0	Do. 6 per Cent. Preference	14¾	15¼	14¾	15¼	3 19 0	„ „	15⅛	15
150,000	10	5/0	Great Northern of Copenhagen	32	34	32	34	3 13 6	January and July......	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) ..	98	101	98	101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	51	55	51	55	4 10 11	May and November ...	52⅞	52
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	103	106	103	106	5 13 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100	103	100	103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October......	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125	130	125	130	4 12 10	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	96	99	97	100	5 0 0	March and September	...	...
30,008	2½	...	West Coast of America	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 13 7	January and July......	...	...
88,321	10	1/0	West India and Panama	⅝	⅞	¾	1	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½	7½	6½	7½	8 0 0	„ „	7⅛	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5	6	5⅝	6½	9 4 8	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	103	106	104	107	4 14 7	January and July......	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾	15¼	14¾	15¼	4 11 10	Mar., June, Oct., Dec.	15 1/16	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103	106	103	106	4 14 4	June and December ...	...	...
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2½	3½	2½	3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...		...		...	July	...	...
172,680	1	2½%	Monte Video Telephone Ordinary	¼	½	¼	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
590,000	5	3/0	National	4⅝	4⅞	4⅝	4⅞	6 3 1	February and August	4 13/16	4¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	13	15	13	15	4 0 0	„ „	14¼	..
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	13	15	13	15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5	5¼	5	5¼	4 15 3	„ „	5 3/16	5 1/16
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98	101	98	101	3 9 8	June and December ...	99⅛	98½
171,504	1	0/8	Oriental	⅞	1⅛	⅞	1⅛	4 8 11	April and October......	...	...
58,000	5	4/6	United River Plate	4¾	5¼	4¾	5¼	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference........................	4¾	5¼	4¾	5¼	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)........	104	107	104	107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 5.	Price Wednesday, Sept. 12.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 12. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜ ⅝	⅜ ⅝	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11⅜ 12⅝	11⅜ 12⅝	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red.)	100 103	100 103	4 7 5	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6 6½	6¼ 6¾	...	...	...	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp.	9 10	9 10	4 12 6	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¼ 5⅝	5½ 5⅝	3 18 3	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7⅛	6½ 7⅛	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	103 111	4 1 6	June and December...	110	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	7½ 8½	8 9	4 8 11	February and August	8⅜	8¼
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 16 0	January and July	12⅞	12½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 123	124 123	3 18 2	June and December ...	123	123
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½ 9½	8½ 9½	6 6 4	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11 12	11 12	5 0 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1 1⅛	1¼ 1⅜	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	3½ 4⅜	4 5	6 0 0	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	99 101	99 101	3 19 9	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord.	14 15	14 15	3 13 4	April and October	15	14⅞
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December ...	...	...
£125,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	96 98	3 11 6	...	97½	...
6,452	10	6/0	Notting Hill Electric Ordinary	14½ 15½	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5⅞ 6⅛	5⅞ 6⅛	3 16 11	,,	...	...
300,000	1	8%	Rand Electric	1 1/16 1⅛	1 1/16 1⅛	10 13 4	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14 15	14 15	4 16 8	February and August	14⅜	14⅛
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	,, ,,	8 3/16	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	2	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 3	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3 4	3 4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12 13	12 13	5 0 0	March and September	12 1/16	12
29,437	5	...	Do. £3 10s. paid	8½ 9½	8½ 9½	...	...	8 1/16	8⅛
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	7/16 7/16	7/16 1⅜	4 8 11	...	...	...
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	11/16 11/16	¾ ⅞	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	3/16 3/16	...	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅜ ½	⅜ ½	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	...	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅜ 6⅛	5⅜ 6⅛	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,060	2	1/2⅜	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	4 5 4	September	...	...
90,000	2	1/2⅜	Do. 5 per Cent. Pref. Non-Cum.	2⅜ 2⅝	2⅜ 2⅝	5 1 1	,,	2⅜	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	106 111	106 111	4 0 11	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 103	101 103	4 7 5	June and December ...	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	12½ 13½	12½ 18½	5 11 1	,, ,,	13	12⅝
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5¼ 5⅝	5 5½	4 10 11	,, ,,	5⅛	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	,, ,,	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	6 8 0	November and May	1⅛	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7⅜	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
54,000	3	2/3⅜	Crompton and Co. (Nos. 1 to 32,098)	3⅜ 4⅛	3⅜ 4⅛	5 5 10	January and July	4	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7⅛	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	1⅞ 2⅛	1⅞ 2⅛	8 0 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅜ 4⅛	3⅜ 4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	90 92	90 92	4 7 5	June and December ...	90½	90⅛
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	68 72	68 72	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4⅛ 5	4⅛ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99 102	99 102	4 8 3	...	...	...
112,100	2	1/2⅛	Electric Construction Co. (Limited)	1⅞ 2⅛	1⅞ 2⅛	5 12 11	January and July	2	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2¾ 3¼	2¾ 3¼	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	102 105	3 16 2	January and July	...	...
30,000	5	4/0	Henley's Telegraph Works Ordinary	11⅛ 12⅛	12 13	5 15 5	February and August	12⅛	...
30,000	5	2/3	Do. 4½ per Cent. Preference	5 5⅛	5 5⅛	4 1 10	,, ,,	5 1/16	5⅛
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	108 112	108 112	4 0 4	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 104	101 104	3 17 10	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	35 38	35 38	4 12 4	March and July	36	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11⅛	10½ 11⅛	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5¼ 5⅝	5¼ 5⅝	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10⅛ 11⅛	10⅛ 11⅛	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7	6½ 7	4 5 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	106½	106
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	2/0	Blackpool and Fleetwood Tramways	14 16	14 16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103 105	103 105	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	21⅛ 22⅛	21⅛ 22⅛	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10⅛ 10⅜	10⅛ 10⅜	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10 10½	10 10½	4 15 3	May and November	...	...
45,000	10	11/0	British Elec. Trac. Ord.	14½ 15⅛	14½ 15⅛	6 9 0	...	15⅛	...
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12 1/16	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123 123	123 124	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (Issued Feb. 5, 1900)	121 124	121 124	...	...	123½	123
40,000	5	2/8 3/16	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅝ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4⅛	3⅞ 4⅛	...	...	3⅞	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 15 0	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	96 99	96 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10 10½	10 10½	2 17 2	June and December ...	10⅜	10½
£355,000	Stock	1½%	City and South London Railway Con. Ordinary	57 60	57 60	2 6 0	February and August	59	...
37,500	10	1/5 1/16	Do. (Nos. 22,501 to 60,000)	5 6	5 6	2 9 4	,, ,,	5⅛	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	138 143	138 143	3 9 11	,, ,,	...	...
£200,000	Stock	5%	Do. (1898)	130 135	130 135	3 14 1	...	...	...
£241,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary xd	21 22	21 22	3 12 9	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference xd	14½ 15	14½ 15	3 18 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
95,000	1	0/9	Isle of Man Tram. and Elec. Power Ord.	...	...	...	March and October	...	...
70,000	1	0/7½	Do. 6 per Cent. Pref.	3/16 ⅜	...	...	,, ,,	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9¼ 10½	9⅜ 10½	4 17 7	May and November	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary	8½ 9	8⅞ 9	4 8 11	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13½	3 15 6	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	102 104	104 106	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¼ 3⅜	3¼ 3⅜	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½ 10⅝	10⅜ 10⅝	4 14 1	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
540,000	Stock	3%	Waterloo and City Ordinary	92 95	92 95	3 3 7	June and December	93	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote them.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,166. [No. 22. Vol. XLV.] FRIDAY, SEPTEMBER 21, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 30c., or 70pf.

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NOTES.

THAT the city of Manchester has been suddenly isolated telegraphically from the rest of the world is a most startling event, occurring as it does when the summer is hardly spent, and the climatic conditions are all that could be desired. We are accustomed to such breakdowns in the winter time, and are ready to accord the praise it deserves to a department which so speedily repairs all damages. But this disaster, originating at a single point, so far-reaching in its consequences, and yet so trivial in its origin, is likely to create surprise of a very disagreeable kind. It would appear that the whole telegraph service, and to some extent the telephone service, centred in the Manchester office is liable to utter destruction by the misuse or careless handling of a spirit lamp in the rear of the test-box. The lamp seems to have burst, as these lamps are apt to do; and the result in this case was to set the inflammable coverings of the wires and the dry woodwork adjoining ablaze. The conflagration, thus merrily started, soon spread to the roof, which duly fell in, destroying all the telegraph instruments beneath and wrecking the poles and standards on the top. Many days will elapse before temporary arrangements can be made to re-establish communications in fresh premises, and meanwhile the most important commercial city in England, next to London, is deprived of its customary means of intercourse with the business world.

JUDGMENT may be suspended until more detailed particulars of the accident come to hand; but on the face of it we are entitled to say that it ought never to have occurred. Whatever the form of spirit lamp employed it had no business to be in such a critical position; and if, as is most probable, the lamp was a "roarer" its employment would be little less than criminal. Further details of the conflagration are given in another note. To add to the confusion of Cottonopolis, the electric light broke down at eight o'clock the same evening. Owing to the interruption of telephonic communication we are unable to ascertain exactly what occurred; but it appears that the breakdown was complete while it lasted, the street lighting, and the lamps in theatres, private houses, &c., being extinguished throughout the city.

THE resolutions of the Cable Makers' Association with regard to specifications of electric supply mains were published on p. 790 of our last issue, but arrived too late to enable us to comment on them then. We have frequently emphasised the importance both to cable manufacturers and cable users of establishing certain conventions as to the sectional area and resistance of electric light cables; for up to the present, owing to the uncertain effect of the "loss in lay" on the resistance of a stranded cable and the practice of specifying the size of cable in terms of the "equivalent sectional area," the same specification could easily convey to different engineers and manufacturers different ideas as to the size and weight of the conductor. The table forming part of the cable makers' manifesto gives the number and size of wires to be employed for each sectional area and the resistance that the cable should have in each case—although the latter information is valueless as it stands, owing to the omission to state at what temperature the conductor is to have this resistance. Apparently the values are calculated for 60°F.

WITH regard to the constant cry of manufacturers for standardisation, we have always pointed out that the remedy lay in the hands of the manufacturers themselves. If each manufacturer standardised his own wares it would be a great advance, and the next step would evidently be an agreement among leading manufacturers to adopt the same standards. In cables for electric light and power supply we have reached this point therefore, for the Association who have signed this report include all the leading English manufacturers of cable of this class. Unanimity as to the terms of contracts is also a great benefit to the industry, especially the resolution as to the non-finality of the engineer's decision. This conversion of an arbitrary clause into an

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arbitration clause should also be insisted upon in the case of tenders for other material than cable.

We print in another column an interesting and instructive communication from Mr. H. G. Barwell, under the heading of "A Common Phenomenon noticed in Cable Work," which we think throws some light upon a subject at one time undoubtedly regarded as somewhat of a mystery by those engaged in submarine cable laying and repairing. It was frequently noticed when a splice between two types of cable was paid out into the sea that peculiar sharp kicks were observable upon the galvanometer employed for keeping a constant test upon the cable during the operation; and these kicks were sometimes so marked that they have not infrequently given rise to the suspicion that an incipient fault had developed in the cable, with the result that paying out has been temporarily suspended until further tests could be taken

In recent years, however, the true cause of the phenomenon has been realised by more than one cable engineer, and Mr. Barwell's observations and experiments tend to confirm their ideas upon the subject. As a proof of this, it is the usual practice now, when making a splice on board ship between two types of cable, to remove all taping from the outer sheathing wires and to scrape and clean them thoroughly at intervals; and good contact between them is further ensured by binding the parts so cleaned together with iron-wire wrappings. If this is effectually and carefully done, the phenomenon under notice is usually conspicuous by its absence. Mr. Barwell's Paper is of interest, however, in that his experiments tend to confirm the accuracy of previous surmises, and the method he suggests of "listening" for the approach of a fault or splice when picking up might very well, under certain conditions and in some circumstances, be extremely useful.

The Paper on "Electrolysis of Underground Metal Structures," which we reprint this week, has the recommendation of being written from the point of view of the complainant owners of such structures. The author, Mr. D. H. Maury, is the engineer to a large waterworks at Peoria, in the State of Illinois, and for many years he has evidently being taking careful stock of the mischief wrought by stray currents from electric tramways. He brings now a serious indictment against the overhead trolley system, and backs up his charges by a formidable array of actual instances, many of which are exhibited in photographs which we have reproduced. The subject is of pressing importance, and electrical engineers are as ready as anyone to admit it. None are more eager for a real solution of the difficulty which shall completely and permanently remove the mischievous tendency to corrosion. It is a libel on their profession to hint that their motive in recommending the bonding of water pipes to the negative conductor is merely to obtain a better conductivity for their return current, and thus to reduce their coal bills. The charge is preposterous. Traction engineers are seriously in earnest in their desire to prevent corrosion; for they know well enough that the popularity of the trolley system is menaced if damage is continually being done to water mains and similar underground conduits. It is an incidental effect that the public—the British public, at any rate—would not long stand.

They appear to be less exacting in America, notwithstanding that the traction companies are palpably more careless. Fortunately, as we have often said before, we in this country have a Board of Trade. Its regulations in regard to tramway leakage may not be all that could be desired; but they are, at any rate, restrictive. Illogical from the beginning, and now gradually being shown by practice to be ineffective, the 7-volts limit is a measure of protection that greatly postpones, though it fails to mitigate, the final catastrophe at the water mains. Seven limited volts are preferable to 70 unlimited—common enough in America! Nevertheless, postponement is not a real solution of the problem. Terrible as it may be to contemplate that American practice precipitates the aqueous irruption in five or six years at most, British practice gains little or no security from the fact that the calamity approaches at no more than one-fourth the pace. There must be no damage at all.

We do not admire Mr. Maury's proposed solution of the difficulty. Having carefully examined on the spot "the double trolley system, overhead, as at Cincinnati," we relegated it to the limbo of curious failures. There are many people of Cincinnati who would gladly do the same with its outward and visible manifestation in that city. Better far than this aerial nightmare to provide the ordinary trolley with an underground insulated return connected permanently to a series of surface contact-studs on the track. We do not think this has ever been tried. The principal drawback to the surface-stud systems in their entirety is the complicated mechanism necessary for rendering the studs alive only when a car is over them. The difficulty vanishes when all the studs are on the return conductor and are never at more than, say, 7 volts above earth potential. This would be but little more costly than the ordinary trolley system, especially when it is remembered that much paraphernalia in the shape of rail bonding, negative boosters, &c., would be rendered unnecessary. Moreover, it is a modification that any trolley traction company or authority, with proclivities in underground corrosion, can be made to adopt at any time without involving serious change in the electrical system of working.

A letter from Prof. J. Chunder Bose this week illustrates in a striking manner how theoretical research may assist practice with useful suggestions. While mainly engaged in trying to evolve a satisfactory theory of the coherer, Prof. Bose has observed phenomena which indicate what may be the best course to follow in wireless telegraphy. Thus, it having been ascertained that with many materials a strong electric radiation produces the opposite effect to that excited by weak radiation, it follows, Prof. Bose shows, that in wireless telegraphy the point-coherer should prove the most sensitive arrangement. The steps in the argument leading to this conclusion are clearly laid down in Prof. Bose's letter. We trust that, in the leisure from his actual researches, he will bestow on his practical brethren some further suggestions of

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this kind; for it is undoubtedly those who best can interpret sound theory who are most competent to lead practice.

THOUGH there is truth in the saying that all the sciences are "but parts of one stupendous whole," M. WILLOT's recent attempt to establish a practical link between stratigraphical geology and wireless telegraphy scarcely illustrates the truism. Acquaintance with the bowels of the earth may be useful knowledge to an electrician, but who would have supposed it would lead to his sending wireless messages along various courses by confining them each to its own allotted geological stratum? Yet such is the proposal made by M. WILLOT, an Inspector of French Telegraphs, at the International Congress of Electricity, at Paris. According to a daily contemporary, the French Telegraphs Department is so enamoured of the scheme that it has appointed a committee "to sink electric pits in different places in order to find out the distribution of electric levels under the earth." Electric pitfalls!

Erratum.—In our report last week of the discussion on "Ions" at the British Association, p. 783, line 26, for "five electrons" read "free electrons."

East London Technical College.—Some particulars of the courses in physics, engineering, mathematics and chemistry are given in an advertisement. Calenders can be obtained from the Director of Studies (Mr. J. L. S. Hatton).

City of London College.—The Michaelmas terms of this college commence October 1. Classes are held on magnetism and electricity, sound, heat, light, mathematics, chemistry, and other science subjects. Prospectuses can be obtained of the secretary, Mr. David Savage, White-street, Moorfields, E.C.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	Sept. 17, 1900
Tangier—Tarifa	Jan. 3, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Pernambuco—Para	Sept. 19, 1900 ...	—

Finsbury Technical College.—At the Technical College, Finsbury, the evening courses begin on Monday, October 1st. Prof. Silvanus P. Thompson opens the Monday evening (Advanced) course with an introductory lecture on the Distribution of Electricity, the succeeding Monday evenings until Christmas being devoted principally to the subject of the Design of Continuous-Current Dynamos and Motors. On Wednesday evenings Dr. E. W. Marchant will lecture on Electric Currents and Methods of Measurement. Prof. Thompson will also give a short course of Special Lectures on Fridays on the Polarisation of Light.

Chinese Cables.—The Eastern Extension and Great Northern Telegraph Companies announce that the laying of the submarine cable between Shanghai and Chefoo has been successfully completed and the line opened for traffic. This, with the Chefoo-Taku cable recently laid by the companies, provides submarine telegraphic communication to Chefoo and Taku, available for international traffic, entirely independent of the Chinese landlines and without any addition to the existing tariffs. The companies also announce the laying and opening of branch cables between Chefoo and Wei-hai-Wei and between Chefoo and Port Arthur.

Appointments.—Mr. L. R. Wilberforce, M.A., demonstrator in physics at the Cavendish Laboratory, Cambridge, and University Lecturer in Physics, has been appointed to the Lyon Jones Chair of Experimental Physics at University College, Liverpool, vacated by the appointment of Dr. Oliver Lodge to the Principalship of the University of Birmingham.

The Admiralty has created an important new post in the dockyard staff, namely that of electrical engineer, to rank next to the four chief assistant engineers. To fill this post the Admiralty has chosen Mr. Louis J. Steele, M.I.E.E., late chief engineer to Messrs. Verity, and formerly assistant engineer with Messrs. Johnson and Phillips. Mr. Steele received his training at the Technical College, Finsbury, under Prof. Silvanus Thompson and Prof. Perry, and was awarded the certificate of the College in 1890. He will be attached to the dockyard staff at Portsmouth.

Obituary.—We regret to record the death of Mr. Abdank-Abakanowicz, a prominent engineer on the other side of the Channel. Bruno Abdank-Abakanowicz was born in Wilkomir, Poland, in 1852. After graduating at the Riga Polytechnicum he occupied the chair of Graphical Statics and Applied Mechanics at the Lemberg Polytechnic from 1874 to 1881, after which he went to Paris and established himself there as a consulting engineer. He has published books on graphical statics and integrating machines, and also many Papers in the *Comptes Rendus* of the Academy of Sciences and various other French publications. Mr. Abdank-Abakanowicz was a Knight of the Legion of Honour, member of the Société de Physique, and member of the Council of the Société Internationale des Electriciens. He was also one of the founders of our esteemed contemporary *L'Industrie Electrique*. In 1889 he organised the United States Section of the Paris Exhibition, and was nominated member of the jury, and he was intimately connected with the French Thomson-Houston Company and other leading firms.

The Propagation of Electric Waves along Parallel Wires.—In a communication on this subject to Section A of the British Association, at Bradford, Mr. W. B. Morton states that in the *Annalen der Physik* for June, 1900, a very complete investigation of this problem has been published by G. Mie. He finds expressions for the wave-length and damping of the oscillations involving a series of ascending powers of the ratio of radius of wires to distance apart. The object of this communication is to point out that the approximate solution, in which the square of this ratio is neglected, can be very easily obtained from the known solution for a single wire, as worked out by Prof. J. J. Thomson and by Sommerfeld. The formula for the damping agrees with that given by Heaviside's simple theory when Lord Rayleigh's high-frequency values are used for the resistance and inductance. Attention is called to an error in the formula for the K_0 function in the work of Thomson, Sommerfeld, and Mie, arising probably from an erratum in Heine's "Kugelfunctionen"; it affects the numerical values worked out in Sommerfeld and Mie's Papers.

The Third-rail System in the United States.—During the last few weeks there has been an outcry against the use of the third-rail system on the elevated railways in Brooklyn. Here, as in other towns in the United States, the third-rail is employed extensively, but recently there have been several accidents to workmen in which shocks from the unprotected line rail were a contributory cause. The Deputy Commissioner of the Department of Public Buildings Lighting and Supplies has in consequence issued an order to the railway companies that they must either make the system absolutely safe or do away with it entirely; and a New York contemporary states that the authorities have ordered that on Brooklyn bridge the charged third-rail must either be removed or protected by guards 3in. high on either side of it. The Baltimore and Ohio Railroad Co. on its new third-rail system through the Belt Line tunnel has encased the third-rail between two planks set on edge, and it is possible that similar expedients may be adopted on other lines. There should be no great difficulty in either placing the third-rail in a safe position or protecting it sufficiently to prevent accidents.

An 1887 Electric Railway.—A description of an electric tramway built in Wichita (Kansas) as long ago as 1887, is published in the September number of the *Street Railway Journal*. Mr. T. C. Hughes, the writer of the article in our contemporary, obtained the concession and was responsible for the erection of the line. The track was of 40lb. girder rail. In the power house were two 100 H.P. horizontal tubular boilers, a horizontal high-speed engine, and a Brush dynamo with an output of 60 amperes at 1,000 volts. The trolley wire was a hollow copper tube ¼in. diameter and

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about $\frac{1}{32}$in. thick, made in 18ft. lengths. At the end of each length was a switch, whose function was to cut out of circuit the section of the trolley wire immediately above the car. Two trolleys pulled by a flexible cord were attached to the roof of the car with spring clamps, one at either end of the car, at a distance apart about 4ft. greater than the length of the sections of the overhead conductor. The front trolley opened the switch as it passed, and the rear trolley closed it, so that the motor was always cut in in series with the line. Thus the return wire could be a separate pole line, independent of the car. The trolley wire and switches were suspended every 5ft. by insulating supports from longitudinal cables, carried by, but also insulated from, span wires, which were stretched between wooden poles. The trolley itself consisted of a frame carrying five wheels, and, as will be readily understood, its construction and that of the section insulator and switch was fairly complicated. The motors were mounted in a rigid frame, journaled at four points on the axles, and geared to one axle with coil wire belts. As might be expected, the line was only kept running a short time; and, moreover, a proposition to remodel the line on the parallel instead of the series system and to mount the motors on a spring suspension was rejected.

An Experiment on Simultaneous Contrast.—At a meeting of Section A of the British Association at Bradford, Mr. G. J. Burch described an experiment on this subject. It is well known that white objects seen against a red background look greenish-blue, and orange against a blue background. This phenomenon is shown in a striking manner in the following experiment due to Hering: A small white disc is viewed with the left eye against a red background, and another similar disc is viewed against a blue background with the right eye. The discs are so placed as to occupy different positions in the field of view. The result, when the light has been properly adjusted, is that the observer sees an amethyst-blue disc and a topaz-yellow disc against a pale purple ground. The reason of this is demonstrated by the author in the following experiment: Two pieces of glass, one red and the other blue, are inserted in a stereoscope in place of the usual slide, each glass having two small squares of black paper on it. Viewed binocularly the four squares appear as two. In front of the instrument, but out of the direct line of sight, are two adjustable slits, and over the eye-lenses of the stereoscope are two diffraction gratings. The position of the slits is so arranged that the spectrum of the first order of the left-hand grating falls on the right-hand square, and that of the right-hand grating on the left-hand square, the two spectra, which can be adjusted to the same intensity, being thus seen side by side, one with the left eye on a red ground, and the other with the right eye on a blue ground. The red glass produces partial red blindness of the left eye, and the spectrum seen by it lacks red, the other colours being unaltered. And for a similar reason the spectrum seen by the right eye lacks blue, the effect being more noticeable owing to the contrast of sensation in the two eyes. In the author's opinion this experiment affords further confirmation of the views of Scherffer, Darwin and Young in regard to contrast.

A New American Trolley Head.—The *Street Railway Review* for August contains a description of the Feist trolley head recently brought out in the United States. We extract the following particulars from our contemporary's description: The device consists of a two-piece harp, made of malleable iron, and a hardened steel axle, threaded at its ends, connecting these pieces. Four holes are bored in this axle, in each of which is carried a graphite pencil of special composition, these pencils being held against the bearing of the trolley wheel by helical springs in such a manner as to secure constant and even lubrication and assure positive contact. One set of lubricating pencils outlasts a 20,000-mile wheel. Thin lubricating washers are placed on this axle between the wheel and the arms of the harp, thereby ensuring lubrication here, and preventing cutting such as would occur with a metal washer. The axle for a two-motor equipment is 1in. in diameter, while for a four-motor equipment it is made $1\frac{7}{16}$in. in diameter. The size of these axles offers an increased bearing surface, thus insuring ample contact and a materially longer life to the wheel, both bearing and axle being evenly and thoroughly coated with the lubricant. An even wearing away of the bearing is thus obtained, effectually obviating the objections to be found in some of the present graphite bushing combinations, where the wheel bearing is not sufficiently lubricated, causing it to wear away in parts unevenly, and so rapidly becoming loose, causing destructive arcs between the wheel and its axle. This results in blistering the axle, and hence there are frequent renewals and repairs, to say nothing of the short life obtained.

Serious Fire at the Manchester Postal Telegraph Office.—A fire, attended with serious consequences, occurred on Wednesday afternoon at the Manchester Central Post Office, doing considerable damage to that part of the building occupied by the telegraph department, and causing great destruction of telegraph apparatus and plant. According to the *Standard*, the fire was first discovered in a test-box, behind which were a number of wires. Suddenly flames were seen coming from the box, and immediately the whole apparatus was enveloped in flames. The woodwork in the room being very dry, the fire spread with alarming rapidity. The efforts of the clerks in the room to subdue it made not the least impression, the fire-extinction apparatus on the premises proving wholly inadequate for the emergency. The city fire brigade were telephoned for and arrived in great force. In a short time they gained mastery of the flames, but not before the roof had fallen in and the telegraph instruments were so completely wrecked as to cut off the city from telegraphic communication with the rest of the world. The vast collection of wires erected over the building were of course dislodged from their supports, and a great number of lines were not merely interrupted, but absolutely destroyed. The outbreak occurred about half-past one o'clock, when there were 300 or 400 operators in the room. There was no panic, however, their retirement being effected in perfect order. The fire, it appears, was caused by the bursting of a spirit lamp which was being used by some employés of the engineering department, who were repairing the wire coils near the test-box. This is the point where all the wires entering the building converge, and is, accordingly, one of the most important spots in the building. The department of the Engineer-in-Chief in London was immediately communicated with, and it is hoped that the assistance obtained from there, as well as from the engineering departments of some of the other principal offices in the country, will enable the Manchester authorities to remedy the effects of the disaster in the course of a few days. The Manchester Post Office is one of the busiest outside London, being the chief centre for telegraphic distribution through the North of England. The various wires converge at Manchester and spread, in a great network, north, south, east, and west. Many important towns are served from the building which has been so seriously damaged by Wednesday's outbreak, and thus the difficulty arising from the isolation of the city is shared by business people over a very wide area. The building, which was opened in 1884, is constructed of Portland stone, and cost about £120,000. The total number of employés is 2,200. The telegraph instrument room in which the fire broke out is 400ft. in length and 83ft. wide, and contains 250 instruments. To meet the emergency in regard to telegrams the authorities of both cities promptly utilised the excellent train service between Manchester and Liverpool. Thus telegrams handed in at Manchester for transmission to distant places were trained every half-hour to Liverpool, and there put on the wires; whilst, vice versâ, messages from all parts of the country for Manchester were wired to Liverpool and thence trained to Manchester. In telegraphic matters the Post Office is noted for the promptitude and ingenuity with which it can cope with an interrupted communication, and many thousands of messages have been already thus diverted. A system is being organised by means of which Lancashire and Yorkshire towns, whose "transmitting centre" ordinarily is Manchester, will be connected through to Liverpool, which, until the Manchester office is at work again, will be the transmitting centre. A vast amount of extra work will be thrown on the Liverpool office, but every effort will be put forth to successfully cope with it.

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THE NEW ELECTRICITY WORKS OF THE GLASGOW CORPORATION.

(*Continued from page 767.*)

The Port Dundas Station.

Site of Buildings.—A satisfactory feature of the Port Dundas station is its position with regard to the Forth and Clyde canal. The canal is at a considerably higher level than the engine room floor, and the ground falls away rapidly from the canal to the roadway. Although this necessitates the coal store, boiler house, engine room, and accumulator house being on different levels, it offers considerable advantages as regards the supply of fuel.

The station is a handsome pile of buildings of red pressed bricks, relieved with red sandstone facings, designed under Mr. Chamen's direction by Mr. Andrew Myles, an architect who has designed many large engineering works in Scotland. The coal store is capable of containing over 2,000 tons of fuel. The boiler house (see illustration in our last issue, p. 767) is 558ft. long by 81ft. wide. It is arranged for only one line of boilers facing towards the coal store and leaving ample space in the rear for economisers, steam pipes, etc., as it is intended as far as possible to keep all steam pipes in the boiler house. There is no ring main, but arrangements are made so that the main steam pipe can be relieved of all pressure at certain times without shutting down the station.

The plans are made for three chimneys, dividing the space behind the boilers into four lengths. The centre chimney, which is the only one at present built, is 200ft. high and 11ft. in diameter; it is built on a square base which reaches to about the roof level, the shaft being of a circular section with an ornamental cap. It is constructed of red pressed bricks and lined with firebrick. Protection is afforded from lightning by a ring of collecting points attached by several diagonal bands to two copper lightning conductors. The other two chimneys are each 250ft. high and 13ft. diameter.

Next to the boiler room and parallel with it, but again on a lower level, is the engine room, which is about 57ft. in width. It is spanned by a 25-ton travelling electric crane by Messrs. Broadbent & Sons, which should be large enough to deal with sets of plant up to 2,500 H.P. capacity. Next to the wall of the boiler house is a trench along which water tanks on weighing machines can be run for the purpose of measuring the condensed steam from the air pump of any engine which may be under test. As will be seen from the detailed description of the plant, all the larger sets are fitted with separate surface condensers, have the air pumps driven directly by the rocking shaft and connecting rods, or more generally in all the recent plants by independent electric motors. The cooling water is taken from the canal at one end of the engine house and returned to it at the other, the necessary pumps for this purpose being of the centrifugal type electrically driven, but owing to the position of the canal very little power is required to effect this purpose. There is another trench on the opposite side of the engine room along which all the feeders are led.

In front of the engine room, and forming the main frontage of the buildings, is in the centre the main entrance, flanked on either side by a battery room 77ft. long by 26ft. wide. The tower itself contains the station engineer's office, an important feature of which is its bay window, which projects over the engine room, enabling the engineer to look from end to end of the engine house without leaving his room. Another special feature is an overhead gangway, which is reached direct from the engineer's room by a spiral staircase. This gangway passes across the engine room above the level of the traveller, and thence across the boiler house, and out on to the towpath by the canal.

All the interior walls are covered with white glazed bricks, and the floor of the engine room is laid with granolithic. The floor of the switch gallery is laid with glass blocks, which serve the double purpose of giving a good light underneath and also of insulating the switchboard attendant from earth. Glass roofs have been employed throughout. Another feature of the buildings is the ample bathroom and lavatory accommodation, not only for the engineers, but also separate accommodation for the foremen and staff.

The portion of the building now opened is the centre one-third of the whole and is 220ft. long; and it is large enough to contain plant for an output of 10,000 H.P.

Coal Handling Plant.—The coal for the station is delivered in 30-ton barges by the Forth and Clyde Canal, and is lifted out of the barges at the rate of 30 tons an hour by means of a Temperley transporter, handling 1-ton lifts, the boom of which spans from the centre of the barge to the far side of the bunker roof. The transporter is made to travel on rails laid on the wharf; the gauge of the rails is 19ft. 4in., which is much larger than required for the transporter itself, but the conditions were such that no support for the rail could be made for a less gauge. The arm of the transformer which projects over the canal is made to hinge up in a vertical direction in order to clear the rigging of vessels when coming along the side, and to give a clear headway when required over the wharf. The overhang on the water side is 45ft., the overhang on the land side is 41ft., the centres of the tower uprights 12ft., giving a total effective travel of 98ft. The power plant is situated on an extended platform and is covered by a galvanized iron house, with glazed windows to enable the driver to have a clear view of the load during lifting, travelling and lowering. All the motions of the transporter are driven electrically by a 500-volt 20kw. British Thomson-Houston enclosed motor. The gear is capable of lifting 25 cwts. at a speed of 300ft. per minute, and of travelling along the beam at a speed of 600ft. per minute, the driver being able to propel the entire transporter along the rails in either direction by the simple movement of a lever. A load can be taken up or let down at every 5ft. along the beam. There is an automatic arrangement by which, as soon as the fall block enters the hood of the traveller, the weight of the load is taken off the hoisting rope, and the load is suspended directly from the traveller running on the beam. This arrangement unlocks automatically when the load is to be lowered. The complete operation, viz., lifting the full skip from the barge, travelling along the beam, lowering, and the return of the empty skip to the barge, is performed by means of one rope driven from the motor on the power platform, and only one man is required to work the transporter. The coal in the barges is filled into skips, these skips are lifted by the transporter, carried along the beam, and deposited into a travelling weighing machine, of Messrs. Pooley & Sons' make, which records the amount of coal passed through it, and passes it into diverting boxes, each fitted with two shoots, which deliver the coal into a reserve bunker holding 4,000 tons, or into steel coal tanks, holding 60 tons each, one of which is situated opposite to but above the level of each boiler. When the boilers are being fired a trap in the bottom of the tank is opened and the coal runs down an inclined shoot into the hopper of the mechanical stoker at its lower end. These shoots are hinged so that they may be slung back from the reserve bunker, which runs parallel with the whole length of the boiler house, and advantage has been taken of the fact that the building stands on the slope of the canal bank to incline the floor of the coal store to about 45deg., so that no trimming is required.

Boiler-house Plant.—The 10 boilers which are being erected at present are all of the Babcock and Wilcox make, containing 4,020 sq. ft. of heating surface, and each is capable of evaporating 15,000lb. of water per hour working at a pressure of 200lb. to the square inch. They are all fitted with Babcock and Wilcox chain grates and mechanical stokers, which are driven electrically by enclosed motors of the General Electric Co.'s make. The grates, detailed descriptions of which have already appeared in *The Electrician*, are mounted on carriages and may be removed complete from under the boilers for examination or repair. The clinker and ash is shot over the back of the grate into a recess, from which it falls through an opening in the ashpit into the ash tunnel, running under the ashpits for the whole length of the boiler-house. A tramway line fitted with a complete system of wire rope main and tail

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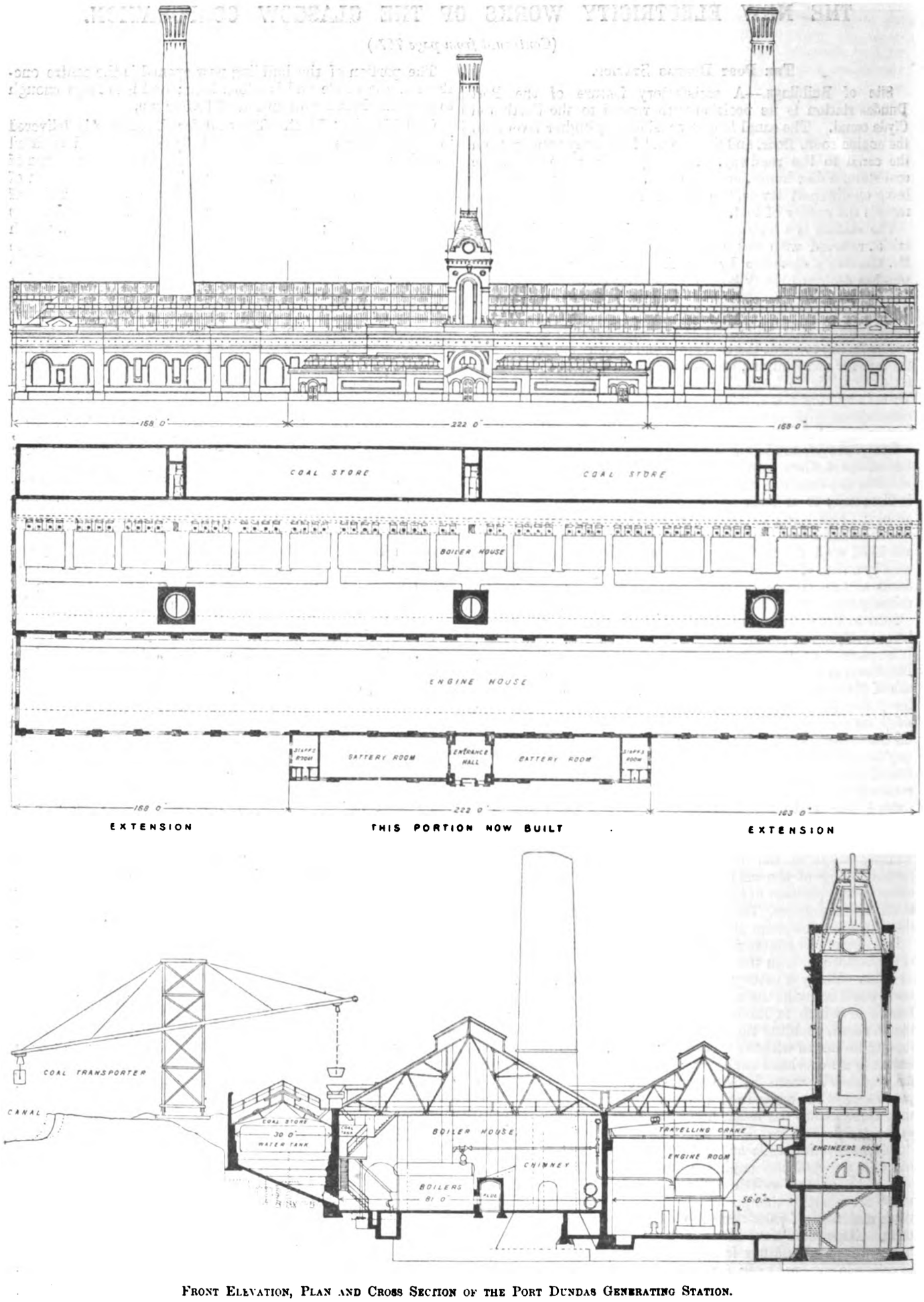

FRONT ELEVATION, PLAN AND CROSS SECTION OF THE PORT DUNDAS GENERATING STATION.

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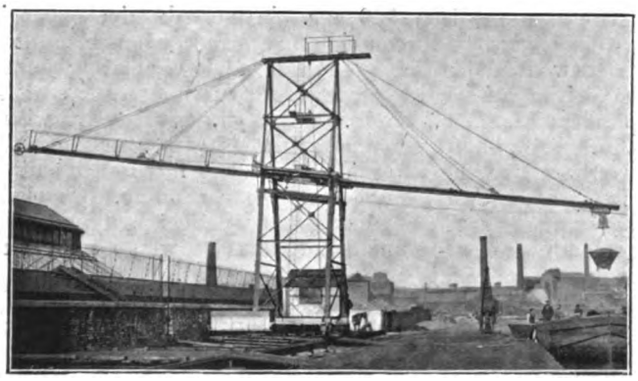
haulage, electrically driven, removes the ash from the tunnel on to a siding in the yard, where it is deposited in carts for removal. The boilers are fitted with the latest safety devices, Hopkinson water gauges and feed fittings, Babcock and Wilcox high and low-water sentinel valves, duplicate dead-weight safety valves, Babcock and Wilcox superheaters, Schaefer and Budenberg steam valves with steel seats and

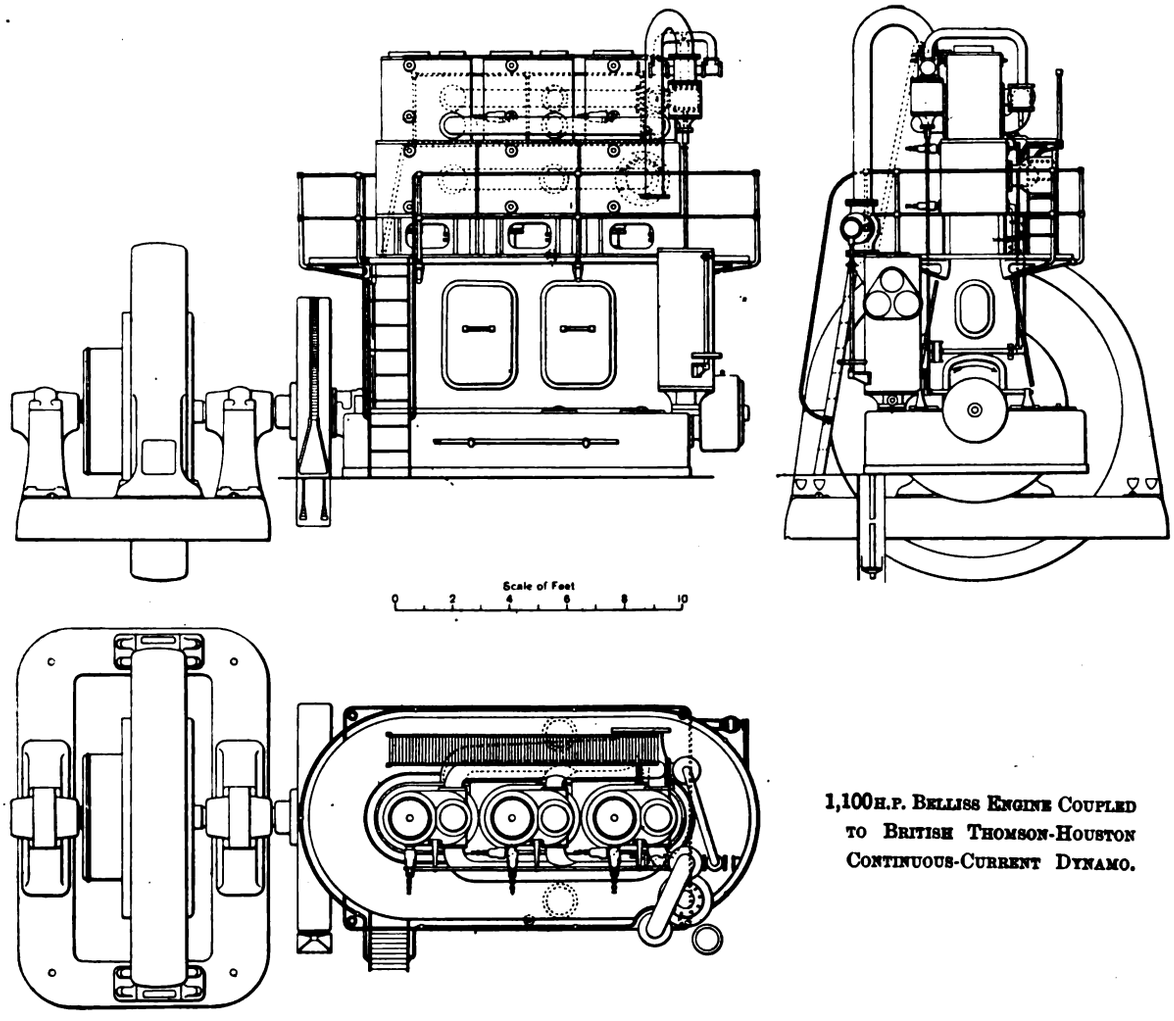


TEMPERLEY TRANSPORTER AT PORT DUNDAS STATION.

their patent safety explosion valve, which shuts the boiler off from the main in the event of a sudden drop of pressure due to the pipe giving out.

The feed range supplying the boilers is composed of two distinct lines of pipes running side by side along the whole length of the boiler-house, and each boiler is provided with an independent connection to each of these lines. The feed pumps are situated in the centre of the range, and consist of two double and one single direct-acting steam pump of Messrs. J. and A. Weir's make, having 7in. water pistons with a 21in. stroke. There is also a Hayward-Tyler three-throw ram pump driven through friction gear by a 12 H.P. series motor, the speed of the latter being regulated by altering the position of the field magnets with regard to the armature core while the machine is running; it is also arranged so that it can be run off either the 250-volt or 500-volt supply. The pump room is also fitted with a large hot well, a set of three gravitation filters, a large reserve storage tank, a feed tank, and duplicate connections from the city water mains. Opposite the pump room is the section containing the firemen's bathrooms and lavatories, which are all fitted with the most modern of sanitary appliances. The return connections from the boilers to the steam mains are 7in. mild-steel pipes with extra heavy flanges welded on, and the sections are bolted together with specially-machined and fitted mild steel bolts; one of these sections consists of an expansion loop of the same material as the pipes. The steam main consists of a 15in. mild-steel pipe with tee connections arranged so that the boilers and engines can be connected right through, or on to the common main as required. In this way it is possible to work a boiler and engine quite independently of the rest of the plant if necessary. These steam pipes were all constructed to Mr. Chamen's specification by Messrs. Stewart and Menzies. The main steam valves are of Messrs. Templer and Ranoe's make and are fitted with special steel seats.

Working platforms are provided for reaching the connections, and some idea of the size of the plant may be gained from the fact that there are, including those in the boiler house, 50 steam valves fitted already, none of them being less than 7in. Behind the boilers are the flues leading to the chimney, and a space with the necessary connection for the erection of fuel economisers should it be considered later on that any advantage would be gained by their use.



1,100 H.P. BELLISS ENGINE COUPLED TO BRITISH THOMSON-HOUSTON CONTINUOUS-CURRENT DYNAMO.

Engine Room Plant.—The machinery at present working consists of seven vertical direct-coupled sets with a combined

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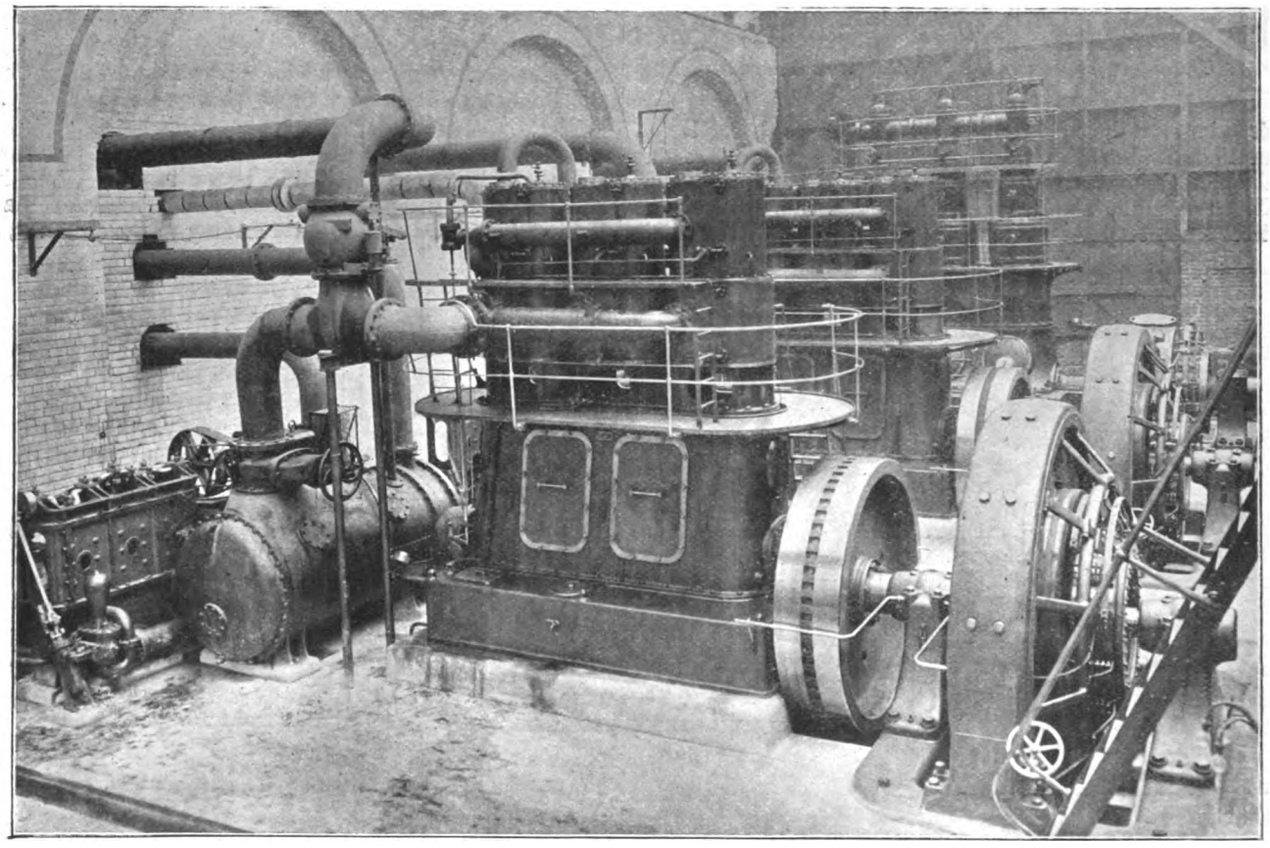
output of about 6,000 H.P. As has already been explained, the first portion of the plant was erected, owing to want of time, on the permanent foundations under a temporary wooden building. The present station was built round this, and when complete the wooden building was removed; while this was being done the plant installed was kept running up to its full capacity of 1,200kw. without a hitch, a fact which reflects greatly to the credit of Mr. Chamen and his assistants.

The four engines that were first supplied and run under these temporary conditions include, first, a 750 H.P. two-crank compound Ball and Wood engine. The engine has cylinders of 20in. and 44in. by a 24in. stroke, and runs at 150 revs. per min. The steam and exhaust valves are of the Corliss type, and the valve chests are placed on the top and bottom of the cylinder, each chest being divided so that one half contains the admission valve and the other half the exhaust valve for one end of the cylinder. The valves are right on the top of the cylinder covers and the ports are simply slots in the covers. The four admission valves are driven from one wrist plate and the four exhaust ports from another. The exhaust valves have a constant stroke, and the wrist plate is driven from an eccentric on the shaft by means of bell cranks and rods. The admission valves have a variable stroke, depending on the load on the engine. The sheave of the eccentric which drives them is not keyed on to the shaft, but is free to swing on trunnions, and the amount of its eccentricity or swing is controlled by the governor. This governor is a combined momentum and centrifugal governor, fitted with adjustable coach springs and weights, and mounted on the arms of the flywheel so that it takes up very little room. The gear will alter the period of admission on all four valves from zero to $\frac{3}{4}$-stroke, and the engine will take up some overload without any apparent alteration in the speed. Both cylinders are jacketed and there is an intermediate receiver fitted with a reheating coil. The lubrication is done by gravitation from tanks on the top platform, each bearing being fitted with an adjustable sight feed lubricator, and the oil after leaving the bearings is collected in a filter tank and again returned to the supply tanks on the platform. The connecting rods and crossheads are of the locomotive pattern. The main bearings are exceptionally long and are fitted with adjustable wedge packing, and the bedplate and back columns are of great strength and weight. This engine is coupled to two dynamos, built by the Walker Manufacturing Co. There is one machine on each end of the engine shaft, and they are compound-wound, eight-pole, 250-volt machines and are used as balancers, one being connected across each side of the three-wire system.

The next set is a 900 H.P. three-crank triple-expansion marine engine with combined surface condenser, built by Matthew Paul & Co. The air and circulating pumps are driven off the I.P. crosshead. The diameters of the cylinders are 17in., 25½in., and 38in. respectively, with a 30in. stroke, and the engine runs at 120 revs. per min. The governor is of the throttle type, and is fitted with suitable adjustment for varying the speed while running. Coupled to this engine is a 12-pole shunt-wound Schuckert dynamo with a smooth core bar-wound drum armature, whose end connections are arranged to assist the ventilation.



THE THREE 1,000H.P. SETS.

The remaining sets of the pioneer outfit are two single-acting constant-thrust enclosed engines, one of 200 H.P. and the other of 400 H.P., both built by the Mirrlees, Watson and Yaryan Co., of Glasgow. The smaller set is a two-crank two-cylinder compound engine with cylinders 14in. and 12in. diameter and a 12in. stroke, running at 380 revs. per min., the two cranks being placed opposite each other. The larger is a four-crank triple expansion engine with one H.P. cylinder 14in. diameter, one I.P. cylinder 22in. diameter, and two L.P. cylinders 24in. diameter, a 24in. stroke and a speed of 330 revs. per min. The four cranks are set so as to give balanced couples, the engines running under full load without any vibration. Each of these engines is coupled directly to a shunt-wound bi-polar Crompton dynamo, the outputs of these machines being 125kw. and 255kw. respectively, at 500 volts to 600 volts.

On the east side of the engine room are erected three fine 1,100 H.P. sets, each built to Mr. Chamen's specification. Two of these engines are of the well-known Belliss type, arranged for triple expansion working, having six cylinders on three lines—viz., one high pressure, two intermediate pressure, and three low pressure, the high and intermediate pressure

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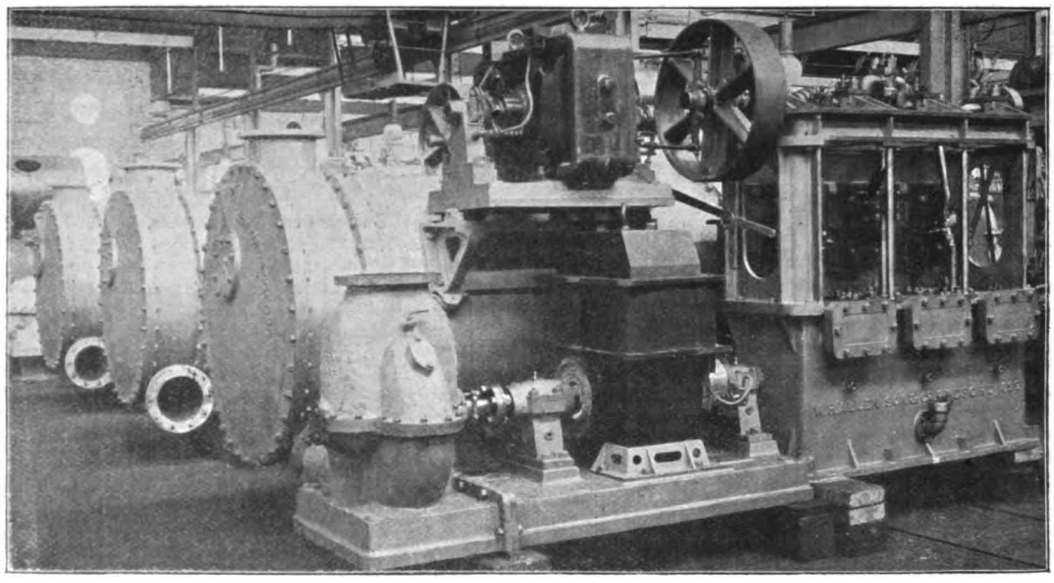
cylinders being placed above the three low-pressure cylinders. Each engine is capable of developing 1,100 H.P. as a continuous load when running at a speed of 230 revs. per min. with a pressure of steam of 180lb. per square inch and exhausting into the condenser. The engines are designed for an overload output of 1,500 I.H.P. under the same conditions, the object of this being to help the station over the peak, and as it would only be required for so short a time a slight loss of efficiency is of no importance. The slide valves are of the piston type, the high or intermediate pressures and low-pressure valves being placed on the same valve rod and operated by the same eccentric. Overload by-pass valves are fitted, worked from the governor, which enable them to maintain their rated speeds at overloads of 50 per cent. These engines are direct-coupled to British Thomson-Houston compound-wound multipolar generators capable of giving the full output of the engines at from 500 volts to 600 volts. The armatures are slot-wound and ventilated, and the field magnets are of cast-steel. Both of these dynamos, as also the third 1,100 H.P. machine, which is of Messrs. Crompton's make, are coupled to throw-over switches so that the series coils may be cut out and the generators run as shunt machines when desired.

The other 1,100 H.P. engine is a Willans three-crank triple-expansion engine designed to work economically at 1,100 H.P., but capable of being worked up to 1,500 H.P. if required, being fitted with automatic adjustable cutoff and by-pass valves for that purpose. There is no flywheel to this set, the armature of the Crompton dynamo to which it is coupled having been built extra heavily to take its place. This set probably represents the very latest practice in continuous-current dynamo building in this country. The field magnets are 12-polar, of cast steel, with laminated poles. Series coils are wound on an insulating frame so as to leave a clear air space between the shunt and series windings. The armature core is slotted and ventilated. Aluminium brush-holders are fitted, and ample commutator surface allowed. The outer bearing is of the adjustable self-aligning and self-oiling type. Our illustration shows the three 1,100 H.P. sets; a general view of the engine room was given in our last issue.

Condensing Plant.—For dealing with the exhaust steam from the enclosed sets described above, five sets of independent surface condensers have been installed. These have been built and erected complete by Messrs. W. H. Allen, Son & Co. Each set is capable of dealing with 27,000lb. of steam per hour. The elements of each set consist of a surface condenser, a three-throw Edwards' air pump and a centrifugal circulating pump, each of the pumps being driven by an electric motor. The shells of the condensers are of cast-iron, cylindrical in form, fitted with branches for the exhaust, the circulating water inlets and outlets, and the air pump suction, and with brackets for carrying the motor for driving the air pump. Each condenser has a cooling surface of 2,550 sq. ft., the tubes being of solid-drawn brass fixed into rolled naval brass tube plates by means of screwed ferrules and tape packing. These ferrules are provided with lips to prevent the tubes from slipping out of place, while allowing sufficient play for side expansion.

The air pumps are designed to run at 160 revs. per min., and are geared by Hollicks' gear to the 30kw. Allen motors. Each pump has three barrels 12in. in diameter by 12in. stroke. All liners and working parts and valve seatings are of brass, the casing of the pumps being of cast-iron. The pumps are driven by an overhead three-throw crank shaft carried by a neat entablature. A small water pump for dealing with the hot well water is driven from an overhung crank on the end of each air-pump crank-shaft. The air pumps have an effective displacement of 2·36 cubic ft. per revolution. The circulating pumps are of the "Conqueror" type, having cast-iron casings provided with suction and discharge branches 11in. in diameter, the diameter of the impeller being 17in. Each pump spindle is directly coupled to the motor shaft and stands under the bracket carrying the air pump. When dealing with the full load the air pumps require about 10 amperes at a voltage of 520.



ALLEN CONDENSING PLANT.

The exhaust connection from every engine terminates in a tee piece, one branch of which passes down to the condenser and the other upwards by way of a Blake and Knowles automatic relief valve to the atmospheric exhaust. The pump motors are capable of exact regulation, and the whole plant runs remarkably smoothly and with the minimum of attention.

Balancer, Booster, &c.—In the central portion of the engine room are placed the motor balancers and the boosters. The first-named consists of a Bruce-Peebles four-pole 250kw. motor-driven dynamo and a 50kw. motor-driven Silvertown bi-polar set. The latter is compound-wound, and capable of dealing with an output of 150 amperes at 230 volts to 300 volts at a speed of 650 revs. per min.

For charging the batteries, two sets of motor-driven boosters have been provided by Messrs. Mavor and Coulson. The motors are shunt-wound machines, and take current directly from the station 'bus bars at 500 volts to 600 volts, and the boosters have an output of 225 amperes at 20 volts to 160 volts. They are separately excited at 350 volts and run at 850 revs. per min. The armatures are wound on Sayers' patent system, and carbon brushes are fitted.

The motors distributed throughout the buildings have in most instances been noticed in connection with the plants that they are driving. The power transmission installation is somewhat extensive, as at present there are 16 motors used for various purposes, all running off the 500-volt mains. A

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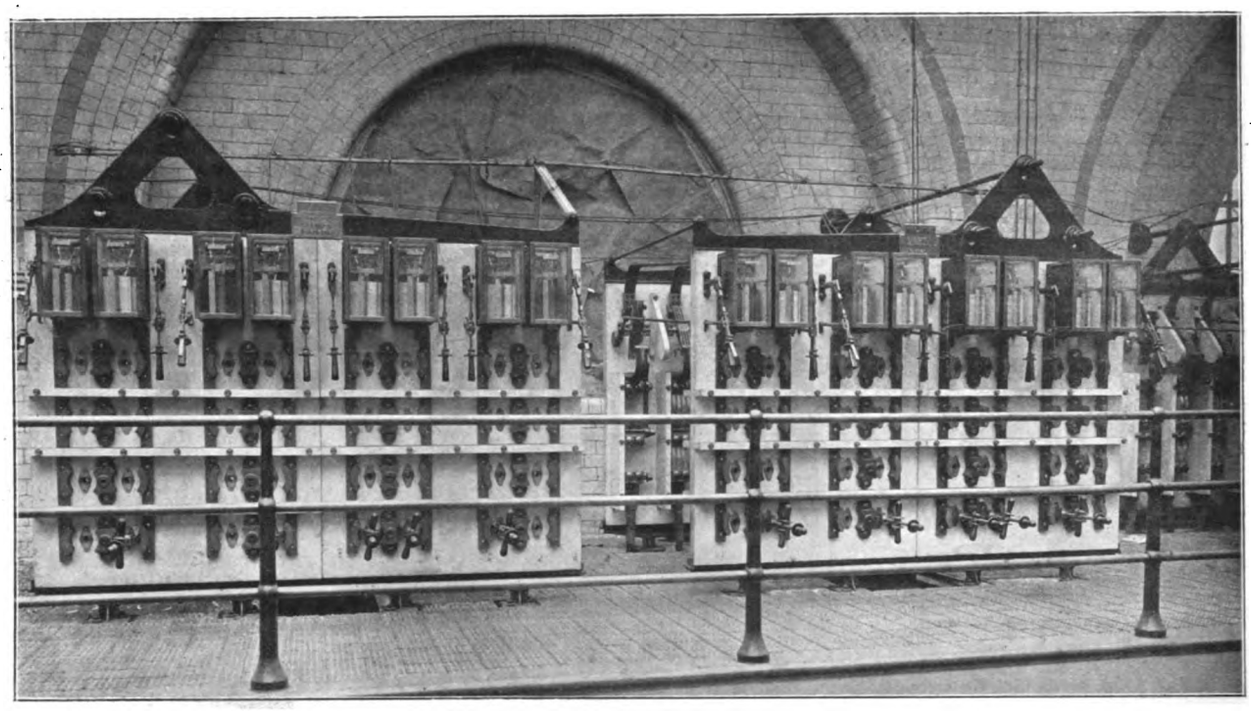
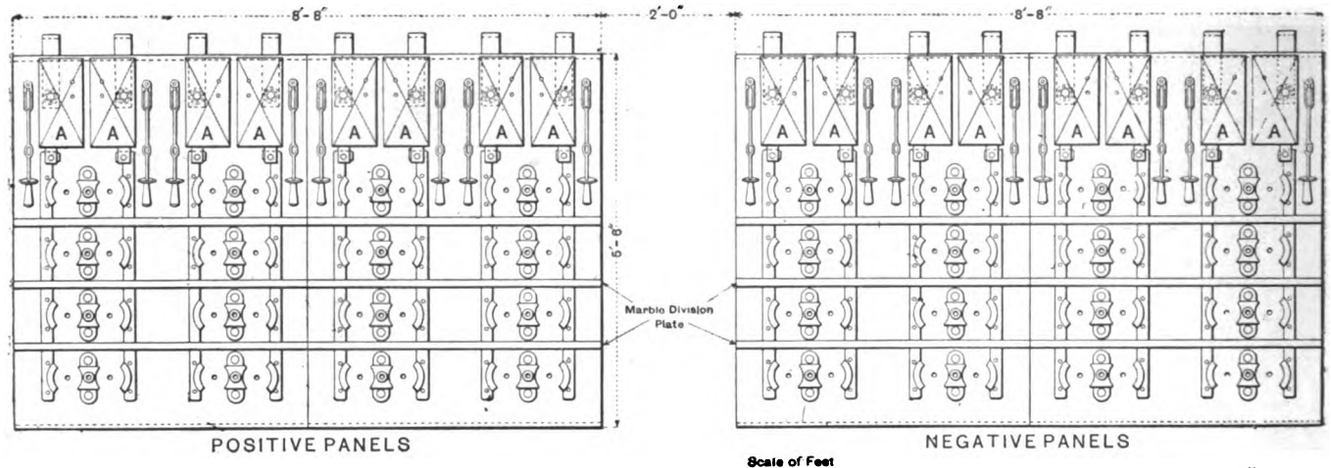
complete engineer's workshop with 12in. screw-cutting lathe, drilling machine, emery wheels, &c., is provided, as is also a joiner's shop, smith's shop, and large stores.

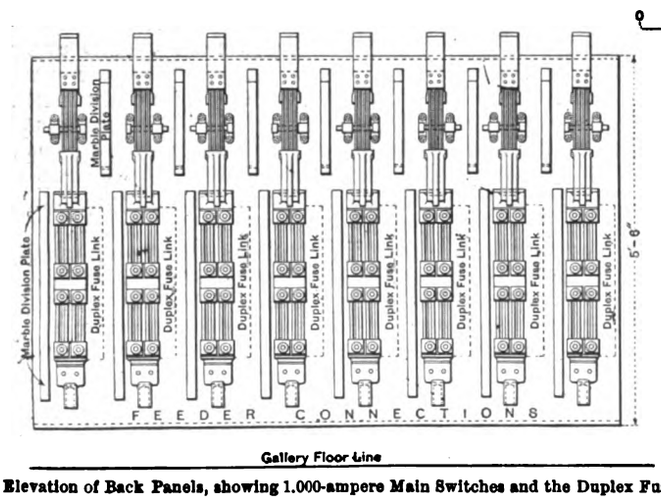
on to one board, with the positive at one end and the negative at the other. The switch gear is divided into two portions. One part consists of the "dynamo panels" placed on the



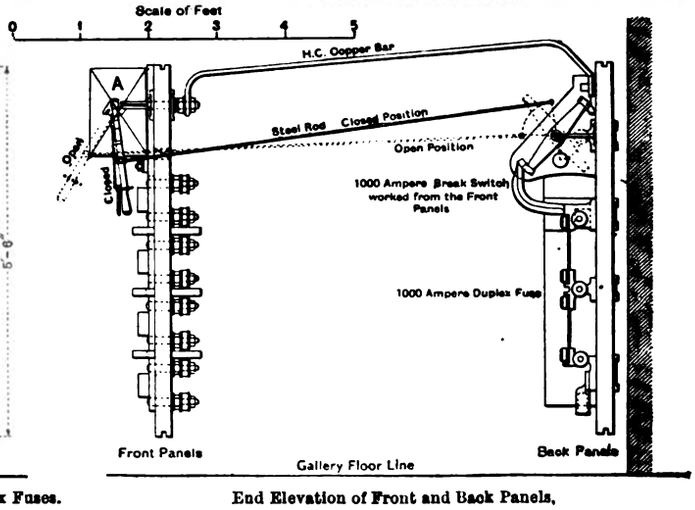
FEEDER SWITCHBOARDS ON THE GALLERY.

Elevation of Front Panels, showing Feeder Bus Bars, Plug Switches and Instruments.





Elevation of Back Panels, showing 1,000-ampere Main Switches and the Duplex Fuses.



End Elevation of Front and Back Panels.

GENERAL ARRANGEMENT OF THE FEEDER SWITCHBOARDS ON THE GALLERY.

Switching Gear.—The general arrangement of the Port Dundas switchboards and switching gear does not follow the usual practice of bringing all the dynamo panels and feeder panels

floor level in the engine room, underneath the switchboard gallery, each pair of panels being opposite its own dynamos. The other part is the "feeder panels," which are placed in a

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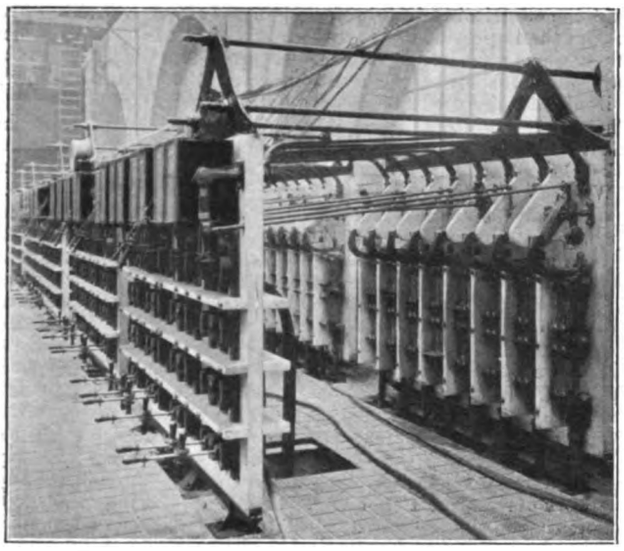
gallery running parallel with the machines for the whole length of the engine room.

Each dynamo, as we have said, is provided with a separate positive and negative panel, consisting of massive polished slabs of white marble, mounted in a steel frame bolted to the floor. The positive panel is fitted with an emergency switch, a zero automatic cut-out, duplex fuse, and a four-way plugging and switching device. The negative panel has a similar set of apparatus, except that the zero cut-out is replaced by a Kelvin indicating and recording ampere gauge. These latter instruments are similar to the "feeder log," described further on, in the general construction, but they are current measuring instruments only. The panels for the three large sets are by Cowans Limited, and for the other by Messrs. Crompton and Co.; those for the steam balancer being manufactured by Messrs. Laing, Wharton and Down. The three large sets are fitted with Andrews' patent return current cut-outs. The recording instruments on all the panels are by Messrs. James White.

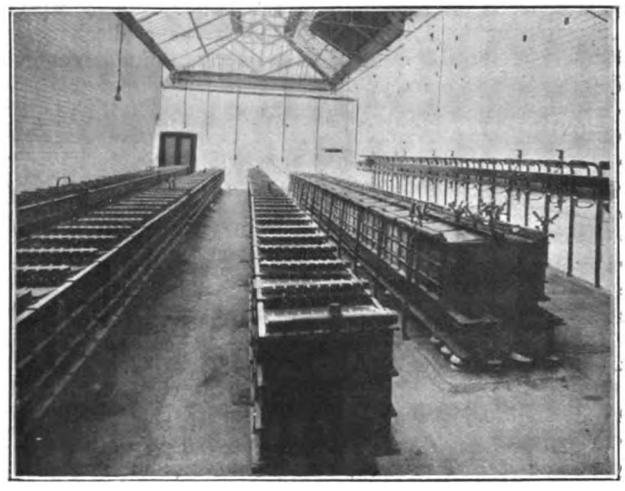
Underneath the switch gallery and above the dynamo panels, which are all connected to them, are run four sets of massive copper 'bus bars, and by means of the four-way plug switches any machine may be switched on to any set of these bars. These bars run from end to end of the entire engine house. The first 'bus bar in each case consists of six sections, the bottom section being 4in. broad by 1in. thick, and the top



View of Feeder Panels from one end, showing Front Panel on Left, and Back Panel on Right Hand Side.

five sections being 4in. by ¼in., thus giving a total sectional area of 14 sq. in. on the main positive and negative bars. The six sections are separated from one another by copper washers ¼in. thick and fastened together with steel bolts. The remaining three 'bus bars on each side are each formed of two sections, 4in. by 1in. and 4in. by ½in. The binding bolts are left long enough in all cases to take five more ½in. bars which will be added as necessity arises. The 'bus bars are erected in 22ft. lengths, and connected together by thin U-shaped copper bars which serve as expansion joints. The present length of 'bus bars amounts to 216ft. Provision is also made for additional lengths of bar for further extensions. All the copper for the 'bus bars was supplied by Elliot's Metal Co., and their erection has been carried out by Messrs. Mechan & Sons.

Connections from these 'bus bars are taken to those mounted on the back of the feeder panels which are erected on the gallery. The feeder panels are divided into sets, supplying eight pairs of feeders, and arranged in two rows one behind the other, and 6ft. 6in. apart, the positive panels for each set of eight feeders being next to the corresponding negative panel, as seen in the illustrations. In this way the positive and negative connections are in all cases only 10ft. apart, and the panels of like polarity stand in front of one another. In the present portion of the building six sets of feeder panels are being installed, supplying 48 feeders. Three of these sets of panels were supplied and erected by the Holland House Electrical Manufacturing Co. of Glasgow, and the other three by Messrs James White. The feeder panels consist of massive polished white marble slabs carried in steel frames bolted to the gallery floor, and the fittings and general construction are of a very solid and substantial nature. The mountings of the negative and positive sides are distinguished by the use of blue and red enamel on the surfaces that did not require to be otherwise highly finished. The back panels receive one terminal of the 1 sq. in. triple concentric feeder cables, and connect them through a duplex fuse to a quick-break main switch; thence across by a bare overhead copper conductor to the front panel through a recording feeder log (marked A in the lower illustration on page 810), devised by Mr. Chamen to keep a record of the load on the feeder and the pressure at the feeding point; from this log the current passes to a vertical plug bar through which the terminal of the feeder may be connected to any of the four 'bus bars mentioned in connection with the machine panels. The other terminal of the feeder is connected to the other pair of panels in the same manner. The middle wire (*i.e.*, the outer conductor of the triple concentric cable) is connected to a special set of panels common to all the feeders. This set of panels is placed in the centre of the gallery, and was manufactured and erected by Messrs. James White. The earth connection from the middle wire to the earth plates is taken through a recording ammeter fitted with an automatic short-circuiting device which comes into action when the leakage current exceeds a certain predetermined amount.



Battery Room.

The panels are uniform in size, being 5ft. 6in. high, 4ft. 4in. wide, and 3in. thick, and all are provided with marble shelves or partitions, which project sufficiently to prevent accidental contact being made from one to the other. The mountings of the panels forming the front row are uniform with one another, and in each case consist mainly of four vertical feeder bars, which can be joined up by means of plugs in the form of S switches to any of four horizontal bars, on the back of the panels, which are fed from the main 'bus bars laid below the gallery. An expansion joint is used to connect the bars on one panel to the corresponding bars on the adjoining panel. In the case of the panels manufactured by the Holland House Company the vertical feeder 'bus bars are of single forgings, complete and without joints of any kind; Messrs. James White's panels, on the other hand, have the contacts silver-soldered on to the vertical bars. Between each pair of vertical feeder bars there are four blocks of forged copper, which are joined through the marble to the horizontal bars on the back, the S switch plugs being used to connect these blocks to the vertical feeder bars. Carbon pieces are fitted to the blocks at the sparking points to enable the circuits to be broken at full load (1,000 amperes) without injury.

The Kelvin feeder log referred to gives a continuous record of the current going out on a feeder and the pressure at the

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feeding point. The solenoids of these instruments are of Lord Kelvin's latest form, made from high-conduction copper tubes, cut with radial slots, and put together in such a way that the axis of the solenoid is exactly the axis of the field. A sufficient number of turns are provided to give an exceedingly intense field. The case has been specially designed for convenience in changing the record sheets, refilling the pens, &c. The clocks on these instruments are all synchronised from a handsome regulator erected on the feeder gallery, each instrument being fitted with electromagnetic mechanism for rotating the recording drums, and the mechanism is actuated every 30 seconds by a relay controlled by the regulator. The main switches enable each feeder circuit to be controlled separately, and are quick break in action with quick-break carbon sparking pieces. The movements of the switches are effected by steel levers and connecting rods, which latter are geared with lever handles, each having a locking device for the "off" and "on" position mounted on the face of the front row of panels. This arrangement enables the attendant to manipulate the switches from his usual position on the gallery. The duplex fuse apparatus consists in each case of a forged copper link which acts as a change-over switch, thus enabling either of the two fuses to be short-circuited or brought into circuit at will.

Battery Installation.—Running parallel with the engine room and one on each side of the tower containing the vestibule, engineer's office, test room, &c., are the positive and negative battery rooms. These have been supplied by the Tudor Accumulator Co., and contain 335 cells, arranged in two sets on the 500-volt three-wire system. There are 25 pairs of regulating cells on each half of the battery. The capacity of the battery is 1,100 ampere-hours at a discharge of 150 amperes, and the cells can stand a maximum discharge of 250 amperes. In connection with these batteries, one of the most noticeable features is the entire absence of all perishable material in the construction either of the stands or boxes. The stands themselves are composed of rolled steel girders, mounted on the Tudor Company's large porcelain insulators, lead washers being used to bed the girders fairly on to the insulators in order to protect them from the attack of the acid spray. The girders are covered with sheet lead; the cells themselves stand on heavy glass slabs which themselves are insulated from the girders with the ordinary glass oil insulators. The boxes are worthy of special note; Mr. Chamen objected to lead-lined wood boxes, on account of the perishable nature of wood, and as, of course, solid lead boxes of this size would have required to be so very heavy that the price would have been prohibitive. After several experimental boxes had been tried, the present type was adopted, which consists of a sheet-lead box inside a "crate" of cast lead, to which it is only tacked at the edges. Owing to the unsatisfactory wear of cement, &c., when exposed to acid, the floor is laid with pure Val de Travers asphalte. Another feature of the battery is the switch gear. Instead of taking the connections from the regulating cells into the engine room, or at any rate to a central position in the battery room, which would have involved the use of an excessive amount of copper conductor, Mr. Chamen has devised the following arrangement, which works exceedingly well, and was manufactured by Messrs. James White. The cells are arranged in three rows, and the row next the engine-room wall is composed of the regulating cells. Running parallel with these, and fixed to the wall, is a steel bar or rail in the form of an H-section girder. Attached to this rail are wrought-iron brackets, on which large gunmetal contacts are fixed, and insulated with substantial vulcanite insulators; the lower contact is in the form of a continuous copper bar, while the upper ones consist of a row of contacts each of which is connected to the terminals of the regulating cells previously mentioned. Another very novel feature of this regulator is the form of brush contact gear. This consists of a trolley carriage running on the H-section girder, already referred to, the whole length of the battery room. This carriage has three sets of contacts—the lower one makes continuous contact with the lower copper bar, which bar forms a constant connection between the battery and the middle wire, the two upper connections make connection with the row of fixed contacts. In order to prevent sparking the trolley also carries a substantial pilot contact and pilot resistance, so that one or other of the two moving contacts is always in circuit with the cells, and short-circuiting is provided against by the resistance being inserted between the two contacts. This trolley is moved by means of a wire rope passing round drums on a shaft at one end. The drums are geared to hand wheels near the dynamo switchboards in the main engine room, and large indicating wheels are provided showing at a glance the position of the contact trolley in the battery room. The contacts on the trolley are in the form of laminated rings making contact on both sides of the fixed contact shoe.

(To be concluded.)

ELECTROLYSIS OF UNDERGROUND METAL STRUCTURES.*

BY DABNEY H. MAURY.

Reports of electrolytic injury to water and gas pipes are rapidly accumulating from cities all over the United States, where the single-trolley system has been in use for any considerable length of time, and the subject is one of serious moment to every corporation or municipality owning underground metal structures of any sort. It is the purpose of the writer, after illustrating a few of the many instances of electrolytic injury which have come under his notice, to discuss the electrical resistance of the joints of cast-iron mains, and to point out the important bearing which this joint resistance has upon all the various remedies for electrolysis heretofore suggested, and to show from actual cases the results which must certainly follow if cast-iron mains are used to convey electric currents.

The writer has been, since March, 1893, engineer and superintendent for the plant now owned and operated by the Peoria Water Works Co. Early in 1893, the water company's street foreman, Mr. W. B. Norris, reported to the writer that extra strong lead service pipes laid under the street railway tracks were bursting with a frequency that was remarkable, and that the appearance of the burst pipes was unusual, and different from that of any pipes the foreman had yet seen. Electrolysis, as occurring in water and gas pipes was, at that time, almost unknown, and very little had been published, even in engineering papers, regarding it. The writer at once suspected, however, the cause of the breaks, and the foreman was instructed to give him prompt notice of every such break, so that he could personally inspect the pipe and note the circumstance attending its rupture. To keep better track of the injury printed tags were prepared, on which the attendant circumstances were noted whenever a pipe burst; the tags were signed by the superintendent, the foreman and the men assisting in the work of repairing the pipe. A sample of the pipe was saved for reference and the tag was attached thereto. Although a number of breaks occurred before these records were begun, and in spite of the fact that some intelligent labourers in search of lead for making joints in water mains appropriated and melted down a good many of our carefully preserved samples, records are still on file of 116 electrolytic breaks.

The bursting of service pipes continued with increased frequency, nearly always occurring on those pipes which passed under the railway tracks; for instance, on streets in which the mains were laid on or towards the south side of the railway tracks, 96 per cent. of the recorded breaks occurred in service pipes supplying the houses on the north side of the street and in pipes passing under tracks.

In investigating the cause of the destruction of our pipes, the query early suggested itself as to whether chemical action pure and simple could have caused the injury. To make clear the claim that the damage was done by the electric current, it seemed to the writer that some evidence should be found of redeposition of the metal supposed to have been removed from the pipes by the current. Our search for this additional evidence was soon rewarded, for early in March, 1894, we observed in the excavation made to renew a broken service pipe, that the lead taken away from the pipe was deposited in the form of glistening particles, or thin metallic coatings, on soil, sand and gravel, all through the adjacent earth, but above the pipe and in the direction leading from it up to the rails—the pipe at this point being shown by voltmeter tests to be electrically positive to the rails. In one excavation, where there was a well-defined wet streak along a fault in a clayey soil, the lead compound, afterwards identified by chemical analysis as sulphide, was observed along this wet streak as far as the sides of the excavation, or more than 6ft. from the pipe, the streak leading diagonally up from the pipe to the rails. A similar redeposition of the metal was observed in the case of

* Abstract of a Paper read before the American Water Works Association at Richmond, Va.

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wrought-iron gas service pipes, and of cast-iron gas and water mains, the joints of the latter being surrounded in nearly every case by soil stained with oxide of iron, while immediately in front of the ring of lead in the joint would be found a bluish metallic discoloration showing the redeposition of the lead. The writer sent samples of the soil thus impregnated with lead and iron compounds to Messrs. Stone and Webster, electrical engineers and experts, of Boston, and to *Engineering News*, and to *Fire and Water*. The letters accompanying the samples, which were published in *Engineering News*, March 22, 1894, and in *Fire and Water* of about the same date, were, it is believed, the first published notes of such redeposition of the metals removed from underground pipes by the return street railway currents. On March 30, 1894, the water company's steel stand-pipe on the West Bluff burst, killing one person and injuring 15 others, one of whom died later from his injuries. Upon examining the wreck of the stand-pipe, the writer at once noticed a peculiar pitting of the inside of the vertical sheets, and the appearance of these pits was so different from that caused by any ordinary oxidation that he was soon almost positive that they were due to electrolytic action. A similar stand-pipe on the East Bluff was drained, and was found to be similarly pitted. The whole inner surface of the vertical shell appeared to be thickly covered with blisters resembling in outward appearance the tubercles sometimes found inside of old cast-iron mains. This blistered covering, which was almost as thin as paper, was composed entirely of oxide of iron, and on brushing it away with the finger tips, the black paint with which the stand-pipe had been originally coated would be found beneath it. The black paint was oftentimes almost unbroken, or, at least, very slightly cracked. When the paint was brushed off, the pit would be disclosed, considerably smaller in area than the surface covered by the blister. The surface of the metal in the pit was perfectly bright and clean and its fibre was clearly discernible. Many of these pits were more than $\frac{1}{16}$in. in depth. They were slightly more numerous in the West Bluff pipe than in the East Bluff stand-pipe, and were in both generally larger and deeper on the lower courses of the vertical shell.

Fig. 1 is from a photograph of the wrecked stand-pipe, the upturned corner of the torn sheet near the centre, showing the pitted appearance of the surface, the blisters having been, of course, shaken off by the fall of the metal and the metal itself having become somewhat oxidised before the photograph was taken. The two largest blotches are streaks of mud. Fig. 8 is from a photograph of a small sample of steel from the stand-pipe and shows the pitting in the sheets around the edges of the rivet heads.

FIG. 1.

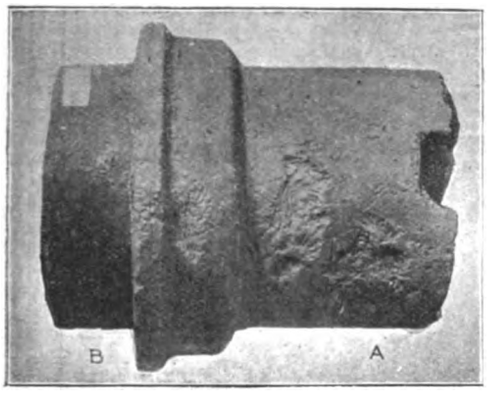

FIG. 3.

It seemed advisable to secure a thorough expert examination with a view to determining the cause, nature and extent of the observed pittings on the stand-pipes, and injuries to the piping system. Messrs. Stone and Webster, of Boston, were selected to make this examination. The work, in which the writer from time to time, assisted, covered seven weeks on the ground, and the report submitted by Messrs. Stone and Webster fully confirmed the suspicions that the pitting was caused by electrolysis, and established the fact that the entire piping system of the water company would be endangered by a continuance of the existing electrical conditions. The West Bluff stand-pipe was distant about 60ft. from the street railway line on Bourland-street. The East Bluff stand-pipe was about 700ft. distant from the railway line on Knoxville-avenue. Both stand-pipes were more than a mile from the power station and were negative to the rails. The electrical examination relative to the stand-pipes was conducted mainly at the East Bluff stand-pipe, which was still in service. A flow of a part of the current from the railway line was clearly traced through the earth to the anchor bolts which held the stand-pipe to its foundation, as shown in Fig. 5, up these bolts and into the steel of the shell, and through the shell and from its inner surface to the projecting section of the 16in. flanged cast-iron pipe which served as both inlet and outlet, and which connected the stand-pipe to the water mains. The current was then traced along this pipe and along the mains to the power station. The deflections of the voltmeter needle were clearly traced to the railway current, being especially influenced by the one or two cars on the line beyond the stand-pipe on Knoxville-avenue, and when the cars stopped running at night the movement of the needle ceased. Where the current left the inner surface of the shell to pass through the water to the inlet pipe it made the pits already described.

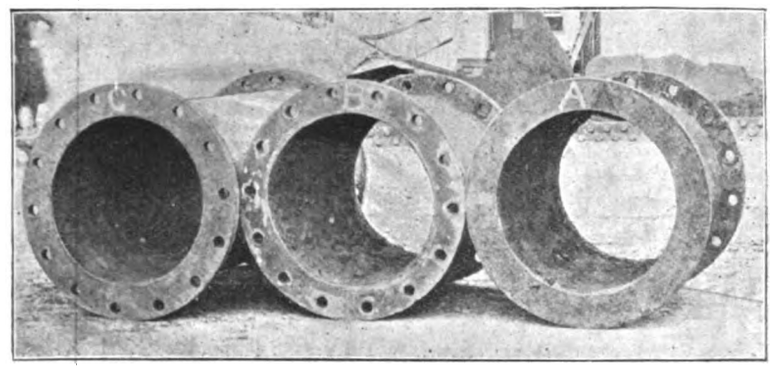

FIG. 2

Fig. 2 is from a photograph showing the interior surfaces of three sections of this inlet pipe, marked A, B and C respectively, the positions occupied by these sections originally being shown by the letters A, B and C in Fig. 5. An examination of the photograph shows the strongly marked and numerous pits which were found inside the sections A and B, while the inner surface of the section C was found to be practically as smooth and perfect as though new. When the condition of the inside of these three sections of pipe was first noted, it seemed hard to understand why A and B should be pitted, while C was unaffected. A closer examination, however, showed that in the flanged joints between the bottom sheet of the stand-pipe and A and B, respectively, corrugated copper gaskets were used, while the pipe B was separated from the pipe C by a thick rubber gasket; and that under the nuts and heads of the bolts holding the flanges together there were grummets or wrappings of cotton wick soaked in tallow. The result of this arrangement was that the current which entered A, after passing through the

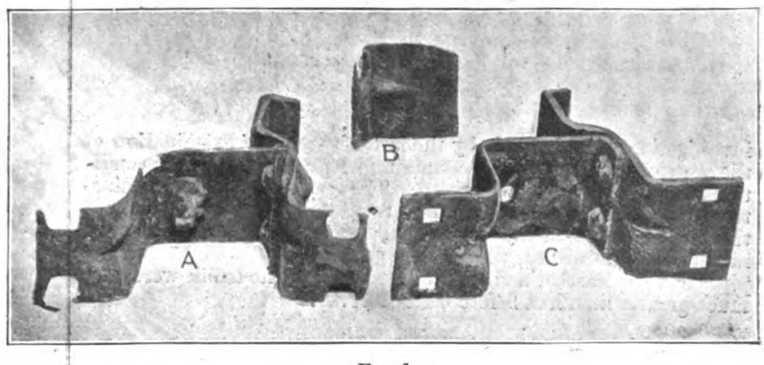

FIG. 4.

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water from the inner side of the shell of the stand-pipe, and which was trying to return along the inlet pipe and water mains to the power stations, encountered at the joint between B and C the rubber gasket and the grummets. The effect of the gasket and grummets was to practically insulate the section C from the sections A and B, and as none of these pipes were in contact with the ground the current was compelled to leave the pipes A and B and travel through the water or along the slimy coating of oxide on the inside of the pipes around the joint between B and C, in order to continue

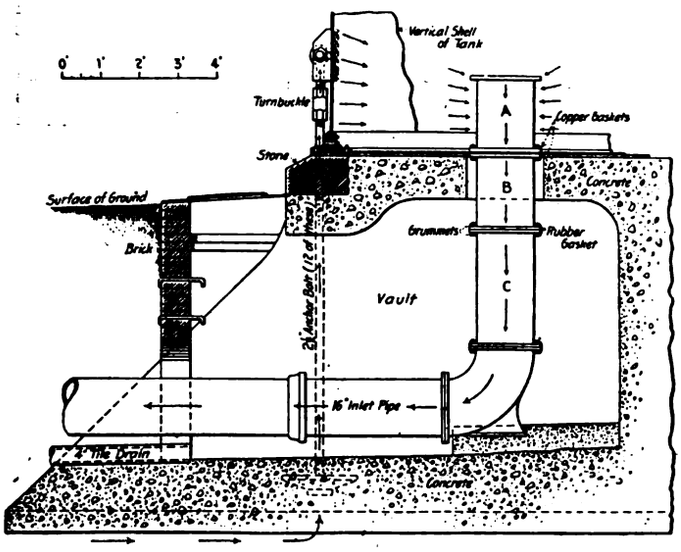

FIG. 5.

on its journey. As the current was not leaving C this pipe was not injured, but the current, in leaving the inner surface of A and B, did pit them, as shown in the photograph. These stand-pipes and the inlet pipes were negative to the rails, and are striking examples of electrolytic pitting under such conditions.

Early in 1898, Prof. D. C. Jackson, of the University of Wisconsin, and Messrs. Stone and Webster were requested to supplement the

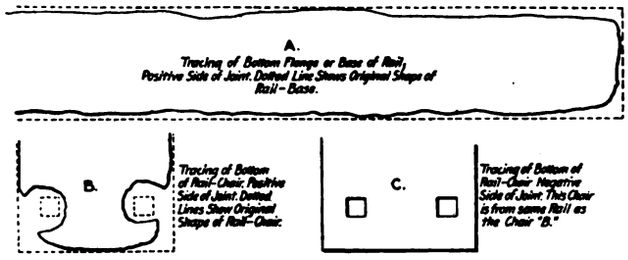

FIG. 6.

investigations already made by the latter by another examination of the system, with a view to ascertaining whether the electrical conditions reported in 1894 still existed. The result of all these examinations and of those made, from time to time, by the writer, showed that the differences of potential between mains and rails had increased rather than diminished, while the number of breaks in the service pipes and the number and extent of pittings in the mains were very much greater than had before been observed.

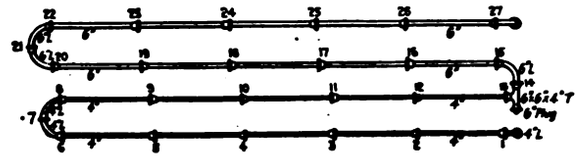

FIG. 7.

With a view to further proving that the injury done to the cast-iron mains and service pipes was caused by the electric current, samples of the graphitic substance dug out from the pits in the mains, and of the scale or incrustation adhering to the mains over the pits, and of the soils at various distances from the mains, and similar samples taken from the neighbourhood of the lead service pipes, were sent to the University of Illinois, where they were analysed by Prof. Arthur D. Palmer. Samples of ordinary soils, unimpregnated by the metallic compounds from the pipes, were also analysed. These analyses showed that there was nothing in the soil which, except for the action induced by the electric current, could injure the pipes, while all of the conditions, as found by chemical analysis of all the samples submitted to Prof. Palmer, were exactly such as would be caused by the presence of the currents complained of.

In 1899, a series of tests were made by Mr. A. A. Knudson electrical engineer, of New York, in conjunction with the writer, at the site of the fallen West Bluff stand-pipe, in order to still further prove

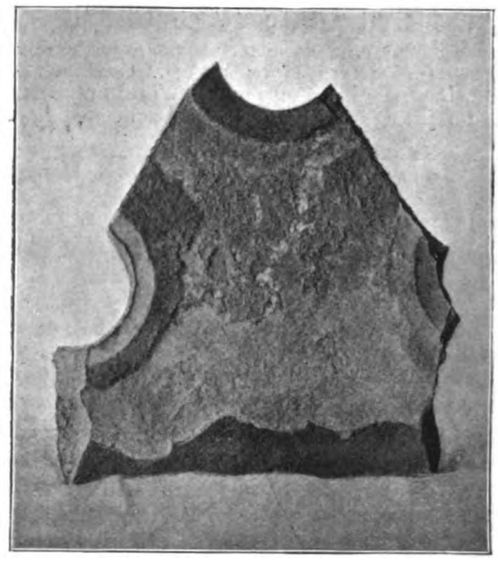

FIG. 8.

that when that stand-pipe was in service, there was an actual flow of current in the manner already shown by the previous tests at the East Bluff stand-pipe by Messrs. Stone and Webster. The anchor bolts were still in the foundations, but the shell of the stand-pipe, as well as the 16in. inlet pipe leading thereto, had been removed. It was necessary, therefore, in order to reproduce, to some extent, the actual electrical conditions that had previously existed, to connect a wire from the ends of the anchor bolts to the 16in. water main in front of the stand-pipe. By connecting in a voltmeter on

FIG. 9.

this wire the variations of potential between anchor bolts and the water main were observed, and by replacing the voltmeter by an ammeter, the actual flow of current was measured. This current was clearly and positively identified as caused by the street railways, and the result of these tests fully confirmed the statement in the reports of Messrs. Stone and Webster, that the pits in the shell of the stand-pipes had been caused by the street railway current.

The joints of cast-iron water mains often offer, as already stated, considerable resistance to the passage of the electric current, and the

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reason for this resistance is apparent, when the construction of these joints is studied. Cast-iron water pipes are coated inside and outside with a preparation of coal tar that is an insulating material. In making a lead joint, the spigot end of one pipe is inserted in the bell end of another pipe and pressed home until it touches the shoulder in the bell. The spigot pipe is centred carefully, so that the annular space designed to hold the yarn and lead may be of equal width all around. The yarn is then rammed in home against the shoulder and holds the spigot in the centre of the bell. There can thus be no actual contact between the two pipes, except where the very end of the spigot abuts against the shoulder of the bell. As both spigot end and shoulder are simply rough castings and are not turned, it follows that they are rarely in mechanical contact at more than two points, and on curves they can only touch at one point. In fact, it is frequently true that after the spigot pipe is once shoved home against the shoulder of the bell, and then released, it works away in the subsequent handling and yarning and oftentimes is not in contact with the bell at all. Even if the two pipes were in actual mechanical contact, the electrical contact would be poor, by reason of the two intervening coatings of tar or asphalt. In that portion of the joint occupied by the yarn, there is no contact between the two pipes, and they are at this point fairly well insulated by the yarn itself, as well as by the two coatings. The rest of the joint is filled with lead, which is a conductor of electricity, but in between the ring of lead and the bell outside of the lead and between the lead and the spigot on the inside, are the two tar coatings which materially interfere with the electrical contact between the two pipes. As it had been stated that the tar coating is completely consumed and burnt out by the heat of the molten lead when a joint is poured, the writer caused a joint to be poured and calked in the usual manner, and then had the bell sawed into three pieces, so that it could be taken off the spigot. It is needless to tell men who have had experience in laying and taking up water mains that the inner surface of the bell showed that the coating was entirely unimpaired by the heat. Measurements were made by the writer in 1898 to determine the amount of resistance offered by the joints in cast-iron water pipes, and also to ascertain whether the pipes themselves showed any pitting as a result of this resistance. A large number of these examinations were made during 1898 and 1899, and in every case the pipe which was of the higher potential was found pitted near the joint, while the pipe of the lower potential, or that into which the current was flowing from the other pipe, showed much less electrolytic injury. To further test the joint resistance and to determine, if possible, the influence of different methods of caulking as affecting this resistance, the writer, in conjunction with Prof. Jackson, caused a line of 6in. and 4in. pipe to be laid and supported on wooden blocks, so as to insulate it from the ground, as shown in Fig. 7. There were 27 joints in all. The pipe was new, and had not been previously used. The caulker was instructed to drive up the lead hard in one-third of the joints, and to caulk these joints in every way in the best possible manner, just as though the pipe were expected to stand the heavy pressure of the Peoria Water Works Co.'s system. Another third of the joints was caulked not quite so hard, while the remainder were purposely only lightly driven up, the work being done as though carelessly, or by a bungler. A current of known strength was passed through the pipes, and the drop of potential around the joints was measured at points 1ft. apart, and was compared with the drop of potential in length of 1ft. of continuons pipe. These measurements were made at different times; first by Prof. Jackson and the writer, then by the writer alone, and later by Mr. Knudson and the writer. The resistance of the joint was found, as shown by the table, to be from a few times to several thousand times that of the same length of continuous pipe, and this joint resistance was in no way affected by the manner in which the lead was driven up in the joint, some of the joints on which the best caulking was done showing the highest resistance. The usual depth of lead in a joint in a cast-iron pipe is about 2½in., but assuming the length of the joint at 4in., the joints in this line offered 89·2 per cent. of the total resistance of the whole line, or on the average the resistance of a joint was 227 times the resistance of 4in. of plain pipe. In making this calculation due allowance has been made for the fact that the points of measurement around the joint were 1ft. and not 4in. apart. These observations, taken over a period of about 11 months, also showed that the resistance of the joints increased rapidly with age.

In Kansas City Prof. Lucien I. Blake, of the University of Kansas, has recently made a number of tests of the joint resistance in cast-iron mains. He found the joint resistance in three lengths of 6in. pipe to be about 96 per cent. of the total resistance of the pipe and joints together; the joint resistance in the 58 joints of 687ft. of 6in. pipe which has been 13 years in service was found to be 96·2 per cent. of the entire resistance of the line; the joint resistance of 38 joints in 399ft. of 20in. pipe was 88·2 per cent. of the total resistance of the line; and the joint resistance in 400ft. of 36in. pipe was found to be 96·7 per cent. of the total resistance of the entire line. Mr. Knudson found in Albany a pipe joint which showed a resistance 1,000 times greater than the resistance of an equal length of the plain pipe. The injury caused by resistance at the joints is not so rapid at any one spot as the injury where the current leaves

Results of Tests of Electrolysis on Experimental Line of Cast-iron Pipe under various Conditions.

No. of joint.	Caulking.	Current in amperes.	Drop of potential around joints in volts.*		
			Pipe dry.	Pipe full of water.	
				Clear.	Muddy.
1	Good		0·0056	0·0091	0·0087
2	Do.....		0·0039	0·0059	0·0048
3	Do.....		0·0046	0·0066	0·0059
4	Do.....		0·0095	0·0134	0·0122
5	Do.....		0·0042	0·0070	0·0058
6	Medium...		0·0080	0·0140	0·0124
7	Good		0·0124	off scale, hard	off scale, hard[1]
8	Medium...		0·0034	0·0050	0·0044
9	Do.....		0·0069	0·0145	0·0153
10	Poor		0·0022	0·0038	0·0033
11	Do.....		0·0016	0·0028	0·0022
12	Do.....		0·0041	0·0063	0·0049
13	Medium...		off scale, hard[2]	off scale, hard[3]	off scale, hard[4]
14	Good	10	0·0108	0·0143	0·0099
15	Do.....		0·0084	0·0118	0·0088
16	Do..... ...		0·0026	0·0031	0·0022
17	Do.		0·0006	0·0006	0·0004
18	Do.....		0·0021	0·0026	0·0023
19	Medium...		0·0007	0·0009	0·0006
20	Do.....		0·0017	0·0020	0·0013
21	Do.....		0·0057	0·0055	0·0046
22	Do.....		0·0054	0·0058	0·0049
23	Do.....		0·0011	0·0013	0·0012
24	Poor		0·0142	0·0125	0·0115
25	Do.....		off scale, hard[5]	off scale, hard[6]	off scale, hard[4]
26	Do.....		off scale, hard[7]	0·0093	0·0089
27	Medium...		0·0016	0·0010	0·0007

* 9in. between points of contact.
Voltmeter showed: [1]0·042, [2]0·50, [3]0·520, [4]0·270, [5]0·370, [6]0·315, [7]0·040.

the pipe for the rails in the positive area, only because all of the current carried by the pipe does not flow around the joint. But one ampere of current, leaving the pipe for the power house in the positive area, pits the pipe but once at that point; while one ampere of current flowing along the pipe and around joints in either the positive or negative district, pits each length of pipe near every joint, where it leaves it to flow around the joint; so that the total injury caused by this ampere is cumulative, and may be, in the aggregate, hundreds of times as great as the damage caused by the same ampere of current where it permanently leaves the pipe.

The effect of the current on the rail joints of a single trolley system is similar to that on the joints in the water mains. Within the past three years the writer has examined many hundreds of rail joints, and it was always easy to tell from the appearance of the rail ends, and of the chairs, when the rails were laid on chairs, which way the current was flowing. The end of that rail which was next to the power station would show little or no injury, while the end of the other rail, or that having the higher potential, was invariably pitted. Fig. 6 is reproduced from tracing from the bottom flange or base of such a rail end (and also from two rail chairs), the solid line showing the shape when the tracing was made, while the dotted line shows the original shape of the rail when it was new and before it had been eaten away by the current. Fig. 6 also shows the bottom portions of two rail chairs. The chair B was taken from the side of the joint away from the power station. The dotted lines show its original shape. The chair C came from the other end of the same rail, on the negative side of the joint, and shows no perceptible injury. Fig. 4 shows two rail chairs and a fragment of a third chair secured by Mr. Knudson and the writer. The chair, A, was a sample of a large number of similar chairs on the high potential side of the joint, and its thin and wasted appearance is plainly shown. The fragment B was broken by hand from another similar chair. The chair at C was from the same piece of roadbed, and is a fair sample of a number of chairs observed near the low potential side of the joint. This chair, as the view shows, is almost a good as new. The soil around the outside of a water main offering an easier path for a current than the water or slime on the inside, outside pittings are more numerous and generally deeper, and they are much more easily observed. The pits on the outside may be caused either by current which leaves one length of pipe to go around a joint into the next length of pipe, or by current permanently leaving the main for some other conductor of lower potential, such as rails, or wires leading to the dynamo; but the inside pits cannot be caused by anything except resistance in the line of pipes itself at the joints, as nothing else could make the current leave the metal of the pipe and travel through the water. Opportunities for observing these pits have heretofore been rare, as the action is naturally slower inside the pipe than outside, and as it is necessary for some one familiar with the effect of electrolysis to be present and actually,

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examine the pipe at the time when it is removed in order that the pits may be identified. The pittings in the 16in. inlet pipe to the West Bluff stand-pipe, observed in March, 1894, and inside pittings found by the writer in a 20in. cast-iron main in 1896, are believed to be the earliest examples of this injury noted, but numerous instances have since been reported. Fig. 3 shows a joint of a 12in. cast-iron main on which the current was flowing from A to B. The very serious outside pittings, nearly ½in. in depth, are plainly shown on the pipe A, while the pipe B, on the other side of the joint was, near the joint, almost uninjured. The surface of the lead in this joint was deeply pitted in places and so much of the metal had been removed that the marks of the caulking tool all around the joint were entirely obliterated. The pipe A was also pitted in a number of places on the inside, while no pits were found on the inner surface of the pipe B near this joint. Mr. A. A. Knudson found deep outside and inside pittings in Albany, in 1899, as shown in the view, Fig. 9. Prof. Blake, from recent examinations in Kansas City, writes as follows: "A 12in. pipe running at right angles to an electric railway, and which was negative to the rails, was found to be carrying a current of varying strength and delivering it into a 36in. main some 750ft. distant. Electrolytic pittings were found on many sections near the joints, only on the positive side, where the current was shunted around the joints. Some of the pittings were ½in. deep. The interior of the pipe could not be examined. Again a length of 6in. cast-iron main was taken up in another part of the city and internal electrolytic effects were apparent near the joint. A chemical analysis of the material dug from the pits gave 22·3 per cent. graphite, 49·7 per cent. iron. A second length was removed and broken into, and a fresh fracture revealed the internal electrolysis by the discoloration of the iron where the pitting was taking place, and which was already ½in. deep, beginning from the inside. A number of similar cases were discovered, and are convincing proof that cast-iron mains cannot convey currents without electrolytic damage when those mains form part of the return circuits of electric railways."

Within the past few months the writer had occasion to remove from the ground a 16in. cast-iron main. This main was negative to the rails, and was nearly 2 miles from the power station. It lay at right angles to the tracks, and the portion removed was distant at its nearest point about 150ft. from the rails, and at its further end, 570ft. from the rails, there being 420ft. of pipe removed. Measurements with voltmeter and ammeter showed a current flowing along this pipe from the rails towards the wet soil of the river bank, in which the further end of the pipe was buried. Every length of pipe showed electrolytic injury. In one pipe the bead in the spigot end had been eaten off for two-thirds of the circumference of the pipe, and in one place the entire thickness of the pipe was eaten out for nearly an inch in depth from the end. There were both outside and inside joint pittings, always on the positive side of the joint, and no pits at all could be found anywhere else on this pipe.

In a recent Paper Prof. Blake states that observations and experiments prove that the effects of electrolysis upon water pipes are not limited to the so-called "danger areas," or districts in which the pipes are electrically positive to the rails. He goes on to say: "Resistance at the joints in cast-iron pipe is sufficient at most joints to shunt a portion of any current allowed in these mains, around the joints through the soil outside or water inside, or through both. Then on the positive side of joints, the effects of electrolysis, both external and internal, are to be apprehended." Prof. Blake then gives in detail the tests previously referred to as made by him to determine the joint resistance, and closes by giving the forcible and convincing examples already quoted of the disastrous results of allowing cast-iron mains to convey electric currents.

It must be clear to anyone who has seen the evidence of injury caused by the return currents, and who has studied the effects on the water mains at the joints, or at any other point where the current, once on the pipe, must leave it, that the owners of such pipes can do nothing to prevent the injury. Street railway companies have frequently recommended that the pipes themselves be connected by wires to the negative 'bus bar of the generator, or to the rails at various points, or to overhead or underground return feeder wires—thus diminishing the resistance of the pipe system as a conductor, and lowering the potential of the pipes usually in what has been termed the "danger district" or the region where the pipes are shown by voltmeter to be positive to the rails. But all such methods contemplate using the pipes to convey the electric current, and they all invite more current to the pipes at some part of the system. It would undoubtedly be a fine thing for the railway companies to have the conductivity of the pipes on which they already rely largely for the return of their current still further increased. It would mean smaller coal bills in the power station and less outlay for construction and maintenance of their own return circuit. It would, also, apparently lessen the rapidity of injury to the pipes in the "danger district," and, by stopping temporarily the number of actual breaks at the points where they have been occurring with greatest frequency, it would stave off the day of reckoning with the pipe owners. But the general pipe system would be carrying much more current, and, as the pitting goes on, at or near the joints, whenever a main is carrying current, either in the positive or negative districts, it would mean that while the injury in the "danger district" would not be so rapid, the whole system would be much more generally attacked, and that by the time a bursting pipe at length called attention to the injury at some point remote from the power station, the entire pipe system would have been seriously injured. Equally impracticable and misleading are the suggestions for maintaining the pipe system at equal potential throughout, and for "insulating sections" or "insulating joints," some of which have been patented. The idea of these sections or joints, as advanced by their advocates, is to break up the metallic continuity of the pipe line and reduce its conductivity, and thus prevent its serving as a path which the return current would naturally choose. The effect of thus dividing a pipe system into a small number of sections would hardly be worth considering, as the ground itself is a good conductor, and the current would leave one section only to go to another, passing through the earth around the insulating joint just as it does around the lead joint in a cast-iron main. To entirely destroy the conductivity of the pipe line, it would be practically necessary to make it up entirely of insulating sections, which, as non-metallic substances are not generally recognised as good material for underground water pipes, and for other equally obvious reasons, would be absurd. The conductivity of the tracks may be, of course, increased by the use of heavier rails, heavier bond wires and improved methods of bonding, or by the introduction of welded joints, or by making practically continuous rails; but the continuous rail itself is at best but a palliative of the electrolytic injury. The rails are not insulated from the ground, and the pipes would still carry and be affected by a large portion of the current, as is clearly shown by numerous electrical surveys and reports of serious damage in cities where the best tracks known to modern science are in use.

In conclusion, the author recommends the double-trolley system, overhead, as at Cincinnati, or conduit, as in Washington and New York, as the only perfect method of keeping currents out of the ground and preventing electrolysis.

AN EXPLANATION OF A COMMON PHENOMENON NOTICED IN CABLE WORK.

BY H. G. BARWELL.

It has probably been noticed by every electrician who has been engaged in cable work that during the whole time a splice is being made sharp kicks are noticed on the galvanometer employed for the usual dielectric resistance test.

On a recent repair, while picking up to a fault, a watch was kept for it coming in by means of a current direct to line through a milammeter, to which was joined one side of a telephone receiver, the other side of the latter being connected through a 1 microfarad condenser to earth (as per Fig. 1). The current observed on the milammeter was 40 milliamperes. On commencing to pick up, the sound in the telephone was found to be intermittent—that is to say, there was alternate buzzing and silence, the cause of which I take to be as follows: The depth of water was 980 fathoms; 480 fathoms from the ship was a splice, type C to D, the latter type having each sheathing wire taped. The fault, which was two nauts beyond this splice, was caused by a wire of the type D having punctured the core at a bad twist, the iron wire remaining in the hole and apparently completely stopping any contact between the copper conductor and the water, as was shown by the fact that the resistance of the fault remained extremely steady at some 40 ohms and exhibited no signs of polarisation with either current. It was evident, therefore, that the fault was in no way responsible for the intermittent buzzing in the telephone, and that it was probably caused by the ship rising and falling on the fairly heavy swell and bringing varying strains upon the splice, which at the commencement of picking up was about midway between the surface and the bottom. On the splice coming over the bow sheave, the buzzing became considerably louder, and continued, without any intermission, until it had passed the jockey, when, on stopping the drum to cut the cable, the noise ceased entirely. Instructions were then given to get the splice on the drum and *worry* it, and then to lay it on the deck again. This operation was repeated several times, and on each occasion, the moment it was handled, buzzing

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re-commenced, but stopped instantly on its being left alone. After cutting out the splice, its insulation was tested and found to be perfect, within the limits of observation. The telephone was then connected to the sea end containing the fault, and found to be absolutely silent, showing, as before stated, that the fault was in no way responsible for the buzzing. The milammeter meanwhile had remained perfectly steady at 40 milliamperes, exhibiting no signs whatever of any variation of the resistance in circuit.

This phenomenon appears to be of the same nature as that mentioned in my first paragraph; and I offer the explanation that it is due to small changes in the capacity of the cable

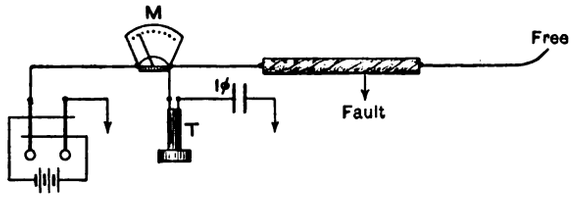

FIG. 1.

caused by variations in the resistance of the contact between the respective sheathing wires at a splice, these variations being due to the application of different strains or pressures, and that the effect is more noticeable when, as in the above case, one of the cables has each of its sheathing wires covered by a partially insulating tape.

As a proof of this the following experiment was tried: Six nauts of type E in one tank, and 17 nauts of type B in another, had their conductors joined together, and their sheathings brought into better electrical contact by means of connecting wires as shown in Fig. 2. On tapping the ends

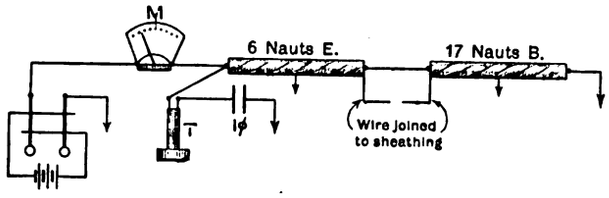

FIG. 2.

of these connecting wires together a very distinct tap was heard in the telephone, which was equally audible when no current was being sent through the cables. One of the wires was then connected to a file, and the other wire scraped over it, when it was observed that the sound in the telephone was very similar to that produced by handling a splice, being more of a buzzing than a distinct tapping. By this means Morse signals could be clearly read, although, as before mentioned, no current was being sent through the cables. The distant end of the type B was then freed, and a galvanometer put in place of the milammeter, and on tapping

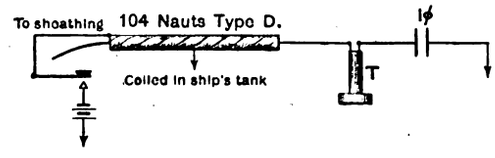

FIG. 3.

the ends of the wires together kicks, similar to those observed while a splice is being made, were produced on the galvanometer. This, I think, proves fairly conclusively that the kicks are due to changes in capacity. It will be seen from the above experiment how very minute the variations in the resistance of the sheathing are which disturb the surface charges, and cause these effects; as, in the above case, the two sheathings were already in good contact with each other through the ship's hull, before the ends of the copper wires were tapped together, and more especially so as a considerable portion of each length of the cable sheathing was devoid of any outer serving. These disturbances are, I think, caused as follows: When two lengths of cable are spliced together, they take up charges which vary according to the respective localities along their length, and possibly also in proportion to the size of their cores, and rates of absorption, &c. Now, if any alteration is made tending to improve or the reverse the connection between their respective sheathings, the *status quo ante* is not maintained, and a redistribution of the free potentials takes place, producing the sound heard in the telephone. The two following experiments are also of interest:—

A current was communicated to the sheathing of 104 nauts of type D coiled in the ship's tank, to the conductor of which a telephone was connected, as shown (Fig. 3). On depressing the key signals were distinctly audible whether the home end of the conductor was freed or earthed, no difference being perceptible when the telephone was connected as shown, or to the home end.

Fig. 4 indicates the connections in the next experiment. In this two 20φ condensers joined in parallel had one of their plates connected to the core of the 104 nauts of type D, and also to one side of the telephone, the other plate being joined to the lever of the key, the lower contact of which was in connection with the cable's sheathing, and the upper to the opposite side of the condenser, so that the latter was short-circuited after each contact. With this arrangement sound signals were quite audible, but not so strongly as in the previous experiment; if, however, the telephone was connected to the far end of the conductor, nothing whatever could be heard. This effect was probably in greater part due to charges induced in the cable from the rolling of the ship, which were imparted to the condenser on depressing the key.

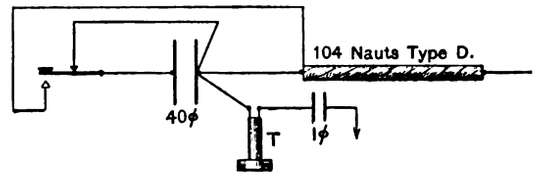

FIG. 4.

These induced charges may also possibly play a part in the first experiment with the two lengths of cable, but I think there can be little doubt that the sounds are mainly due to the improvement in the contact between the two sheathings in this particular case, and the resulting redistribution of the free potentials.

From the foregoing it will be seen that by joining a telephone up as in Fig. 1, a splice can be heard when the ship is approaching it picking up, provided there is no other disturbing influence at work, such as a variable fault in the circuit; and knowing the depth of water, and noting the first indications of the splice being disturbed on the telephone, one may form a fairly approximate estimate of its distance from the ship.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"L'Electricité à l'Exposition de 1900." By E. Hospitalier and J. A. Montpellier. No. 3. (Paris: Vve Ch. Dunod.)

"Elektrische Bleicherei." By Dr. P. Schoop. (Stuttgart: Ferdinand Enke.) 1·20m.

"Die Drahtlose Telegraphie." By Adolf Prasch. (Stuttgart: Ferdinand Enke) 2·40m.

"Die Wechsel und Drehstromgeneratoren." By Dr. F. Neithammer. (Stuttgart: Ferdinand Enke.) 1·20m.

"Eine Methode zu Experimentellen Untersuchungen an Induktions-motoren." By Alexander Heyland. (Stuttgart: Ferdinand Enke.) 1·20m.

"Les Décharges Electriques dans les Gaz." Translated from the English of Prof. J. J. Thomson, F.R.S., by Louis Barbillion. Preface by C. E. Guilleaume. (Paris: Gauthier-Villais.) 5f.

"The Official Gazette of the United States Patent Office." No. 10, Vol. XCII. Published by authority of Congress. (Washington: Government Printing Office.)

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial Publishing and Printing Offices,
2 & 3, SALISBURY COURT, FLEET ST., LONDON.
Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

Subscription Rates.—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

	Year	Half-Year	Quarter	
United Kingdom	26s. 0d.	13s. 6d.	7s. 0d.	Post free, payable in advance.
Postal Union	30s. 0d.	16s. 0d.	8s. 0d.	

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THE THEORY OF ELECTRONS.

In our leading article last week we commented upon Prof. J. CHUNDER BOSE's Paper "On the Similarity of Effect of Electrical Stimulus on Inorganic and Living Substances," one of the most important communications made to Section A of the British Association at Bradford. To-day we shall consider the scarcely less interesting discussion on "Ions" which took up the greater portion of a day's proceedings in the same section. The electron theory was its prominent feature. What is an electron, and what are its properties? This, we conceive is the most pressing question at the moment for the physicist; and we hope that when the history of the development and growth of our ideas in this important branch of physics is written, as no doubt it will be, by some future WHEWELL of the twentieth century, the discussion which was opened in so masterly a manner by Prof. FITZGERALD will be found to have added materially to the progress of knowledge of this subject—to have added to it, if not by any new discovery, at least by what is of no less importance for discovery, the clearing up of our conceptions upon such matters, by separating the chaff from the wheat, by defining more clearly the horizon of our knowledge. Often the investigator, like a traveller in the desert, may have to wander far and wide in search of a solid fact upon which he may take his stand. And oftener still some mirage is ready at hand to delude him and make him believe he has reached truth that is indeed far away. He needs the critical mind, and the old experienced hand to draw him back, as it must itself at times have been drawn back. This is the function which discussion at such meetings as the British Association performs, and this we believe is the service which the critic renders to science.

We wonder which of the many ideas suggested at the Bradford meeting will ultimately take the strongest hold in the struggle for existence, as the fittest to survive. The *pièce de resistance* in the debate was, we consider, the

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electron theory of matter—that matter is made up of one primordial atom, the atom of electricity, whose existence was first emphasised by HELMHOLTZ: the electron, as Dr. JOHNSTONE STONEY has very aptly styled it. We regret that the name of PROUT was not mentioned in the discussion, but this we suppose was a mere accident, although the theory is truly PROUT'S in modern dress. The evidence in support of this great generalisation is no doubt still scanty; but nevertheless the theory has received the support of experimental discovery. For example, it has been shown by FITZGERALD, LARMOR, and LORENZ that it affords the simplest explanation of the results of the experiments of MICHELSON, on the supposition that the diameter of the earth is slightly altered to the extent of 4cm. by its motion through the ether. One point, however, which appears to us to be of no little moment, and to give some support to the theory that all matter is made up of electrons, was omitted in the discussion, namely, the relation that has been found by LENARD to exist between Lenard rays—or, as we may now be justified in calling them, electrons—and the mass of bodies through which they pass. LENARD, it is well known, found that in every case the absorption is directly proportional to the density. This fact appears to add substantial weight to the theory that the atoms of matter are really made up of such electrons. These electrons, which have been found to compose cathode rays, Lenard rays, and one type of the radiation from radio-active substances, have been shown to move with a velocity so great as one-third of the velocity of light, and in so doing they are enabled to travel through considerable thicknesses of metals. What, we ask, would be the result if they actually moved with the velocity of light? Their effective inertia, we know from the electromagnetic theory, would be infinite. It is possible that in moving through a body like the Earth they may encounter some measurable resistance. If this be so, the dream of LE SAGE may, in part, have been realised; for a swarm of such particles or electrons from all directions in space, and moving with the velocity of light, or almost this velocity, towards a given centre, would, by the resistance offered to them, exert a pressure proportional to the mass of a body placed in their path, and to the solid angle subtended by that body at the centre, towards which they all tend. In other words, the pressure would be proportional to the mass of the body, and likewise to the mass of any body placed at the centre, and at the same time would vary inversely as the square of the distance between them. But, after all, vague speculations of this sort do not go far towards clearing up the problem of gravitation.

The discovery of Röntgen rays marked an epoch in the history of the science of matter in its ultimate state. The identical properties which they possess with cathode rays, Lenard rays, and the rays from radio-active bodies in every case—except one, that they are not deflected by a magnet—is in itself highly suggestive; and we may remind our readers that when LENARD attended the meeting of the British Association at Liverpool he strongly and stoutly maintained the identity of the rays he had discovered with those of RÖNTGEN. At present such questions are still in the region of debate and uncertainty. But each and all of them would seem to afford clues, some more clearly defined than others, pointing to the solution of the great problem of physics and chemistry—the ultimate constitution of matter. It will be only by persistently following up these clues, and strengthening each step by experimental evidence, that the proper value of the electron theory as a solution of this problem will be established.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Dielectric Strength.—The dielectric strength of a medium is measured by the fall of potential per unit of length along the lines of electric force which the medium will stand without breaking down and allowing a spark to pass. The minimum of dielectric strength lies at a pressure of about 0·7mm. in hydrogen, 0·3 in air, and about the same in carbonic acid. In hydrogen, the minimum strength is 233 volts per cm., in air 300, and in carbonic acid 378. The measurements are taken, according to E. Bouty, in a field between two plane and parallel electrodes. This gets rid of brush and glow discharges. When the variation of the dielectric strength with the pressure is studied, it is seen that, apart from the lowest pressures, the dielectric strength varies with the pressure in a lineal manner. If y is the dielectric strength and p the pressure, the relation between the two is expressed by the formulæ

$$y = 1{\cdot}4 + 63{\cdot}33\,p \text{ in hydrogen.}$$
$$y = 1{\cdot}593 + 119{\cdot}09\,p \text{ in air.}$$
$$y = 1{\cdot}703 + 144{\cdot}4\,p \text{ in carbonic acid.}$$

The constant term denotes no doubt the part played by the electrodes in opposing the passage of an electric discharge. The above values are those found for glass, whereas much higher ones were found by Max Wolf for brass. Wolf's direct relation between the coefficient of p and the inverse mean free path is correct as between hydrogen and air, but only very roughly so in the case of CO_2.

[E. BOUTY, *Comptes Rendus*, August 20 and 27, 1900.]

Metastability of Weston Cell.—E. Cohen has found an important flaw in the perfection of the cadmium cell as a standard of E.M.F. Not only can cadmium sulphate in the form used, *viz.*, $CdSO_4 + 8/3H_2O$ exist in two modifications below 15deg., but the cadmium amalgam itself is unstable, and can exist in two modifications below 23deg. The amalgam contains 14·8 per cent. of cadmium. At 0deg. a potential difference of 5 millivolts exists between the two modifications of the cadmium amalgam, and that difference is, of course, large enough to destroy the suitability of the cell as a standard of E.M.F. The fault is found both in the cells of the Reichsanstalt and of the European Weston Electrical Instrument Co. The passage from one modification to the other is apparently quite spontaneous. Above 23deg. there is, of course, no danger, but then a constant temperature cannot be ensured without the use of a thermostat, and the supposed advantages of the Weston cell, derived from its surprisingly low temperature coefficient, are thus rendered illusory. No doubt a similar instability exists in the Clark cell, and it is only by a careful study of the behaviour of the various cadmium amalgams and compounds that any improvement can be attained. Such a study is now being pursued in Amsterdam.

[E. COHEN, *Proc. Akad., Amsterdam*, August 28, 1900.]

Conductivity of Pressed Powders.—The distinction between metallic and electrolytic conduction is chiefly based upon the temperature coefficient of the resistance. If the resistance increases with the temperature, the conduction is metallic. If it decreases, the conduction is electrolytic. Conductors belonging to both classes, or to an intermediate class, have not hitherto been obtained. But F. Streintz has made some experiments on powdered conductors which indicate something like a transition from one class to the other. He prepared fine powders of platinum black, graphite, and lamp-black, and subjected them to considerable pressure in a hole bored in a block of ebonite, at the same time determining their resistance by auxiliary electrodes inserted in the block. The resistance of 1mm. of platinum black having a section 1mm. square was found to be 0·92 ohms at zero, as against 0·14 for ordinary metallic platinum. But the temperature coefficient of platinum black is only half that of platinum. Lampblack under the same conditions showed a resistance of 40,000 ohms, and a *negative* temperature coefficient amounting to the enormous value of 1 per cent. for 1°C. The column of lampblack is therefore equivalent to a dilute solution of

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sulphuric acid. Graphite, on the other hand, showed a resistance of only 21·9 ohms, and had a positive temperature coefficient. It therefore ranges itself among the metals in this respect. To complete the electrolytic character of lampblack, some kind of ionisation and consequent polarisation remains to be established.

[F. STREINTZ, *Ann. der Physik*. No. 9, 1900.]

Magnetisation of Electrolytic Iron.—Electrolytic iron has hitherto been studied after its formation. C. Maurain has, however, conceived the idea of investigating its magnetic properties in the act of deposition, and depositing it under the influence of magnetic fields of various intensities. The deposits were obtained from a solution of ferrous sulphate in sodium pyrophosphate, and were very brilliant and adhesive. The brass electrodes were mounted in the centre of the magnetising coil itself. It was found that the magnetometer deflection, produced by the deposit, increased in a linear with the time. Since the current was steady, this means that the magnetic susceptibility of the bottom layers of the deposit remained the same as that of the top layer. The magnetisation also increased with the magnetising force, and in that respect the deposit showed no difference from a deposit magnetised after deposition. But a quantity not hitherto fully appreciated is the high coercive force and residual magnetism of these deposits. There is practically no loss of magnetisation after the removal of the field. It even resists an opposite field, when the latter is not too strong. But when the opposite field attains a certain strength, say 20 units, the collapse of the magnetisation is sudden and complete. Nickel similarly deposited, though showing the same remanent magnetism, exhibits a gradual diminution of magnetism with an increasing demagnetising force.

[C. MAURAIN, *Comptes Rendus*, August 13, 1900.]

Mechanical Action of Cathode Rays.—Experimental determinations of the force exerted by cathode rays upon light moveable bodies are as yet lacking, though Riecke has estimated the force acting upon a cathode shaped like a propeller. If the force thus found is regarded as that due to the reaction of projected particles, an amount of energy results which surpasses the whole energy of the cathode rays. It is, therefore, not permissible to deduce the kinetic energy of the cathode particles from such experiments. H. Starke has adopted a different arrangement. He used a cathode with a number of plates resembling a propeller. But the cathode was kept fixed, and the cathode rays impinged at an angle of 45deg. upon a thin plate of aluminium suspended above the cathode by means of a thin platinum wire. The results were almost all negative. An influence machine gave nothing but irregular disturbances, probably due to electrical forces unconnected with the impact of cathode rays. An influence machine of 20 plates, yielding a discharge potential of 10,000 volts, and a current intensity of 10^{-7} amperes, gave something like an appreciable deflection, which indicated, however, that the force to be measured is below 10^{-4} dynes. The experiments are to be continued.

[H. STARKE, *Ann. der Physik*, No. 9, 1900.]

Protection of Magnetic Observatories.—The new electric tramway between Vincennes and Nogent-sur-Marne, which passes at a distance of 3,000 yards from the Parc Saint Maur magnetic observatory, disturbs the needles at the latter to a very appreciable extent, the greatest disturbances being due to the electrical events attending the starting of the cars. Fortunately, these disturbances are symmetrical to the natural curve, and are of a much greater frequency than the natural fluctuations of the earth's magnetism. They can therefore be made practically negligible by employing needles of square or rectangular section, strongly magnetised, by increasing the moment of inertia of the swinging system by means of a piece of copper, and by damping with copper discs. This has been done by T. Moureaux with a declinometer and a bifilar magnetometer, for which bars 5cm. long and 5mm. thick were chosen, with a magnetic intensity of 200 units. The ordinary bifilar showed oscillations amounting to 0·0002 C.G.S. units, but these disappeared almost completely on the new bifilar. A bifilar put up in the Fort de Nogent, within 800 yards of the tramway, showed disturbances of 0·0003 units, which were, however, reduced to one-tenth of that amount in the new instrument. The only effect of the vagrant currents was a slight thickening of the curve traced by the magnetograph.

[T. MOUREAUX, *Comptes Rendus*, July 30, 1900.]

THE INTERNATIONAL ELECTRICITY CONGRESS.

The International Electricity Congress, which was held in Paris in connection with the 1900 Exhibition from Aug. 18 to Aug. 25, was formally opened by M. Mougeot, Under-Secretary of State for Posts and Telegraphs, on Saturday, Aug. 18. France was represented by delegates from the Ministries of Commerce, War, Marine, and Agriculture; other countries which had sent delegates were Great Britain, Germany, Austria, Belgium, Bulgaria, Corea, Denmark, Ecuador, Spain, United States, Guatemala, Hungary, India, Italy, Japan, Liberia, Luxembourg, Mexico, Norway, Holland, Russia, Servia, and Switzerland. The following societies were also represented:—

Association Amicale des Anciens Élèves de l'Ecole de Physique et de Chimie Industrielle de la Ville de Paris.
Association Amicale des Ingénieurs Electriciens.
Association des Industriels du Nord de la France.
French Chamber of Commerce.
Compagnie des Chemins de fer de l'Ouest.
Société Amicale des Ingénieurs sortis de l'Ecole Supérieure d'Electricité
Société Française de Physique.
Société Internationale des Électriciens.
Syndicat Professionel des Industries Electrique.
Syndicat Professionel des Usines d'Electricité.
Elektrotechnische Institut of Karlsruhe.
Verband Deutscher Elektrotechniker of Berlin.
Elektrotechnischer Verein of Vienna.
Association Amicale des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore de Liège.
Canadian Electrical Association of Toronto.
American Institute of Electrical Engineers.
Franklin Institute (U.S.A.).
New York Electrical Society.
Institution of Electrical Engineers (Great Britain).
Koninglijk Institut van Ingenieurs de La Haye.
Société des Ingénieurs et Architectes Hongrois of Budapest.
Associazione Elettrotecnica Italiana of Turin.
Societa d'incoraggiamento d'Arti e Mestieri of Milan.
Associacão des Engenheiros civis Portuguezes.
Association Suisse des Électriciens.
Parnasse d'Athènes.

The number of members of different nationalities attending the Congress was as follows:—

France	346	Canada	4
Germany	79	Argentina	4
Belgium	54	Brazil	3
Great Britain	51	Turkey	3
United States	50	New Zealand	2
Italy	45	Chili	1
Switzerland	39	Denmark	1
Russia	20	Egypt	1
Austria	16	Luxembourg	1
Hungary	10	Peru	1
Holland	10	Portugal	1
Spain	5	Sweden	1
Japan	5		
Roumania	5	Total	758

In his words of welcome, M. Mougeot alluded particularly to the foreigners who had hastened to Paris in a common sentiment of fellowship and love of science, all with the same idea of solidarity and anxious to improve the lot of humanity. After M. Mougeot's graceful words of welcome, M. Mascart, President of the Organisation Commission of the Congress, delivered a short address, also expressing his gratitude to the number of his foreign colleagues who had replied to the Committee's invitation to attend the congress. He expressed the hope that this reunion of savants and engineers of different countries, who had directed their efforts to the progress of electricity, would tend to strengthen the bonds of friendship formed previously at similar gatherings and to create fresh friendly relations. M. Mascart then gave a short historical sketch dealing with the development of electricity during the past century, and pointed out the entire

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transformation it had brought about in all industrial and commercial methods. The following general committee was then elected :—

PRESIDENT : M. E. Mascart.

VICE-PRESIDENTS :

France.—MM. Moissan, H. Fontaine and Gariel (Vice-preaidents of the Organisation Commission).
Germany.—Prof. F. Kohlrausch and Prof. Dorn (delegates of the German Empire).
England.—Prof. Perry and Sir William Preece (delegates of the British Government).
Austria.—Prof. Jullig (delegate of the Austrian Government).
Belgium.—M. Eric Gérard.
United States.—Mr. Carl Hering and Dr. A. E. Kennelly (delegates of the United States Government).
Hungary.—M. de Fodor.
Italy.—Prof. Colombo (delegate of the Italian Government).
Russia.—Prof. de Chatelain (delegate of the Russian Government).
Switzerland.—M. Turrettini (delegate from the town of Geneva).

GENERAL SECRETARY : M. P. Janet.

REPORTER : M. Hospitalier.

Presidents were then chosen for the various sections :—

Section I.—Scientific Methods and Measuring Apparatus.—M. Violle.
Section II.—Sub-section A : Production and Mechanical Utilisation of Electricity.—M. H. Hillairet. Sub-section B : Electric Lighting.—M. Hippolyte Fontaine.
Section III.—Electro-Chemistry.—M. Moisson.
Section IV.—Telegraphy and Telephony.—M. Wünschendorff.
Section V.—Electro-Physiology.—M. d'Arsonval.

The President read a letter from Lord Kelvin, who expressed his regret at being unable to attend the congress, owing to ill-health, and wished the congress every success. A telegram of thanks and respectful sympathy was addressed to Lord Kelvin in reply.

Profs. Ayrton and Dorn then expressed the thanks of the foreign delegates for the graceful and hearty welcome which had been extended to them.

On Monday, Aug. 20, and during the week the various sections met separately.

Section I.—*Scientific Methods and Measuring Apparatus.*

On Monday M. Cornu explained a new system of units proposed by M. Rey-Pailhade, based on a physical unit of time equal to the 100,000th part of the mean solar day. The examination of the whole question of units was, however, relegated to a committee formed as follows :—

Prof. Ayrton (Great Britain), Prof. de Chatelain (Russia), Prof. Dorn (Germany), M. de Fodor (Hungary), M. Gérard (Belgium), M. de Hoor Tempis (Hungary), M. Hospitalier (France), M. Lombardi (Italy), and Dr. Kennelly (United States).

A short discussion on "Photometry" followed, in which MM. Cornu, Gova, and Hospitalier took part.

On Tuesday, August 21, Mr. Hildburgh gave a detailed description of apparatus for rectifying alternating currents, and this was followed by a Paper by M. Arnoux on practical standards of E.M.F.s. M. Arnoux referred to the Clark standard cell adopted by the 1893 congress at Chicago, and pointed out the defect of a large temperature coefficient, which was not always known with accuracy, and also the large variation in the internal resistance of the cell, which necessitated the employment with it of highly-sensitive and not very portable galvanometers. In 1884 Czapski called attention to the cadmium cell, in which cadmium and sulphate of cadmium replaces the zinc and sulphate of zinc in the Clark cell, with the result that the variation of E.M.F. with temperature is about a thirtieth as great. Later, in 1897, Jaeger and Wachsmuth made an interesting study of the cadmium cell at the Berlin Reichsanstalt, confirming the observations of Czapski. Gouy, to whom a bioxide of mercury cell is due, had made an interesting and very complete communication to the 1900 International Physics Congress on the cadmium standard, in which he acknowledges that his own cell could not rival the cadmium cell with regard to temperature variation. Gouy made use of the H form of cell adopted by Jaeger, Wachsmuth, and Kahle, but M. Arnoux himself prefers the ordinary cylindrical arrangement in practice, as it enables cells to be made of about a fiftieth the resistance, and with which, in consequence, less sensitive and more portable galvanometers can be employed. M. Weyde having exhibited a mechanical model representing the effects of a continuous or alternating E.M.F. in a circuit possessing resistance, self-induction, and capacity, the section adjourned for the day.

The first part of the session on Wednesday was devoted to oscillographs. M. Blondin exhibited, on behalf of M. Blondel, some new oscillographs, devised by the latter and constructed by M. Dobkevitch. There were three types of this apparatus, viz., the bifilar one, one with soft iron, and the third with a strip of soft iron, a modification of the last mentioned. After explaining the details of the three instruments, and showing the optical arrangement permitting the curve to be projected either on a photographic plate or on a screen, M. Blondin considered the relative advantages and disadvantages of the various types. The bifilar oscillograph was the most accurate, but it required delicate handling and was particularly suitable for laboratory investigation. The frequency of the oscillations of the moving part was 10,000 to 15,000 oscillations per second. The oscillograph with the soft iron strip was recommended for commercial use. Its frequency of oscillation could reach 45,000, and, constructed with a permanent magnet, its weight did not exceed 12kg. to 15kg. A single incandescent lamp sufficed to photograph the curves, and, owing to the use of a permanent controlling magnet, continuous current was not necessary when using it. Mr. Duddell referred to the work he had done in connection with these instruments, and stated that, so far as the bifilar oscillograph was concerned, he had come to the same conclusion as M. Blondel, with whose researches he had not been previously acquainted. M. Dobkevitch gave the following figures for the oscillograph : With a vibrating ribbon without magnetic shunt, 25,000 to 80,000 vibrations, with a sensibility of 40mm. per ampere at a scale placed at a metre distance ; with a strong magnetic shunt, about 10,000 vibrations with a sensibility of 180mm. per ampere at a scale placed at a metre distance. By varying the magnetic shunt he could obtain various degrees of sensibilities and frequencies. The dimensions of the mirrors were : Thickness, between 0·06mm. and 0·10mm. ; width, 0·2mm. to 0·3mm. ; height, 0·5mm. to 1mm. M. Carpentier also spoke, alluding to M. Abraham's method of recording variable currents.

A Paper was then read by Mr. Addenbrooke describing a set of electrostatic instruments for performing accurate measurements on alternating-current circuits. The instruments are intended to perform for alternating currents more or less what the Crompton potentiometer does for continuous currents. The ammeter is an electrostatic voltmeter connected to the terminals of a resistance in the main circuit, and the wattmeter is an electrometer whose quadrants are connected to these same terminals while the needle is connected to one terminal of the alternator or is given a potential proportional to it.

The proceedings on Thursday were opened with a Paper by M. Violle on "Photometry." M. Violle first quoted the conclusions of the International Congress at Geneva in 1896 with regard to photometric units and standards of light, and then proceeded to criticise these and to review the various investigations of light standards which have been made since then. He concluded his Paper with a description of some recent photometers. Herr Hartmann, of the well-known Frankfort firm of instrument makers, then presented a note on "Apparatus for Measuring the Frequency of Alternating Currents." This apparatus consists, in principle, of an electro-magnet traversed by the alternating current, which acts on a vibrating strip and makes it emit a sound. The electro-magnet is placed successively in front of a series of these strips, and the one that give the sharpest sound is discovered. Up to a certain point the excitation of the neighbouring strips permits the apparatus to be used for certain frequencies not included in the natural periods of vibration of the strips in the series. Herr Hartmann then exhibited an apparatus based on the same principle and intended to control the frequency of a given alternating current. It consists of two vibrating strips adjusted to frequencies, one slightly greater and one slightly

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less, than the frequency required. When the frequency is constant the apparatus will emit no sound at all. M. Blondin then presented on behalf of M. Blondel a communication on tests of two-phase or three-phase alternators made at the Central Laboratory of Electricity by MM. Blondel, Dobkevitch, Duris, Farmer, and Tchernosvitoff by means of oscillographs. They found that the load on one phase caused a deformation of the wave form of the other phases, this deformation being greater the more unequal the loads were. Finally, the armature reaction produced in the field-magnet circuit pulsations which were often very strong, and whose frequency was double the product of the frequency of the armature current and the number of phases.

On Friday the Units Committee presented their report, which was as follows:—

The Committee does not take into consideration propositions to introduce any modification into the decisions of previous congresses.

The Committee does not consider it necessary at present to give names to all the electromagnetic units. However, in view of the employment of practical measuring apparatus giving directly field strength in C.G.S. units, the Committee recommends that the name "Gauss" be given to the C.G.S. unit.

The Committee also proposes to call the unit of magnetic flux, whose magnitude shall be defined subsequently, the name "Maxwell."

Dr. Kennelly, in the name of the American Institute of Electrical Engineers, withdrew its propositions with regard to the prefixes and rationalisation of electromagnetic units.

The first clause of the report was passed unanimously, but there was some discussion on the other recommendations. M. Mascart did not consider that it was necessary to give any name to the C.G.S. unit of magnetic field. He was of opinion that this decision was contrary to the spirit of the congresses of 1881 and 1889, which did not give to the C.G.S. units the names of savants. He would admit that a name might be given to a practical unit. In any case, however, the name of Gauss seemed likely to lead to confusion, for Gauss was the inventor of the first absolute system (millimetre-milligramme-second), which was still employed at the present day in certain cases. M. G. J. Van de Well was in favour of adopting the name Maxwell for the unit of magnetic flux, but he thought that the magnitude of this unit should be defined. Prof. Kohlrausch said that the absolute units sufficed for physicists, but if engineers found the necessity of naming the units, Prof. Dorn and himself did not see any inconvenience in their giving them names such as Gauss and Maxwell for instance. However, the German delegates could not, he said, give an undertaking on behalf of their Government, and he thought that the congress should limit itself to recommending these new names without trying to give them a legal sanction. Prof. Ayrton was of the same opinion as M. Mascart, and pointed out that apparatus such as the Ayrton-Mather field tester had been used for several years without any necessity being felt for giving a name to the unit of field strength. Moreover, the C.G.S. unit of magnetic field was the one in practical use. M. Mascart said that there was ambiguity in the word "practical." Although the C.G.S. unit of magnetic field was employed in practice, it did not belong to what was called the practical system of units. M. Hospitalier desired that they should give names to the two units in question. He did not ask for a legal decision, but a simple recommendation by the section. After further discussion, in which MM. Ayrton, Carpentier, Dorn, Fernandez, Adison, Hospitalier, Kohlrausch, Mailloux, Mascart, Alexander Siemens, and Silvanus P. Thompson took part, at the suggestion of M. Eric Gérard the question was put by the President whether the section would recommend that special names be given to the C.G.S. units of magnetic field and magnetic flux, and this proposal was adopted with only two dissentients. After a short adjournment the two proposals were put that the section recommended the adoption of the name "Gauss" for the C.G.S. unit of magnetic field and the name "Maxwell" for the C.G.S. unit of magnetic flux. These two recommendations were adopted successively, two members only dissenting in each case.

M. R. Arnoux then exhibited a new type of thermo-galvanometer which he had designed in conjunction with M. Chauvin. This instrument differed from others on the same principle in the arrangement of the gear to amplify the deflection, and in the arrangement to compensate for the external temperature. The hot wire of variable length f is coupled to a fixed lever of very short length, b, and these two form a triangle with the frame of the instrument, the length of the third side being a. The angle F of this triangle subtending the hot wire will be very nearly 180deg. The following relationship is obtained between these magnitudes: $f^2 = a^2b^2 - 2ab \cos F$. On differentiating, this becomes

$$f df = ab \sin F dF, \quad \text{or} \quad \frac{df}{dF} = \frac{f}{ab \sin F}.$$

This relation shows that a small variation in the angle F, corresponding to an elongation df of the wire will have a maximum value when the lever b is very small and the angle F either very nearly zero or very nearly 180deg. By employing this principle, a deflection of 90deg. of the needle was obtained with the consumption of 0·85 watt in the hot wire, corresponding to a current of 3·5 amperes at one-tenth of a volt, whereas most hot wire instruments would require three-tenths of a volt with the same current for this result. The arrangement for compensating for variations of external temperature consists of fixing parallel to the hot wires a number of wires identical to it and stretching the whole by means of a strong steel spring.

M. P. Janet described a recording apparatus made for him by M. Richard. This apparatus had been specially designed to study the working of three arc lamps connected in series. It included three recording voltmeters to register the differences of the potential at the terminals of each of the lamps, and a recording ammeter for the current. The four pens register on the same drum, which facilitates the comparison of the curves.

At the afternoon sitting on Friday, M. C. Perskyi read a communication on "Television," describing a number of apparatus based on the magnetic properties of selenium.

(*To be continued.*)

THE CENTRAL LONDON RAILWAY.

(*Continued from page 732.*)

At each sub-station the secondaries of the six transformers are brought by means of low-pressure switches (Fig. 46) to three main 'bus bars, which lead to the top terminals of each of the two 2,000-ampere Samuelson quick-break switches seen upon the two panels immediately to the left of the transformer panels (Fig. 45). These two panels are devoted to the alternating-current side of the two 900kw. rotary converters. These switches carry 2,000 amperes per blade at 330 volts, and have to be protected by marble division slabs. From their bottom terminals leads are carried down under the floor to the brush holders for the collector rings of the rotary converters. A diagram of the switchboard connections is shown in Fig. 47.

The rotary converters are 12-pole, three-phase, 25-cycle machines, corresponding to a speed of 250 revs. per min. Each has an output of 900kw. at 500 volts continuous current, the alternating-current input voltage corresponding to this being 305 across collector rings. Fig. 48 shows an elevation and section of one machine. The base, a cored iron casting, is in one piece, and on this are bolted the bearing pillow blocks, the magnet frame, and collector brush rigging brackets. The magnet frame or yoke is of mild cast steel, in two halves bolted together, and carries the 12 inwardly-projecting magnet cores and pole-pieces, which are of laminated sheet steel. The field coils are wound on sheet-iron spools having brass flanges. The winding space on each spool is divided, the upper portion being devoted to the shunt winding, which consists of 912 turns in series of No. 11 B and S per spool, while the lower portion is reserved for the series winding. This series winding consists of eight copper strips, 2·5in. by 0·075in., in parallel, there being 2½ turns per spool. The object of this compounding is that the rotary may be adjusted automatically to maintain constant voltage under all conditions of load by means of phase control. Nominally, a rotary converter has a fixed ratio of voltage

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between collector and commutator, but the voltage between the generator and rotary collector ring may be varied by displacing the phases of current and E.M.F., causing the current to lead or lag, as higher or lower voltage of commutator may be required. This is only the case if reactance arrangements be introduced, but in practice, unless extreme variations are required, sufficient reactance exists in the armature of the generator itself, and the leading currents in its armature, produced by the over-excited rotary, help the field excitation, and considerable variation of voltage may be obtained. Thus, suppose in this case a heavy load comes on, the field becomes over excited, by reason of the increased ampere turns due to the series winding, and causes the alternating currents to lead in phase, with a corresponding higher voltage at the commutator. The compounding has been so adjusted, by shunting part of the series amperes, that the continuous-current voltage keeps quite constant even under the most trying fluctuations of load. The outside diameter of the magnet yoke is 123in.; the length parallel to the shaft is 22in., and the magnetic density in the steel 48,000 lines per square inch. The magnet cores are 12in. square, and the length of the pole arc 15⅞in.; the density in cores is 95,000 lines per square inch. The armature core, which is slotted to receive the winding, is built up of separately insulated sheet-

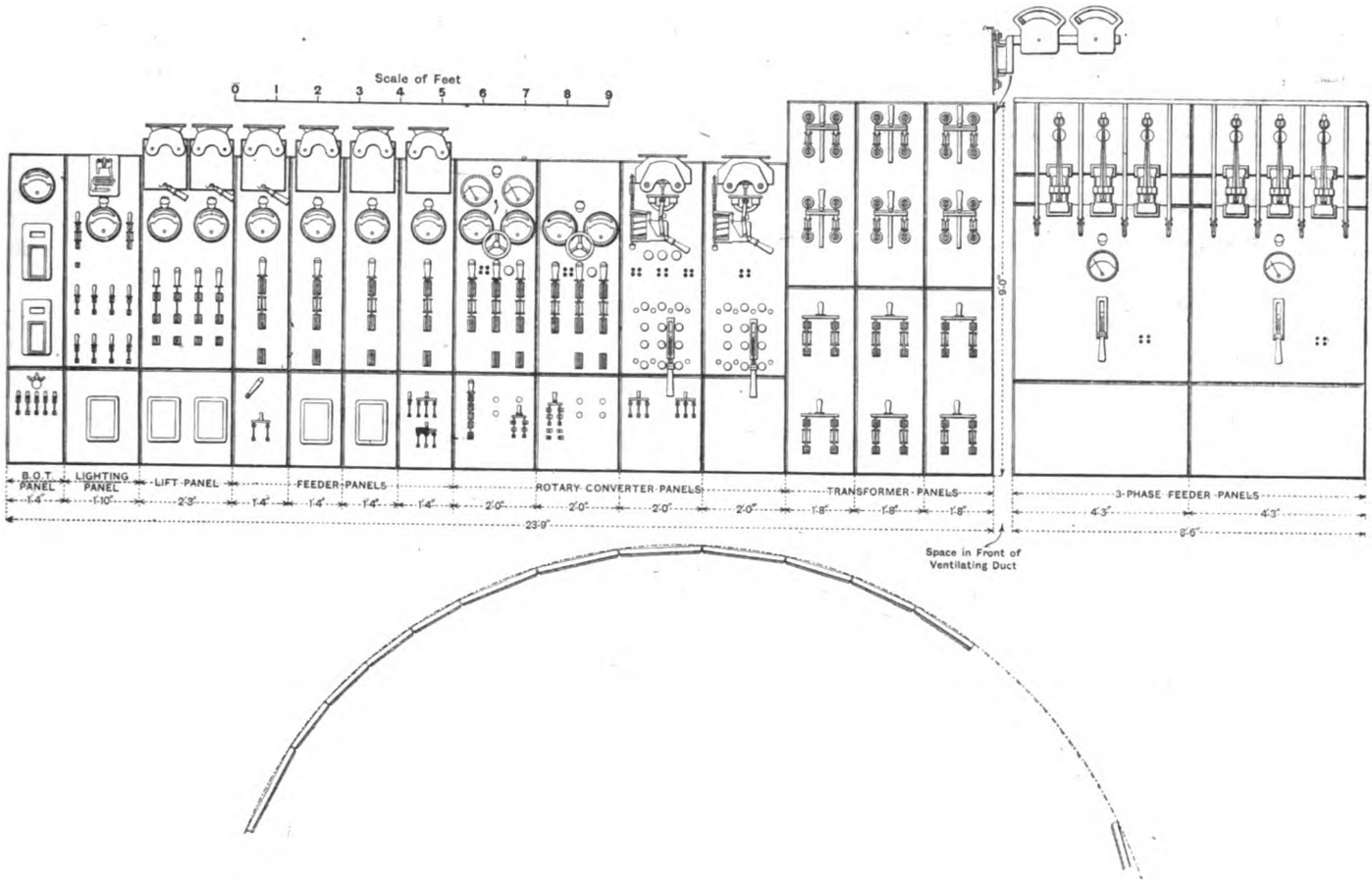

FIG. 45.—GENERAL ARRANGEMENT OF HIGH AND LOW-PRESSURE SWITCHBOARD AT THE NOTTING HILL GATE SUB-STATION.

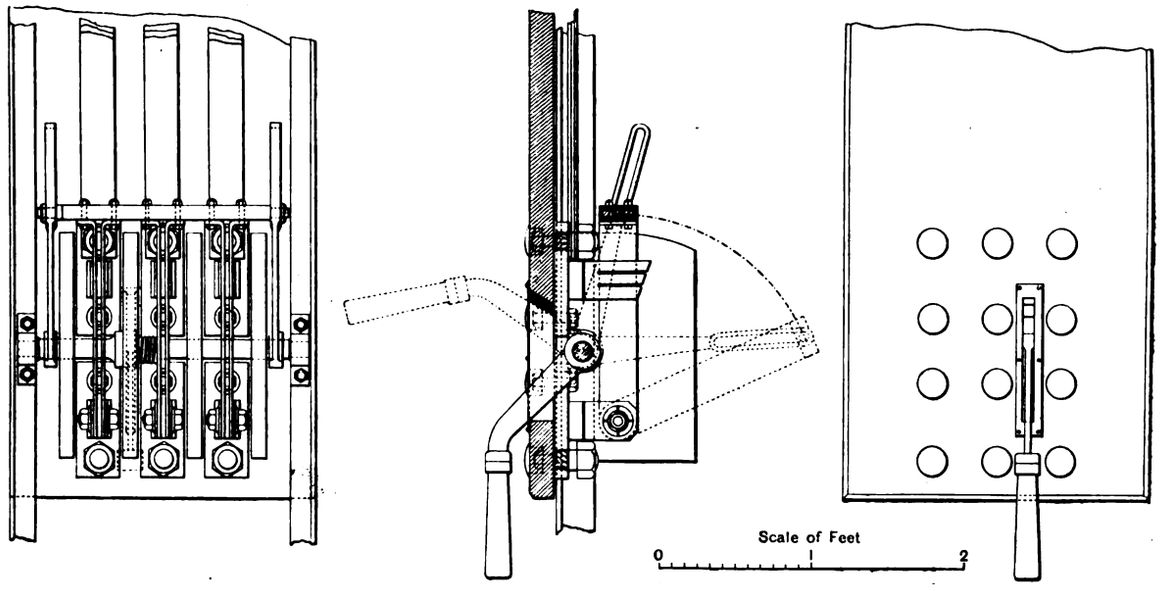

FIG. 46.—THREE-PHASE LOW-PRESSURE SWITCH.

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iron punchings 0·014in. thick, and is carried on a heavy cast-iron spider, the laminæ being secured thereto by dovetailing. The magnetic density in the teeth is 128,000 lines per square inch, and in the core below teeth 51,000 lines. The winding is of the multiple circuit drum class, bar type construction being employed. There are four

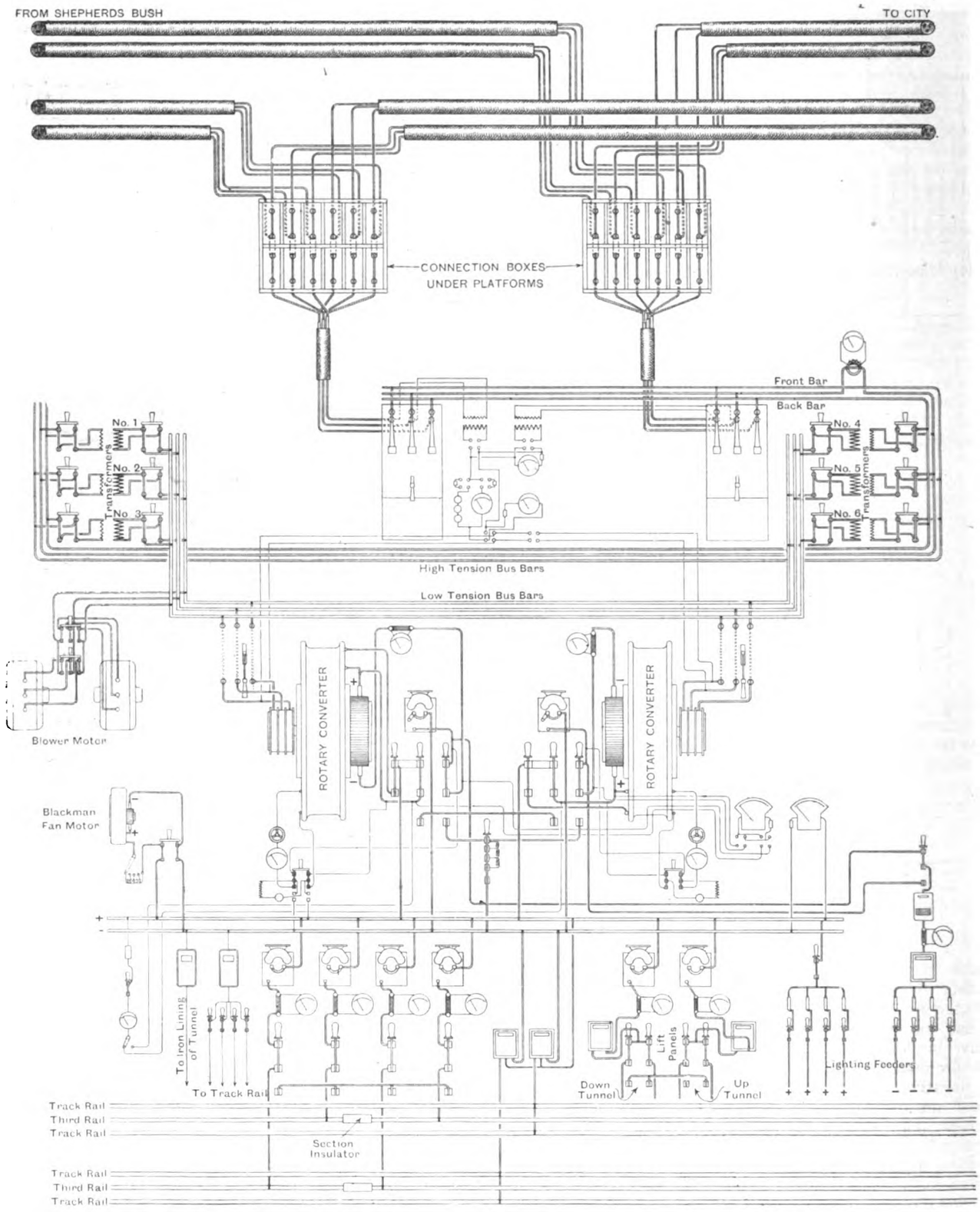

FIG. 47.—DIAGRAM OF CONNECTIONS AT THE NOTTING HILL GATE SUB-STATION.

conductors, each 0·4in. by 0·125in. per slot, the dimensions of the slots being 1·25in. deep by 0·44in. wide, and 288 such slots altogether. The number of parallel paths through the armature is 12, leaving 48 turns in series between brushes. The cross-section of these 12 paths is 0·6 sq. in., and figuring on the resultant current gives a current density of 2,400 amperes per square inch. Into this winding are 18 equidistant tappings for the three-phase currents, or three tappings per pair of poles, which are brought down to the three collector rings carried on a separate spider on the shaft. The collector is 24in. diameter, and each ring is 3½in. wide, and has eight copper gauze brushes, which are supported on cast-iron brackets bolted to the base. The commutator is 54in. diameter and 17½in. long, and has 576 segments, or one segment per turn. It is supported by a separate cast-iron spider. There are 12 sets of carbon brushes, each set having

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eight brushes 1½in. wide by ¾in. thick, and they are carried in holders on spindles fixed to brackets on a cast-iron ring. This ring is supported on arms bolted to the magnet frame, and is free to move in a groove turned in these arms. By means of a handwheel and worm this ring, carrying all the sets of brushes, can be rocked round to any position, but in actual operation for all loads the brushes remain fixed at the mechanical neutral position.

The weights of the various parts of the machines are approximately as follows:—

Armature, complete with collector, commutator and shaft	24,800lb.
Magnet frame, cores, pole pieces, and spools complete	19,550lb.
Collector brackets, brush rigging, &c.	4,000lb.

Returning to the switchboard (Figs. 45 and 47) we find the next two panels contain the main switches and instruments for the continuous-current side of the rotaries, one panel being for each rotary. The three large single-pole, quick-break, divided blade switches on each panel are the positive, equaliser and negative switches respectively. The bottom of the positive switch is connected to the series winding and the top is connected to the positive 'bus bar. The latter two switches are double throw, the lower point connects the equaliser switch to the equaliser 'bus bar, and the upper position connects positive brush ring direct to the positive 'bus bar, the rotary then running as a shunt machine. If the positive is closed at the same time then the series winding is short circuited, but if open then the series winding is open. The negative switch when thrown upwards—which is its normal running position—connects the machine through the circuit-breaker to the negative 'bus bar. The circuit-breaker is located above the three-phase rotary switch for that particular machine. The down position connects the machine through the starting rheostat to the negative 'bus bar. Above the negative switch is the main ammeter, of the Weston shunt type, showing the total current going out from the rotary on the continuous-current side. The field switches, which are of the double-pole type, are mounted on the sub-bases of their respective panels, and the field ammeter, which reads either way, is mounted to the left of the main ammeter in each case. The field rheostat is mounted above the board, and is regulated by means of a hand wheel. Auxiliary three-pole field switches are mounted on the sub-bases of the three-phase rotary panels, so that when starting up on the alternating-current side the field can be divided into four separately-insulated parts, the double-pole field switch also being open. On the sub-base of No. 1 rotary panel there is the four-point starting rheostat, one end of which is connected to the bottom terminals of the two negative switches and the other end to the negative 'bus-bar. Also at the top of this panel there is the alternating current machine voltmeter, which can be connected across two of the rings on either rotary by means of a plug receptacle on each panel. To the right of the machine voltmeter is the synchronising voltmeter. The synchronising lamps are located, besides the circuit breaker, on No. 1 three-phase rotary panel.

Now follow the four-line feeder panels. The positive 'bus bar is continued along the top of these panels, and feed down to each feeder through separate circuit-breakers and double-throw quick-break switches. The third rail is divided in each tunnel at a point outside each sub-station. This enables the station to feed into any or all of the four sections by throwing the feeder switches to the "Up" position. By throwing the switches downward either or both rails may be made electrically continuous by means of a common 'bus bar connecting the lower points of the switches together; and the line can be fed right through by the other stations at work at the time, thus enabling the station to shut down. A Weston shunt type ammeter connected in each feeder indicates the current going out to each section. The track rails are in permanent connection to the negative 'bus bars. The total current returning by the rails in each tunnel is recorded separately by two Thomson integrating wattmeters (one for each tunnel). Mounted on the base of the first of the feeder panels are the two three pole switches for operating the two 6 H.P. three-phase blower motors for the air blast transformers. On the base of the fourth feeder panel is a double-pole switch and starting rheostat for a series-wound Blackman fan motor for ventilating the sub-station.

The passenger lift panel is arranged next to the feeder panels. There are two positive cables (one in each tunnel) running the entire length of the line. The lift motors at the various stations are connected to these and in each case use the rail as a return. The cables are brought into each sub-station and connected up to the middle points of the four lever

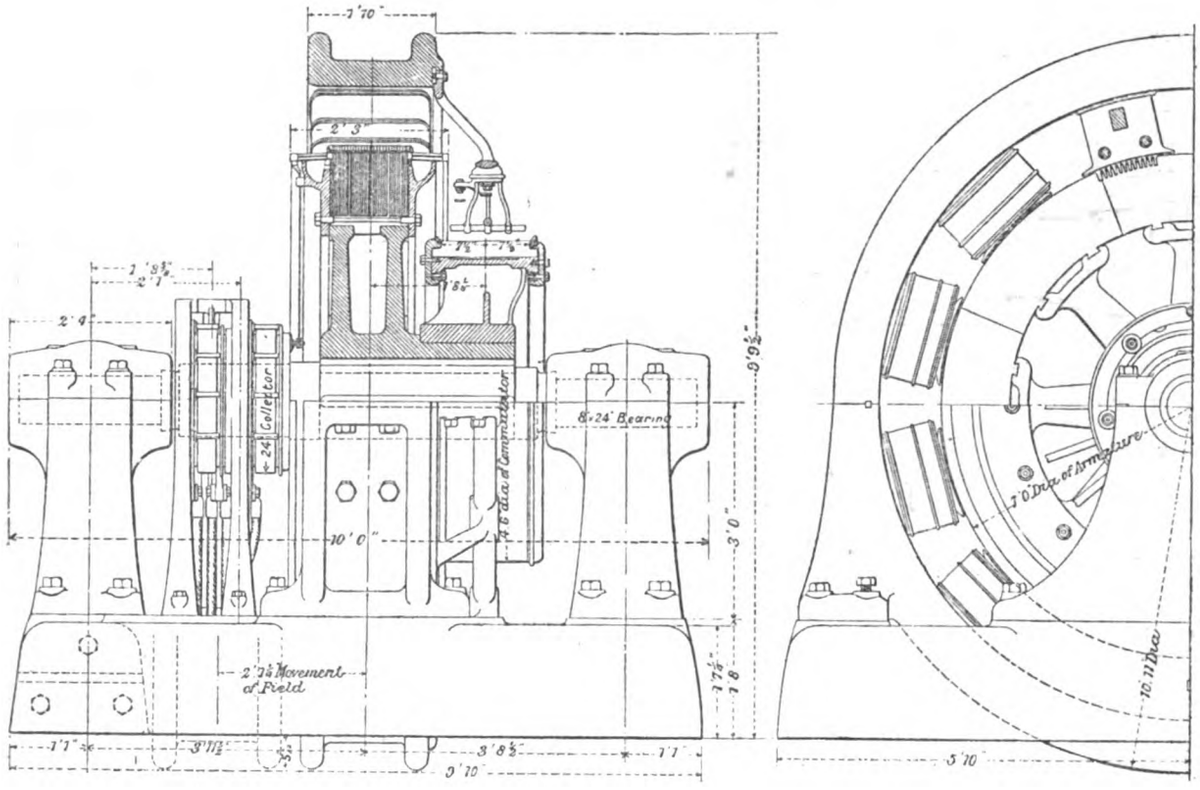

FIG. 48.—ELEVATIONS AND PART SECTION OF THREE-PHASE CONVERTER.

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switches, two for either direction. The bottom point connects all cables together, and serves to interconnect the separate sections of third rail, so that they may be operated independently of any particular sub-station. The top points of the four switches feed the four insulated sections of the third rail, two for each tunnel, each through an ammeter and circuit breaker to the positive 'bus bar at the back. Two Thomson integrating wattmeters are mounted on the sub-base of the lift panel, and record the total amount of current going out in either direction to the lifts. It is interesting to note that the ammeter reads either side of zero. The deflection to the left of zero corresponds to the amount of current restored to the line by the lift motors while their individual lifts are on their downward journeys. The lift cables might also act as auxiliary feeders to the line, but are not required for this purpose.

The main lighting and distributing switches are arranged on the next panel. Two positive and two negative lighting feeders run the whole length of the tunnel (one positive and negative in each tunnel). The distributing boards in each station are connected across these and the whole line is lighted up on the three-wire system. The positive and negative main cables enter each sub-station and are connected through switches and fuses to the positive and negative 'bus-bars. There are also several battery stations along the line which are also connected across the lighting mains, so that while the sub-stations are running the lighting can be done from the machines and also charge the batteries at the same time. A minimum cutout is in circuit, and is shown at the top of the lighting panel, so that should the machine volts drop below the battery volts the minimum cutout acts and throws the lighting load on to the batteries, thus preventing the batteries feeding back into the machine. The batteries are used for lighting the stations, offices, and depôt during the time that the line is shut down. There two main switches on the lighting panel, one a single-throw switch, which connects the positive lighting 'bus bars to the main 'bus bar, the other connects the negative lighting 'bus bars to the negative of either rotary (whichever may be running). A main ammeter indicates the total amount of current sent out for lighting. A Thomson integrating wattmeter records the total amount of energy used for lighting purposes.

The next and last panel on the board contains various testing instruments. The Weston round ammeter at the top of the panel is for testing the third rail leakage on any section from either rotary by means of a two-way switch on the sub-base of the panel. Underneath the ammeter is an Elliott recording voltmeter showing drop in volts from certain fixed points along the line to the sub-station. There is also a recording ammeter showing total return by earth to the sub-station.

(To be continued.)

Electrical Engineering in Bengal.—We have received a copy of six lectures on "Electrical Engineering with Particular Reference to the Conditions in Bengal," delivered last March by Mr. J. W. Meares at the Civil Engineering College, Sibpur. Mr. Meares, who is electrical engineer to the Government of Bengal, chose to treat his subject in an elementary manner, and his lectures are likely to have given a good general idea of electrical engineering methods to an audience of civil engineers who had not much previous knowledge of the subject of electricity. The lecturer devoted most attention to electric lighting, although possibly telegraphy might have been more useful to some of the civil engineering students. The three lectures on house-wiring and private generating stations, as well as model specification, extracts from wiring rules, and an electric lighting act, show that Indian and home practice do not differ very much. The wood-casing system is still preferred by Mr. Meares to more modern methods, with which he confesses that he has not had experience. There are as yet few public supply stations in India, and from the brief descriptions in the book it would appear that these are also erected more or less in accordance with European practice. Probably the buildings are different, but such detail was, of course, outside the scope of these lectures.

ELECTRICITY WORKS ACCOUNTS.

Halifax Municipal Electric Supply Works.

Since the acquisition of the tramways as a customer, the Halifax undertaking stands as a splendid example of the economy resulting from a combined lighting and traction load. The accounts which we deal with in our table indicate most excellent results all round.

A general and substantial reduction in the costs has been effected, and the result has been that in conjunction with the much greater output the working profit was £9,002, representing no less than 11 per cent. on the mean capital expended, and this notwithstanding the lower average total revenue secured of only 2·8d. per unit sold. The aggregate costs at 1·2d. per unit are just about half the average of stations of similar output in 1898. Of the total output of 1,371,333 units sold the tramways took 895,024 units, or 65·3 per cent., and of the total revenue for current sold (for all purposes) of £15,820 the tramways contributed £7,459, or 47·2 per cent. The beneficent influence of the traction load on the undertaking by increasing the load factor is not, of course, by any means adequately represented by the consequent low working expenditure. It is only by taking into account the influence on the capital charges that the advantages can be appreciated.

Of the working profit of £9,002, £810 represented the contribution to the sinking fund and £2,685 the interest charges. After meeting these and placing aside £3,489 to a renewal account there was left £2,000 transferable in aid of the rates.

A comparison of the results with those of past years is facilitated by the following table:—

Year to March.	Plant capacity kw.	Equiv. lamp con.	Output. Units sold.	Sold to tramways.	Sold for public lighting.	Total costs per unit sold.	Total works costs per unit.	Total rev. per unit.	Working profit to mean cap.
1896	600	9,816	119,028	—	4,815	4·74d.	3·36d.	5·74d.	1·27%
1897	600	14,146	177,530	—	12,430	3·57d.	2·55d.	5·86d.	3·78%
1898	850	20,800	239,814	—	21,107	2·87d.	2·05d.	4·85d.	3·77%
1899	1,400	32,020	628,759	279,867	59,264	1·65d.	1·21d.	3·42d.	7·11%
1900	1,250	45,403	1,371,333	895,024	82,123	1·24d.	0·90d.	2·81d.	11·0%

Nottingham Municipal Electric Supply Works.

Seldom have we to deal with accounts which indicate such sustained and rapid progress of an undertaking as do those of Nottingham. Last year we had occasion to note the result of the reduction in the tariff which was then made—viz., an advance in the lamp connections of nearly 77 per cent, and in the output of over 86 per cent. During the latter period covered by our analysis this week the lamp connections advanced from the equivalent of 67,339 to 100,378 8 c.p. lamps or by 49 per cent., while the output shows an increase of 66·7 per cent.

In character, as well as in magnitude the load has improved as is indicated by the load factor of 10·8 per cent., which obtained last year as compared with one of 9·3 per cent. in 1898-9.

Owing to the probably unavoidable rise in the fuel charge and in spite of a very general reduction in the other items, the works and total costs have slightly risen. In particular and in the aggregate, however, the various items of expenditure are all still well below the average at the output and load factor.

It will be noticed that the average revenue per unit has further dropped, exhibiting the very moderate figures of 2·8d. for ordinary consumers, and 2·96d. from all sources.

In the following table some figures are given which will show the progress the undertaking has made since the starting of operations:—

Year to March.	Lamp connections.	Output. Units sold.	Load factor per cent.	Total costs per unit sold.	Total works costs per unit.	Total revenue per unit.	Working profit per cent. to mean cap.
1896...	17,400	171,654	6·98	2·85d.	1·71d.	6·09d.	4·30
1897...	25,725	297,185	8·48	2·20d.	1·32d.	5·94d.	7·62
1898...	38,140	480,381	7·44	1·83d.	1·21d.	5·37d.	9·85
1899...	67,359	894,674	9·30	1·38d.	0·95d.	3·47d.	7·65
1900...	100,378	1,491,184	10·8	1·41d.	1·06d.	2·96d.	6·59

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	NOTTINGHAM.		HALIFAX.	
Undertaking Worked by	Nottingham Corporation.		Halifax Corporation.	
Date of Commencement of Supply	September, 1894.		December, 1894.	
System of Supply	Three-wire continuous-current, with batteries.		Alt.-curr. trans. sub-stations and con.-curr. for [tramways.	
Chief Engineer	H. Talbot.		H. F. Street.	
YEAR ENDED	MAR. 31, **1899.**	MAR. 31, **1900.**	MAR. 31, **1899.**	MAR. 31, **1900.**
QUANTITIES—				
Units generated	951,319	1,603,579	702,904	1,460,770
,, **SOLD (TOTAL)**	**894,674**	**1,491,184**	**628,759**	**1,371,333**
,, sold to consumers	875,743	1,470,280	569,495	1,289,210
,, sold for public lighting, &c.	18,931	20,904	59,264	82,123
,, used on works	9,079	16,180	19,540	20,131
UNITS SOLD PER 8 C.P. LAMP CAPACITY	**17·6**	**18·6**	**14·4**	**35·1**
Maximum supply demanded	1,099 kilowatts	1,578 kilowatts	—	—
Number of public lamps	15	15	42 arc, 84 glow[a]	53 arc, 106 (16 c.p.) glow
Number of consumers	850	1,145	381	—
Connections to mains in 8-c.p. lamps	67,339	100,378	32,020	45,403
CAPACITY OF PLANT IN 8-C.P. LAMPS	**50,700**	**80,250**	**43,800**	**39,060**
CAPACITY OF PLANT IN KILOWATTS	**1,622**	**2,569**	**1,400**	**1,250**
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	**£234,955** / **£145**	— / —	— / —	— / —
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	234,955 / 145	— / —	— / —	— / —
RECEIVED (TOTAL)	**123,710** / **76·3**	**£123,710** / **£48·1**	**£60,832** / **£43·4**	**£69,417** / **£55·5**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	123,710 / 76·3	123,710 / 48·1	60,832 / 43·4	69,417 / 55·5
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**111,245** / **69·4**	— / —	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	111,245 / 69·4	— / —	— / —	— / —
REPAID (TOTAL)	3,014 / 1·86	5,814 / 2·26	nil / —	200 / 0·160
RESERVE OR SINKING FUND	2,869 / 1·77	3,330 / 1·30	4,132[b] / 2·95	5,025 / 4·02
DEPRECIATION FUND	7,532 / 4·64	7,532 / 2·94	— / —	3,138[j] / 2·51
EXPENDED (TOTAL)	127,393 / 78·6	166,098 / 64·6	72,470 / 51·8	91,086 / 72·8
Lands and buildings	52,768 / 32·5	64,266 / 25·0	21,690 / 15·5	25,747 / 20·6
Plant	37,540 / 23·1	53,151 / 20·7	28,256 / 20·2	36,861 / 29·5
Mains	34,923 / 21·5	46,519 / 18·1	22,037 / 15·7	28,030 / 22·4
Miscellaneous	2,161 / 1·33	2,161 / 0·84	447 / 0·32	447 / 0·358
BALANCE OF CAPITAL ACCOUNT	−3,683[a] / −2·27	−42,388[a] / −16·5	−11,638[c] / −8·32	−21,669[c] / −17·3
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	**£12,921** / **3·467d.**	**£18,414** / **2·964d.**	**£8,957** / **3·417d.**	**£16,069** / **2·813d.**
Revenue from supply	12,194 / 3·273d.	17,604 / 2·835d.	7,871[d] / 3·003d.	14,793[h] / 2·590d.
,, meters, &c.	303 / 0·081d.	383 / 0·062d.	222 / 0·085d.	140 / 0·025d.
,, public lighting	316[b] / 0·085d.	311 / 0·050d.	840 / 0·321d.	1,027 / 0·180d.
,, sale of lamps, &c.	} 103 / 0·029d.	{ 85 / 0·014d.	— / —	— / —
,, miscellaneous sources		{ 31 / 0·005d.	25 / 0·010d.	110 / 0·019d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£5,145** / **1·381d.**	**£8,740** / **1·403d.**	**£4,330** / **1·653d.**	**£7,068** / **1·237d.**
WORKS COSTS	**3,524** / **0·946d.**	**6,555** / **1·056d.**	**3,164** / **1·208d.**	**5,167** / **0·904d.**
Generation of electricity	*3,323* / *0·892d.*	*6,381* / *1·028d.*	*3,060* / *1·168d.*	*5,072* / *0·888d.*
Fuel (including cartage, &c.)	1,610 / 0·432d.	3,643 / 0·587d.	1,449 / 0·553d.	3,057 / 0·536d.
Oil, waste, water, stores	376 / 0·101d.	748 / 0·120d.	507 / 0·194d.	583 / 0·103d.
Wages at station	918 / 0·246d.	1,368 / 0·220d.	904 / 0·345d.	1,125 / 0·197d.
Repairs and maintenance at station	419 / 0·112d.	621 / 0·100d.	201 / 0·077d.	296 / 0·052d.
Distribution of electricity	*124* / *0·033d.*	*109* / *0·016d.*	*104* / *0·040d.*	*96* / *0·017d.*
Wages, &c.	84 / 0·023d.	38 / 0·006d.	58 / 0·022d.	22 / 0·004d.
Repairs, renewals of mains, &c.	40 / 0·011d.	63 / 0·010d.	46 / 0·018d.	73 / 0·013d.
Public lighting	*77* / *0·021d.*	*74* / *0·012d.*	— / —	— / —
Attendance	} 77 / 0·021d.	74 / 0·012d.	— / —	— / —
Renewals		— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	**1,619** / **0·435d.**	**2,183** / **0·353d.**	**1,166** / **0·445d.**	**1,902** / **0·333d.**
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*277* / *0·074d.*	*277* / *0·045d.*	*360* / *0·137d.*	*772* / *0·135d.*
Management	*1,342* / *0·360d.*	*1,906* / *0·307d.*	*806* / *0·308d.*	*1,130* / *0·198d.*
Salaries	970 / 0·260d.	1,411 / 0·227d.	367 / 0·140d.	484 / 0·085d.
Stationery, &c.	111 / 0·030d.	77 / 0·012d.	20 / 0·008d.	19 / 0·003d.
Establishment charges	169 / 0·045d.	318 / 0·051d.	321 / 0·123d.	127 / 0·022d.
Law charges, &c.	92[e] / 0·025d.	100[e] / 0·016d.	98[e] / 0·037d.	500[i] / 0·088d.
FINANCIAL RESULTS—	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded
WORKING PROFIT FOR YEAR	**£7,776** / **7·65%**	**£9,674** / **6·59%**	**£4,627** / **7·11%**	**£9,002** / **11·0%**
Sum carried to Depreciation Fund	3,576 / 3·52%	4,347 / 2·96%	— / —	3,489[j] / 4·27%
Sum carried to Reserve or Sinking Fund	1,621 / 1·59%	3,175 / 2·16%	810 / 1·24%	810 / 0·99%
Net interest on loans (incl. Debenture charges)	2,579 / 2·54%	nil / —	1,955 / 3·00%	2,685 / 3·28%
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	2,152 / 1·46%	1,862 / 2·83%	2,000 / 2·45%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	39·8%	47·5%	48·4%	44·0%
Expenditure per kilowatt capacity	£3. 3s. 5d.	£3. 8s. 1d.	£3. 1s. 10d.	£5. 13s. 0d.
REVENUE PER KILOWATT CAPACITY	**£7. 19s. 5d.**	**£7. 3s. 5d.**	**£6. 8s. 0d.**	**£12. 17s. 0d.**
Expenditure per 8-c.p. lamp capacity	2s. 0½d.	2s. 2d.	1s. 11¾d.	3s. 7½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**5s. 1¼d.**	**4s. 7d.**	**4s. 1d.**	**8s. 2⅜d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**3s. 10d.**	**3s. 8d.**	**5s. 7½d.**	**7s. 1d.**
Price charged for lighting, per unit	4d. to 2d.	4d. to 2d.[d]	5d.[f]	4d.
Price charged for power, per unit	1d.	1d.	2½d.[f]	2½d.
Price charged for public lighting	4d. to 2d.	4d. to 2d.[d]	4d. per unit[g]	3d. per unit

NOTTINGHAM.—REMARKS—*a* Over-expended. *b* Being £85 for attendance and repairs and £231 for current. *c* Includes insurance £40 and stock management £44. *d* On maximum demand system, 4d. per unit for first 400 hours per annum. *e* Includes insurance £56.

HALIFAX.—REMARKS—*a* Of 32 c.p. *b* Includes £32 accident insurance fund. *c* Over-expended. *d* Includes £2,332 from tramways for supply of 279,867 units at 2d. per unit. *e* Includes £50 to insurance and £41 expenses of deputations. *f* Subject to discounts from 5 per cent. to 15 per cent. *g* Less 15 per cent. discount. *h* Inclusive of £7,459 from tramways for 895,024 units at 2d. *i* Includes £21 insurance, £169 expenses of deputations, £41 contribution *re* Ruckers transformer patent and £201 "Proportion Joint Expenditure." *j* Renewal account.

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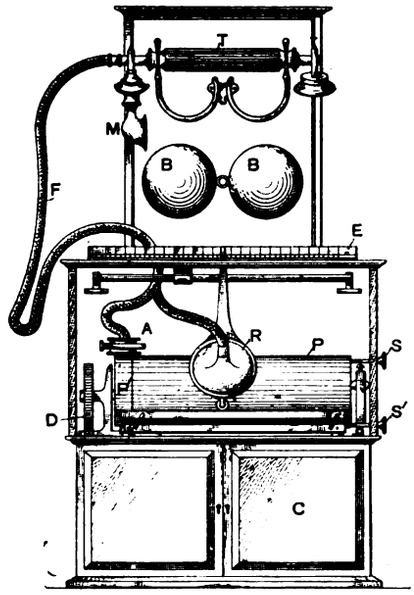
THE KUMBERG "TELEPHONOGRAPH."

In a recent issue (July 13, p. 427) we described a recording telephone, still in an experimental stage, which we had had an opportunity of examining and testing. The results did not appear to us particularly encouraging at the time, but since then Mr. Kumberg has been endeavouring to improve his instrument with a view to placing it on the market. We have received the following description from the inventor; it supplements to a certain extent our previous description:

This novel instrument is a combination of the phonograph with the telephone, and the accompanying drawing shows how it is achieved. The crux of the invention consists in a simple mechanical device, inside the electro-magnetic recording diaphragm cell R, which device increases and multiplies the impulses of the electrical vibrations, and thereby cuts clean and deep sound waves in the coating of a cardboard cylinder P, measuring 10in. in length, and 5in. diameter. This cylinder is interchangeable. By revolving the cylinder the record is made at 150 spirals to the inch, and the number of words which may be thus taken down when the whole length of cylinder is covered, is some 15,000, which would represent a page of an ordinary newspaper.

There is also a second cylinder P′ an inch broad, but of same diameter as its fellow P. The function of this cylinder is to take the place of an attendant and to answer calls. This is accomplished through the medium of the "automatic speaker" A, which informs the caller that Mr. Brown is out, and adds, for instance: "I am the telephonograph, if you will give your message it will be recorded, and Mr. Brown will hear it on his return."



When, on the other hand, the person who is called up is at hand, he disengages the automatic speaker A by means of the lever S′, and if he chooses to take his message without recording it phonographically, he can do so by pulling the upper lever S. M is a special mouthpiece having a separate channel for conveying the sound-waves directly to the recording stylus of the home station.

On the scale bar E slides a pointer which must be pushed against the tail of the electro-magnetic diaphragm R when leaving the office. The machine is then ready to record messages received. C is the battery and motor case. The other details of the sketch are common with ordinary telephonic instruments, and therefore no explanation if needed. In conclusion, it may be observed that the cylinders are inexpensive, and that the machine will soon be on the market.

Tramcar Fuse Boxes.—Several curious accidents, says the *Electrical Review* of New York, have taken place recently in New York and Brooklyn on account of dusty fuse boxes under street railway cars. Under some stress of overload, a fuse has suddenly blown, setting fire to the bottom of the car and causing "entirely unnecessary" panic among the passengers, who are alarmed by sudden outbursts of flames. It appears that, frequently, carelessness in caring for and inspecting fuse boxes has been the cause of this happening.

CORRESPONDENCE.

COHERER THEORY AND PRACTICE.

TO THE EDITOR OF THE ELECTRICIAN.

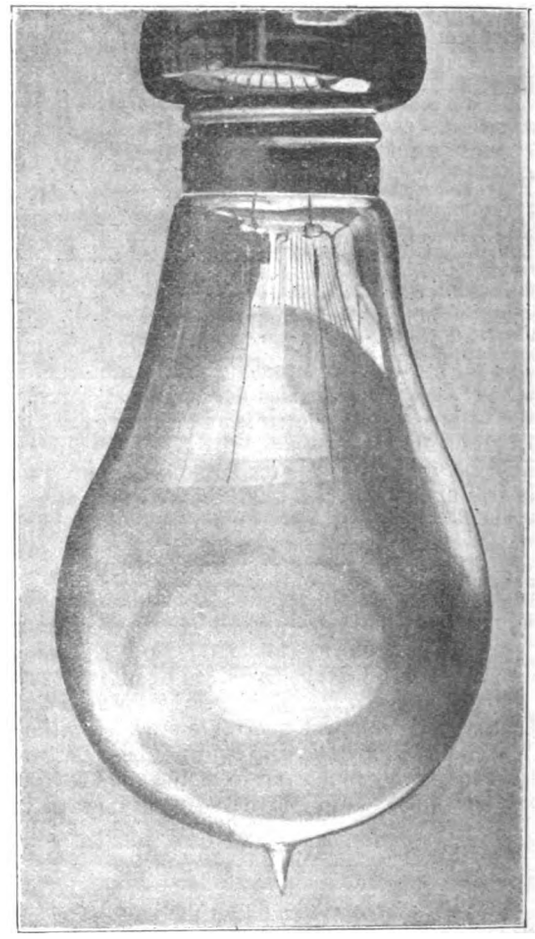
SIR: In trying to work out a satisfactory theory of the molecular receiver, or coherer, I have obtained several results which are suggestive and may prove of interest in practice. In the present letter I wish to draw attention to the reversal effect produced by electric radiation when the intensity falls below the critical value. If the receiver consists of a mass of metallic particles, it follows that the outside particles will exhibit the normal—say, the positive—effect; as the radiation gets absorbed in passing inwards, a reversed or negative effect may take place in the particles in the interior. The resultant effect will thus be a differential one. Some experiments I carried out seem to verify this deduction. Now, in long-distance space telegraphy the intensity of radiation is very feeble and near the critical value; hence it appears that, other things being equal, Prof. Lodge's method of single contact should theoretically be a more sensitive arrangement (there being no danger of any differential action) than the method of contacts in multiple.—Yours, &c. J. C. BOSE.

London, Sept. 18.

CARBON FILAMENTS AND LIGHTNING FLASHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On my return from my holidays I notice your observations with respect to the effect of lightning storms on



electrical apparatus, and it has occurred to me that a peculiar case which has recently been brought under my notice might be of interest. If you think so, will you please make use of this communication. During one of the recent unusually heavy storms a flagstaff on the offices of the engineer of the line at Derby was struck; a short-circuit was established in the holders of two incandescent lights, and the safety fuses of the same were of course blown. The lamps in question

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and the fuses applied to a "Ring" service employed in lighting the offices referred to. A few days subsequent to the occurrence attention was called to the appearance of one of the lamps—a peculiar configuration having appeared on the frosted portion. I have caused this lamp to be photographed, and I enclose photagraphs showing this peculiar condition. I am not sure whether to attribute this to deflagration of the filament. The appearance of the glass bulb which I am also sending you scarcely supports this theory, the marks being more like a stain than a deposit of carbon; the configuration, however, clearly follows that of the filament.

As the pecular condition of this lamp was not noticed immediately after the disruption of the fuses, I cannot, of course, say that it occurred at the same time, but from the fact that a short-circuit occurred at the same instant as that on which the flagstaff was struck and the safety fuses blown, it would appear that a highly-induced charge took place at the same moment in the "Ring" service, and it is probable that the effect on the lamp in question was then produced. The appearance of other lamps was as usual.

Although on the Derby station there are many instances in which the lighting of offices is effected by a "Ring" service, in no other case has anything peculiar arisen with the lamps in circuit, nor have any of the fuses been blown, nor, so far as can be ascertained, has the insulation of the service shown depreciation.—Yours, &c., W. Langdon.

Derby, Sept. 17.

[Beyond question, the shading on the lamp sent to us follows the shape of the filament. It might reasonably be supposed, therefore, to have originated with the filament; and the theory of deposition under the influence of the lightning flash appears quite probable. The lightness in tone of the deposit may arise from the extreme thinness of the carbon film.—Ed. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the note in your issue of August 31, page 691, which commences: "A curious phenomenon has occasionally been observed in the glow lamps on the circuits of the Calcutta Electric Supply Co.," I should like to make a few remarks on the subject, as it is a phenomenon that I have frequently noticed, and from which I have experienced more serious consequences, which is probably accounted for by an experience of much heavier lightning storms in the Transvaal, where I have resided for the past seven years. Practically all the lighting circuits of the Transvaal mining companies are overhead, especially between the various buildings; and in scattered areas to the extent of some 300 yards or 400 yards in length. The system that seems to suffer mostly is the three-wire (which may be explained by higher E.M.F. being employed across the outer conductors, tends more readily to short circuit), the fault arising therefrom being the perforation of the insulation between the conductors in the flexible cords, which usually occur in series on both "legs" simultaneous, sweeping away a dozen lamps or more with one lightning flash; and oftentimes, after repeated flashes, a system is so deranged by the destruction of fuses, &c. (especially when the neutral is provided with a fuse) that the whole of the lamps on one leg have been destroyed.

With the two-wire system using from 100 volts to 120 volts the trouble seems to be minimised to the loss of a few individual lights.

For some time past I have contented myself with the explanation that the pulsating which the lights were subjected to was due to the effect of mutual induction between the lightning flash and the overhead conductor, which takes the form of a very high potential oscillatory current, which disappears entirely with the lightning flash (I am of a firm opinion that overhead conductors with their continuations, machines, &c., under the varying conditions with which they operate, are not capable of maintaining any static charge whatsoever); the E.M.F. and current value of the charge so generated being governed by the distance therefrom and direction that the lightning flash takes with respect to the direction and length of the overhead conductor, the greatest inductive effect taking place when the lightning flash takes a direction near about parallel to the overhead conductors.

The suggestion of the "coherer" theory being applied as an explanation is to my mind improbable for the following reasons:—

1. That lamps which are situated in close proximity to the generating station, with consequently short lines, are not so affected.

2. With very crooked overhead conductors, which pass from building to building, making a circuitous route, the pulsations are noticeable but usually do no damage.

3. With very straight lines pulsations are very great and usually accompanied with some damage.

If my memory serves me rightly, I have never known a low-tension armature used for lighting purposes to be burned out by lightning, whilst I have repeatedly seen punctures in the core insulation of 100-110-volt machines which I have have had for re-winding, the reason for which I have accounted to lightning discharges, the E.M.F. of the machine being insufficient to cause a short circuit by reason of the working current following the lightning discharge. However, I think the bulk of the discharge finds its way through the insulation of the conductors.

With transmission of power plants this phenomenon appears to me to take the same shape—in drum armatures almost without exception, two adjacent coils will be found to be burned out, short circuiting two diametrically opposite coils, oftentimes without injuring the core insulation. With ring armatures my experience has been the same, with the exception that they seem to stand much longer. I think that is due to the fact that the insulation of the diametrically opposite coils is much more perfect, having to pierce the core insulation twice.

I have frequently noticed with continuous-current transmission of power plants that when the machines at one end get damaged the other end invariably escapes; I attribute this to what I believe to be an important counter-effect which the "flow" or "return" current plays neutralising the inductive effect of the lightning flash in one conductor, and this accounts for the flow of the induced charge from one line to the other either by way of perforating the insulation between the coils of the armature diametrically opposite, or by discharging through the arrester to earth at one station, and from earth to the other line at the other station arrester, and completing the circuit by a simultaneous condenser action between the two conductors.

I will illustrate by describing some observations on the behaviour of a lightning storm on a 50-unit 500-volt continuous-current transmission of power plant, the property of the New Goch Mines (Ltd.) of Johannesburg.

The overhead lines are about 2½ miles long, the first ¾ miles being straight, subsequently turning through an angle of 120deg. for the remaining 1¾ miles, and extends from the company's mill engine house to their pumping station at Rosherville, the two stations being telephonically connected. At each station the machines are protected by double-pole lightning arresters, each pole being separately earthed.

The arresters are so constructed that any discharge can readily be seen, and its duration noted—in some instances I have observed discharges which continued for, I should say, between one and two seconds. Discharges were recorded from the + conductor at the generator end, and from the − conductor at the motor end simultaneously, and vice versa, some of the discharges being almost inaudible. Whilst these observations were being made the lightning storm was well overhead, and generator and motor kept running; when the current was switched off and switches kept out at both ends the discharges seemed equal from both wires and appeared at both ends alike.

Observations were made with a high-tension polyphase plant belonging to the same company, and with this, discharges appeared from all wires at both ends simultaneously.—Yours, &c., S. P. Blackmore.

Birmingham, Sept. 10.

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MUNICIPAL, FOREIGN & GENERAL NOTES.

Aberavon.—A committee has been appointed to make application for a provisional electric lighting order.

Aberdeen.—The Corporation have adopted the report prepared by Mr. Bell in regard to the provision to be made for laying feeder and pilot cables from Dee Village to the different feeding points. Mr. Bell recommended the committee to authorise the building of a concrete subway above the new sewer which was to be laid in Crown-street and Portland-street, thus obviating the road being opened more than once. The estimated cost of the subway is put at from £5,400 to £6,600, according to the design adopted.

The Town Council have adopted the recommendation of the Electric Lighting committee to increase the salary of the city electrical engineer (Mr. J. A. Bell) from £300 to £350, increasing by annual increments of £50 to £500.

Ashton.—The local Ratepayers' and Property Owners' Association have resolved to oppose the Wigan and District Tramways Co.'s application for a light railway order unless they will undertake to construct the new line to the standard gauge, will efficiently light the route of the proposed railway electrically, or to pay to the township of Ashton a sum equivalent to such lighting.

Bermondsey (London).—The Vestry have approved the specifications of Messrs. Kincaid, Waller, and Manville for the steam dynamos and boosting and balancing sets, and for feed pumps and pipe work for their electricity works, and it has been decided to advertise for tenders. It is estimated that, with a battery of accumulators, the plant will have a capacity equivalent to 8,000 8 c.p. lamps alight. The Vestry are advertising for a resident electrical engineer at a salary of £250 per annum.

Bolton.—Mr. J. A. Day, the recently-appointed borough electrical engineer, will take up his duties on Monday next.

Bournemouth.—Application is about to be made for power to borrow £200,000 for the electric tramways to be constructed by the Corporation under their 1900 provisional order.

Bradford.—The Tramways committee recommend the Corporation to promote a bill for powers to construct extensions of the electric tramways.

Sanction to a further loan of £56,000 for electric lighting extensions has been received by the Corporation.

Buckie.—A representative of the North British Electricity Supply Co. is to wait upon the Burgh Commissioners to explain the company's electric lighting proposals.

Bury St. Edmunds.—The demand for electric current is being maintained, and Ald. Lake, chairman of the Electric Lighting committee, considers the prospects of the undertaking very satisfactory.

The police station is to be wired for the electric light.

Cannock.—Application is to be made for a provisional electric lighting order.

Cardiff.—The tramways pass into the hands of the Corporation on Jan. 1, 1902, and the Council have already obtained powers to adopt electric traction and to make extensions of the existing lines. Mr. Arthur Ellis, the recently-appointed electric tramway engineer, has promptly set to work and presented a report, in which he states that the work of equipment should be proceeded with without delay, and that the whole of the equipment and plant should be completed and ready for testing at least a month or six weeks before the system is opened for regular service. Considering the limited time to carry out the various works and the great difficulty in obtaining early deliveries of plant, &c., especially engines and generators and cars, Mr. Ellis has confined his report to the question of the type of plant to be adopted and to the site. The Roath Brook site has, he says, two most essential points in its favour, viz., its close proximity to a railway, and also to a brook. There was also ample room to make extensions, and there would be no difficulty in the distribution of power. He therefore advises the selection of the Roath Brook site for the power station. As to plant, he therefore makes the following recommendations: The engines to be of the compound vertical condensing type, running at a speed not exceeding 100 revs. per min., and fitted with Corliss valve gear. The generators to be of the compound type and mounted direct to the shafts of the engines between the high and low pressure cylinders. He recommends slow speed engines as a tramway load is constantly varying. In connection with the condensing plant Mr. Ellis recommends a cooling tower, for the following reasons: The Roath Brook is not of very great size, and is not of regular capacity throughout the year, although there is a good flow of water for nearly nine months in the year. In any case it would not be of sufficient capacity for the amount of plant which will be installed, nor of sufficient area to allow of the water being cooled after delivery from the condensers. By using a cooling tower the same water would be used over and over again, and any losses from evaporation would be made up from the water from the brook. In addition to this, during the greater part of the year the water from the brook could be used to feed the boilers. The boiler-house plant would consist of Lancashire boilers, economisers, superheaters, pumps, mechanical stokers, and coal conveying plant, the mechanical stokers and coal haulage plant to be driven electrically. In conclusion, Mr. Ellis states that what he has seen of Cardiff a very quick service would be necessary, and by making provision for this the receipts per car per day would be much greater than with a slow service. The committee have adopted the report, and Mr. Ellis has been instructed to prepare specifications for machinery, &c.

Crieff.—A provisional electric lighting order is to be obtained by the Council.

Devonport.—The Corporation will construct the tramways authorised by the provisional order of 1899 and the act of 1900, provided satisfactory arrangements can be come to with the Devonport and District Tramways Co. as to working, and the town clerk has been instructed to apply to the Board of Trade for an extension of 12 months of the time within which the tramway may be commenced and completed.

Douglas (Isle of Man).—In reply to a query as to the position of the electric lighting question in this town, the chairman of the Electric Light committee (Ald. W. Goldsmith) explains that the committee has been waiting in expectation of the electric tramway undertaking being offered for sale by the liquidator. He promised that the committee would have an early meeting and submit a report.

Electric Railways and Tramways in Germany.—In 1891 only three towns in the German empire possessed electric traction. In 1895 the number had increased to 33, in 1896 to 46, in 1897 to 62, in 1898 to 77, and in 1899 to 93. The length of tramways working at January, 1900, was 2,286 kilometres, and 837 kilometres were in course of construction.

Enfield.—The Council has resolved to apply for a provisional electric lighting order.

Farnworth (Bolton).—The foundation stone of the electricity generating station was laid by the chairman of the Electricity committee, Mr. W. B. Richardson, J.P., last week. The total cost of the electric lighting and tramway scheme is estimated at about £22,000, and Mr. Richardson said the Council had powers to construct about 6 miles of tramways in the district, and authority to lay tramways in other districts. An agreement had already been made with the Kearsley Council. The plant would be capable of generating current for the equivalent of 6,000 16 c.p. lamps, and a number of arc lamps for public lighting, in addition to the needs of the electric tramways.

Folkestone.—The Council are recommended to obtain powers to construct electric tramways involving an expenditure of about £95,000.

G.P.O. Telegraph Staff.—It is stated that important changes are about to be made in the internal arrangements of the Telegraph department of the General Post Office. Some of the leading newspapers have hitherto been allowed to monopolise the services of the most skilled of the Postal Telegraph Department operators, and no sooner does a male operator make himself thoroughly competent than he seeks and obtains a position on the "private wire" staff. The Postmaster-General has now, it is stated, decided that in future newspaper proprietors must provide their own telegraphists.

Huddersfield.—Application has been made to the Board of Trade to borrow £38,305 for converting two additional tramway routes to electric traction.

Ince (Lancs.).—The Council has decided to apply for an electric lighting provisional order. The South Lancashire Electric Supply Co. have also given notice of intention to apply.

Ipswich.—The Council have notified the Ipswich Tramway Co. of intention to exercise their powers of purchase under the Tramways Act, 1870.

Italy.—Extensive public works improvements are in hand at Bari, and it is anticipated that the gas lighting of the public thoroughfares will shortly be superseded by the electric light.

At Salerno Messrs. Sprecher & Co., mill owners, have put down an extensive electric generating plant, which supplies current for the public lighting of Carva and Vietri. A concession is being sought by a local firm of engineers for a scheme to divert the course of the river Tusciano for the generation of electric energy to provide current for an electric tramway from Salerno, through an extensive district, to Torre dell' Annunziata. 20,000 £10 shares are to be issued.

Kilmarnock.—Mr. F. B. Lea, the local representative of the British Electric Traction Co., attended at the meeting of the Council last week to explain the company's proposals to construct electric tramways between Beansburn and Riccarton, with a spur line from the Cross to Hurlford.

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Lake District Electric Tramway Scheme.—The scheme of the British Electric Traction Co. to construct a light (electric) railway between Bowness and Ambleside has been withdrawn, to be revived in a modified form later.

Light Railways.—The Ormskirk and Southport Light Railway order has been submitted to the Board of Trade, and objections must be sent to the secretary, Railway Department, Board of Trade, London, by Oct. 11.

The promoters of the Loughborough Light Railway scheme (Loughborough and District Electric Traction Syndicate) have come to terms with the Council as to the amount to be contributed for streets improvements, and the order will now be issued by the Light Railway Commissioners.

Liverpool-street—Romford Electric Railway.—A rumour having been published that the Great Eastern Railway Co. have under consideration the construction of an electric line from Liverpool-street to Romford (to be submitted for parliamentary consent next session), Mr. J. F. S. Gooday, the general manager, has stated publicly that the company have no such undertaking in hand.

Lowestoft.—A bill for powers to construct a system of electric tramways is to be promoted by the Council. Application has been made to the Local Government Board for sanction to borrow £20,000 for electric lighting extensions.

Malta.—The revenue from the electric lighting department of the Malta Government for 1899 was £12,860, compared with £11,236 in 1898, an increase of £1,624. The revenue for 1897 (the first year of working) was £9,123.

"Men of Note in Commerce and Finance."—This is the title of a new biographical business directory edited by Mr. H. A. Bassett and published by Effingham Wilson, 11, Royal Exchange, London. Mr. Bassett has gathered together a mass of somewhat scrappy information regarding a large number of men engaged in "city" operations. Too many of the entries savour of the "Directory of Directors," and with regard to others, without unduly extending the size of the book some additional interesting particulars should undoubtedly have been furnished, more particularly as this is obtainable from other published works. Mr. Bassett has, so far as we have had time to check the entries, done his work very well, and those interested in the commercial men with whom they are in daily contact will find these brief sketches an inducement to seek elsewhere for more extended particulars. It is the fault of books of this kind that they must be very incomplete, and "Men of Note" is no exception to this rule.

Moss Side.—The Council have applied to the Local Government Board for sanction to borrow £10,870 for refuse destructor works.

Municipal Trading.—The evidence given before the Joint Select Committee of the Houses of Lords and Commons on Municipal Trading has just been issued in Blue Book form. As already announced, the Committee recommends that it should be re-appointed next session.

Nottingham.—The Corporation are converting the local tramways to electric traction on the overhead trolley system, and the *Nottingham Guardian* of the 15th contained a plan of the existing tramway routes and of the proposed extensions. The work will entail an estimated capital expenditure of £585,500, and the total length will be about 40 miles. Contracts have already been let, that for the cars having been placed with Messrs. Dick, Kerr & Co., the poles are being supplied by Messrs. John Spencer, of Wednesbury, the rails by Messrs. Bolckow, Vaughan & Co., and the points and crossings by Messrs. Askham Bros. and Wilson.

Plymouth.—A breakdown occurred at Plymouth electricity works last week, and as the somewhat circumstantial account of the accident in the local Press might lead to the assumption that the interruption was serious, the following particulars may be of interest: At about 3:15 p.m. on the 11th inst., the commutator on the dynamo side of the tramways negative booster flew into pieces. This was caused by the breaking of the gun-metal ring holding the commutator. The results were rather startling. A number of pieces went through the roof, smashing a lot of glass, while other pieces flew about the room in all directions. The brush gear was wrecked, the pedestal of the machine cracked right across, and the magnet and armature windings were considerably damaged. The conducting cables were also injured. The current was, of course, interrupted, and it took a little time to get it on again. Luckily nobody was hurt, although there were several narrow escapes. The machine was 4kw. capacity, and ran at about 1,400 revs. per min.

Presentation.—Mr. F. Kershaw, who has severed his connection with the Bradford Corporation electricity works in order to become chief assistant to Mr. A. H. Gibbings, was last week presented with a case of cutlery by the chief officials and staff at Bradford.

Rubber in Rhodesia.—According to a report recently presented to the British South Africa Co. by Mr. Lyttleton Gell, there are extensive tracts of natural rubber forests in north-west and south-east Rhodesia, the rubber product being of a high commercial value. In Southern Rhodesia indigenous rubber is reported in abundance in the Sabi Valley and along the Zambesi. Unfortunately the native methods of extraction here as elsewhere in Africa are very destructive to the trees, and the present methods of preparation of the rubber for market are very faulty, and reduce the market value of South African rubber considerably.

St. Helens.—The North-road and St. Helens Junction electric tramway routes are ready for Board of Trade inspection.

Salford Royal Technical Institute.—The calendar for the fifth session (1900-1) of this Institute is issued, and is a copiously illustrated and well-arranged publication. Information regarding the course of study in the day and evening classes available for students is given, the illustrations conveying an excellent idea of the efforts made to provide the necessary plant and apparatus for efficient instruction in the various branches of theoretical and practical work. Electrical and mechanical engineering, physics, &c., are well to the front.

Shoreditch (London).—The Lighting committee have been authorised to purchase 25 10-ampere and 25 25-ampere meters at a cost of £5 each.

Skegness.—The consulting engineer (Mr. W. C. C. Hawtayne) recommends the Council to apply for a provisional order, and a special meeting will be held to consider the matter. The North British Electric Supply Co. has intimated an intention to apply for an order.

Southampton.—The consulting engineers (Messrs. Kincaid, Waller and Manville) have been instructed to prepare specifications for the construction of two additional electric tramway routes. The estimated cost of construction, exclusive of cars, distributor mains and feeders, is put at £19,180.

South London Tramways.—The London County Council recently proposed to apply for Parliamentary powers to construct a tramway from Camberwell-green to Forest-hill provided the Camberwell and Lambeth Vestries and the Lewisham Board of Works agreed to contribute one-third of the cost (estimated at £155,450) of the necessary street widenings. The Lambeth Vestry have declined to entertain the offer.

The London County Council propose to seek powers to construct an electric tramway along the new street between Bermondsey New-road and Tooley-street, and have informed the Bermondsey Vestry that the making-up and paving of the carriageway of the new street will shortly be put in hand. In order to avoid breaking up the concrete of the carriageway for the purpose of laying the tramways, the Council propose that the construction of the electric conduits, drains, pits for road boxes and grooves for the rails be proceeded with at once in anticipation of powers being granted by Parliament, leaving the slot rails and tram rails to be laid when parliamentary sanction has been obtained. The paving between the rails is to be granite setts, "because, if the slot rails for the conduit are to be put down at a later date, wood paving will not be suitable." Bermondsey Vestry having approved the double track will ask the Council to take current from the Vestry's generating station, and reserve to themselves the right of action in regard to the system of traction until the Council's application comes before Parliament.

Stalybridge and Hyde Electrical Scheme.—It has been decided by the Stalybridge, Hyde, Mossley and Dukinfield Electric Traction and Lighting Joint committee to promote a bill for powers to construct a system of electric tramways in the towns named and to supply current for lighting. The consulting engineer for the scheme is Mr. A. H. Gibbings.

Teddington.—A provisional electric lighting order is to be applied for by the Council.

Torquay.—An electric tramway scheme, prepared by Mr. J. Taylor and estimated to cost about £50,000, is at present under the consideration of a sub-committee of the Electric Lighting committee.

Wednesbury.—The Council have formally notified the South Staffordshire Tramways Co. of their desire to purchase so much of the company's undertaking as lies within the borough of Wednesbury.

Workhouse and Asylum Lighting.—The Ormskirk Guardians have appointed a sub committee to report upon the question of adopting electric lighting.

The Local Government Board having intimated to the managers of the Poplar and Stepney Sick Asylum that they could not give consent to a loan for the electric lighting of the institution until an estimate of the cost of the work had first been obtained, this estimate has now been furnished.

The Brighton Corporation have referred a report of the resident electrical engineer (Mr. Christie) as to the electric lighting of the workhouse to a committee. At present there are about 1,000 gas jets in use. The capital cost of the whole installation, consisting of 1,000 lights wired, two 10 H.P. motors, and all accessories, is put at about £1,500.

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NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Submarine Cable-Laying and Repairing. —By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"Armature Winding of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"Temperature Coefficients of 'Conductivity' Copper." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 84·9°F. Printed on strong cardboard, 6d. net.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Electrician" Reading Case.—To hold four numbers of the Journal. Strongly bound, 1s. net; post free, 1s. 4d.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"Secondary Batteries, their Design and Manufacture."—By F. J Wade.

"Primary Batteries: Their Construction and Use."—By W. R. Cooper.

"Practical Telephony."—By Dane Sinclair and F. C Raphael.

"'The Electrician' Wireman's Pocket-book."—Edited by F. C. Raphael. *Nearly ready.*

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]

TENDERS INVITED.

Ilford District Council invite tenders for direct-current meters and cutouts. Specification may be obtained from the clerk (Mr. John W. Benton), Council Offices, Cranbrook-road, Ilford, and specification can also be seen at (but not obtained from) the offices of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C. Tenders to Mr. Benton by noon of Oct. 8. An advertisement contains further particulars.

Grimsby Corporation require tenders for wiring the Free Library. Specifications from the borough electrical engineer (Mr. W. A. Vignoles), with whom tenders must be lodged by Oct. 6. See advertisement.

Manchester Tramways committee invite tenders for cast-iron bases for tramway poles. An advertisement giving further particulars and specifications, &c., can be obtained from the general manager (Mr. J. M McElroy), Tramways Department, Town Hall, Manchester. Tenders to chairman of committee by Oct. 1.

Hoylake and West Kirby District Council invite tenders for the "free wiring" of premises in the district. An advertisement contains further particulars, and tenders must be sent to the clerk (Mr. Roderick Williams), District Council Offices, Hoylake, by Oct. 4.

Birkenhead Corporation invite tenders for the supply, delivery, and erection of feeder mains, &c. An advertisement gives further particulars, and specifications, &c., may be obtained from the borough electrical engineer (Mr. Wm. Bates), Bentinck-street, Birkenhead. Tenders to town clerk (Mr. Alfred Gill), Town Hall, Birkenhead, by 4 p.m. of Oct. 2.

Aberdeen Town Council invite offers for the manufacture and supply of 25 electrical tramcars, and equipments for six horse cars

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about to be converted. Tenders must be in before 12 noon of Oct. 17. An advertisement elsewhere gives further particulars. Mr. J. Alex. Bell, Cotton-street, Aberdeen, is city electrical engineer.

Aberdeen Electric Lighting committee invite tenders for two 200kw. and one 420kw. direct-coupled continuous-current generators and one 120kw. balancing set. Willans engines in both cases. Tenders to city electrical engineer by Sept. 29.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for supply of stores during the 12 months ending Oct. 31, 1901. Among the articles required are brake blocks, copper, india-rubber, iron castings, ironmongery, sundry tools, &c. Some information is given in an advertisement, and all further particulars and forms of tender may be obtained at the stores department, Osborne-street, Manchester. Tenders, addressed to the directors, must be lodged with the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. of Monday, Oct. 8.

Wigan Corporation invite tenders for material for the equipment of their electric tramways, particulars of which are set out in an advertisement. Tenders must be sent to the borough electrical and tramway engineer (Mr. H. Collings Bishop) by 27th inst.

Bradford Corporation require tenders for an engine and dynamo, switchboard apparatus, &c., for their destructor works. Specification may be obtained from the city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. Further particulars are given in an advertisement. Tenders to town clerk (Mr. Frederick Stevens) before Oct. 9.

Eray Urban District Council will on Oct. 4 receive and consider tenders for the supplies required at their electric light works for 12 months, including cables, house wires, switches, holders, incandescent lamps, &c., &c. Specification, &c., can be obtained of Mr. P. MacDonnell, clerk to the Council, Town Hall, Bray, Ireland, to whom tenders must be delivered before 10 a.m. of Oct. 4.

Walthamstow District Council invite tenders for electric lighting plant and apparatus, including gas plant, gas engines, dynamos, switchboard, boosters, balancer and measuring instruments. Tenders to vestry clerk by 5 p.m. Sept. 25.

Devonport Corporation invite tenders for two vertical engines, two 300kw. generators, balancer, battery, booster and motor, switchboard for lighting and traction, storage battery, and a 10-ton travelling crane. Tenders to town clerk by 5 p.m. 26th inst.

Sheffield Corporation invite tenders for : (*a*) Two 600kw. two-phase steam alternators and exciters, and (*b*) alteration of present single-phase plant to two-phase. Tenders to chief engineer and manager of electric supply department (Mr. S. E. Fedden) by Oct. 6.

Dublin Electric Lighting committee invite tenders for electricity supply mains and accessories. Tenders to town clerk by 4 p.m. Oct. 4.

Dublin Corporation invite tenders for power machinery at Ringsend, including pumping engines and pumps, boilers, electric motors and pumps. Tenders to town clerk by noon Oct. 3.

Eastbourne Corporation invite tenders for water-tube boilers, with fittings, feed pumps, &c. ; 400kw. steam alternator, with exciter (vertical enclosed high-speed engine) ; and main switchboard and connections. Tenders to town clerk by noon Oct. 4.

Long Eaton Council require tenders for establishing telephonic communication between their waterworks pumping station, Stanton-by-Bridge, near Derby, and the service reservoir at Castle Donington. Tenders to surveyor by Oct. 1.

St. John, *Hampstead* (London) Vestry, invite tenders for eight dry-back marine boilers, steam and water pipes, feed pumps, &c. Tenders to vestry clerk, by 4 p.m. Sept. 27.

Salford Electric Light committee invite tenders for seven iron transformer chambers. Tenders to chairman of committee by 10 a.m. 24th inst.

Brighton Corporation invite tenders for 25 electric motor-car bodies, trucks, and electric-motor equipments, and also for steel girder tramway rails, fishplates, and joints. Tenders by Oct. 1.

Hull Electric Lighting committee invite tenders for steam and water pipes, feed-pumps, &c. Tenders (addressed chairman of committee) to town clerk's office by noon Sept. 27.

Medomsley (Durham) Parish Council invite tenders for the electric lighting of the road leading from Black Hall Mill to Medomsley. Particulars from the clerk (Mr. M. T. Milburn).

Tenders are invited for an overhead travelling crane and an economiser for the *Dundee* electric lighting station. Tenders to clerk to Gas Commissioners by noon, 26th inst.

Tunbridge Wells Council invite tenders for the erection of a chimney shaft at the electricity works. Tenders to town clerk by 24th inst.

Hackney (London) Vestry invite tenders for the constructional ironwork for their electricity and refuse destructor works. Tenders to vestry clerk by Oct. 3.

Hackney (London) Electric Lighting committee invite tenders for electricity supply mains. Tenders to vestry clerk by 5 p.m. Oct. 3.

Nottingham Corporation require tenders for the erection of a new power station. Tenders to city engineer by 21st inst.

Middleton Council invite tenders for erection of electricity station buildings. Tenders to town clerk by Oct. 11.

Fulham (London) Vestry invite tenders for coal handling plant at their electricity works. Tenders to clerk by 6 p.m. 25th inst.

Tenders are invited for wiring the *Suffolk* County Asylum, Melton. Tenders to Mr. A. T. Cobbold, County Hall, Ipswich, by Oct. 5.

Varna (Bulgaria) Municipal Council invite tenders for the electric lighting concession for 40 years. Tenders by Oct. 15.

Fuenteovejura (Cordova, Spain) municipal authorities invite tenders until Oct. 9 for the electric lighting concession for 20 years. Tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

As stated in our issue of the 7th inst., the Salford Corporation have placed an order with Messrs. W. T. Glover & Co. for the supply and laying electric lighting cables, tramway feeders, and street-lighting accessories for £159,684. 12s. 8d. The adoption of report of the committee recommending the acceptance of the tender was moved by Ald. Shaw, who said Messrs. Glover's tender was the lowest which conformed to the specification, and the cables would be subjected to the test mentioned in the specification before they were taken over. Councillor Higson said there was one tender lower than Messrs. Glover's, but the reason it was not accepted was because it was proposed to substitute tar in place of a bituminous compound. The British Insulated Wire Co. were £650 lower, but their tender did not conform to the specifications. He congratulated the Council and Messrs. Glover that they had a firm within the boundaries of their borough capable of undertaking the work. The mayor said he was pleased there were local firms capable of carrying out the Corporation contracts. Local firms like Mather and Platt, Galloways, and some others could do their work, and it was pleasant to think that they were practically employing their own people. The resolution was carried.

Poplar and Stepney (London) Sick Asylum District Managers have received the following tenders for the installation of telephonic communication at the asylum :—

G. Weston & Co. (*accepted*) ...	£135	London & Prov. Telephone Co.	£176
Private Wire & Tel. Instll. Co.	191	Barlow Bros. & Co.	175
F. Emerson & Sons	188	V. G. Middleton	165
Palatine Telephone Co.....	185	G. W. Lummis-Paterson & Co.	163
Strode & Co.	183	Julius Sax & Co.	160
Consol. Telephone C. & M. Co.	182	Cox-Walkers	158

Messrs. Weston & Co. subsequently asked permission to withdraw their tender on the ground that a mistake had been made in their estimates. A decision on this point will be given at the next meeting of the managers.

Aberdeen Town Council have accepted the following tenders for the supplying of tramway rails, fishplates, tie-bars, and bolts and nuts :—

Bayliss, Jones and Bayliss (20 tons bolts and nuts)	£16	10	0	per ton.
A. and J. Main & Co. (35 tons steel tie-bars)	12	7	6	do.
P. and W. Maclellan (fishplates)	8	13	9	do.
Ditto (straight rails)	7	13	9	do.
Ditto (curve do.)	7	13	9	do.

The following tenders were received by the Southampton Guardians for supplying the generating plant and wiring the new workhouse infirmary :—

Lankester & Son (*accepted*)	£3,499	10	0	Nat. Elec. Wiring Co.	4,890	0	0
Maple & Co.....	5,494	5	6	F. Troy & Co.	4,825	0	0
Gifkins & Co.	5,465	0	0	Lea and Warren	4,500	0	0
T. F. White	5,406	2	6	Cox Walkers.....	4,254	0	0
H. M. Ashton	4,998	0	0	Shalders and Davis...	4,100	0	0
Crompton & Co.	4,950	0	0	Drake and Gorham...	4,058	0	0
				Foote and Milne	4,056	0	0

Nuneaton and Chilvers Coton Council have accepted the following tenders :—

Babcock and Wilcox (boilers)	£1,060
Edmund Charrington (switchboard)	391
Clarke, Chapman & Co. (new armature)	66
Nuneaton Engineering Co. (crane)	120

As stated in our last issue, the tender for accumulators has been given to the Hart Accumulator Co.

Bradford Tramways committee recommend the acceptance of the tender of MM. V. Demerbe & Cie. for the supply and laying on the Demerbe system the rails for the Farsley, Thackley, Idle, Clayton, Quensbury and Manchester-road tramway routes. The rails are, however, to be rolled in England.

Glasgow Corporation have accepted the tender of Messrs. Chamberlain and Hookham for the supply of 150 2-ampere electricity meters at £3. 10s. each, and that of the Callender Co. for the supply of half-mile of 0·5 sq. in., and half-mile of 0·25 sq. in. lead-sheathed

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cable, and 5 miles of telephone wire, and 1 mile of 0·15 sq. in. triple concentric cable, at £335, £176, £275, and £651 per mile respectively.

A contract for the supply of the storage battery required by the committee of management of the Kensington and Knightsbridge and Notting Hill Electric Lighting Companies in connection with their Wood-lane works has been secured by the Hart Accumulator Co.

Messrs. Lowdon Bros. & Co. have obtained the contract for the overhead equipment of about 10 miles of light (electric) railway at Southend-on-Sea. The line is to be opened in April.

Heywood Council last week accepted a tender for the supply and erection of electricity generating plant at £8,389.

Birkenhead Corporation have accepted the tender of Mr. J. Merritt for the erection of an electric tramway car shed at £10,183.

APPOINTMENTS VACANT AND FILLED.

Royton District Council are considering the advisability of applying for provisional orders for electric lighting and traction, and invite applications from engineers for preparing plans, &c. An advertisement gives some particulars, and all further information may be obtained from the clerk (Mr. Thomas Bleasdale), Town Hall, Royston, near Oldham.

Bermondsey (London) Vestry require a resident electrical engineer. Further particulars are given in an advertisement, and applications must be sent to the clerk (Mr. Frederick Royal), Town Hall, Bermondsey, London, S.E., by noon Oct. 3.

Fleetwood District Electric Light and Power Syndicate require a shift engineer. Applications to Mr. Oswin Hansom, resident engineer, Electricity Works, Fleetwood, Lancs. See advertisement.

A shift engineer is required for the Rathmines (Co. Dublin) electricity works. Applications to resident engineer (Mr. G. F. Pilditch), by 24 inst.

Birmingham Small Arms Co. require an assistant electrician. See advertisement.

A traveller is required by a firm of electric wire and cable manufacturers for the Midlands and South of Yorkshire. See advertisement.

A lecturer and demonstrator in physics is required for University College, Nottingham. Applications by 25th inst. to secretary. See advertisement.

The Council of Hartley College (Southampton) invite applications for the appointment of assistant lecturer in engineering. Applications to clerk (Mr. D. Kiddle) by Oct. 3. See advertisement.

A science master is required for the Kilmarnock Academy. Applications to clerk by Oct. 1.

A junior demonstrator in physics is required for Owens College, Manchester. Applications to the Registrar by 24th inst.

Mr. H. W. Angus, chief assistant at Bolton, has been appointed borough electrical engineer by the Eccles Town Council.

Mr. A. J. Oridge, of Brighton, has been appointed meter superintendent of the Sheffield electric lighting department.

The British Thomson-Houston Co. have appointed Mr. T. W. Sheffield district manager of their branch depôt recently opened at Trevelyan Buildings, Corporation-street, Manchester.

BUSINESS NOTICES.

Messrs. Doherty and Donat, engineers and contractors, 40, South King-street, Manchester, are the sole licensees for Great Britain for "Zschocke's" patent water cooling towers, and we are informed that already cooling plants representing over 600,000 I.H.P. (including 35 electric lighting and power stations) are in successful operation all over the world.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the Woodlands Electric Co. (Ltd.), will be held at 10, Berey's-buildings, Church-street, Liverpool, on Oct. 15, to receive an account of the winding-up. Mr. F. J. Armstrong is liquidator.

In the bankruptcy of E. B. Pym, electrical engineer, 29, Bramham-gardens, London, S.W., lately trading at Bar-chambers, Scarborough, the trustee, Mr. A. H. Wildy, has been released.

In the bankruptcy of E. M. Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C., the trustee, Mr. A. H. Wildy, has been released.

Claims against A. G. Inrig, electrical engineer (trading as the Globe Electrical Co.), 46, White Post-lane, Victoria Park, London, E., must be in by Oct. 2. Mr. E. H. Hawkins, 3, Barbican, E.C., is trustee.

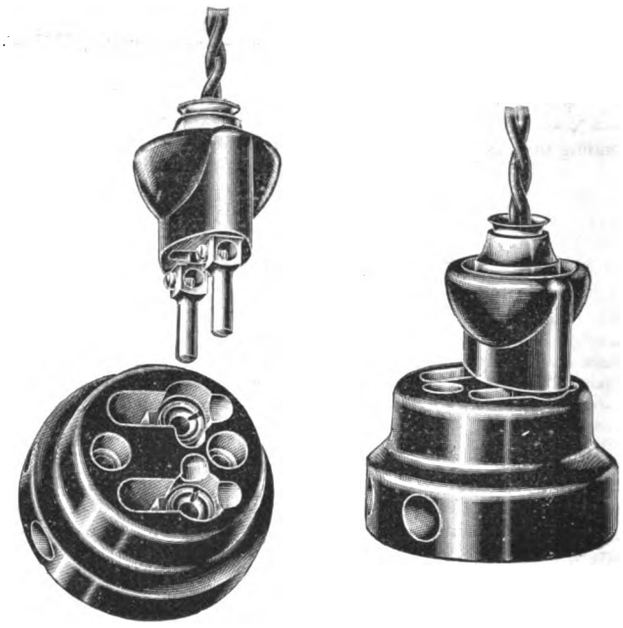
A first and final dividend of 2s. 1½d. will be payable on 26th inst., at the O.R.'s, 31, Manor-row, Bradford, in the bankruptcy of Herbert Sewell, electrician, &c., Clifton-place, and 63, Birkland's-road, Shipley.

Engineering Works for Sale.—Our advertisement columns contain particulars of engineering works in the city of Dublin which are offered for sale by tender as a going concern owing to the death of the late proprietor. The works are centrally situated and have a suitable set of offices, pattern shop, machine shop and foundry, and smith's shop, together with a number of tools which are all of modern type, many of them being new. Tenders are to be addressed to Mr. A. Basil Wilson, M.I.C.E., Maryville, Malone, Belfast, from whom further particulars can be obtained.

Plant for Sale.—Mr. Gabriel Moon notifies in an advertisement that he will sell by auction on Tuesday, 25th inst., the whole of the Earlestown public electric lighting and generating plant, together with the stock-in-trade of an electrical engineer and contractor. Sale commences at 11 a.m. Catalogues from the trustee (Mr. George F. Clarke), Cross-lane, Earlestown, and Hardshaw-street, St. Helens, or from the auctioneer, Earlestown, Newton-le-Willows.

Johnson and Phillips' Cables.—Johnson and Phillips Electric Cable Works announce that, in consequence of a slight fall in the market price of raw materials an additional 5 per cent. on the trade discounts previously allowed off vulcanised rubber cables listed in the firm's February, 1900, catalogue can now be allowed. A well got-up new list (No. 10, September, 1900) of Johnson and Phillips' cables is now available. The additional cable factory for the manufacture of lead-covered and armoured cables for town lighting is now completed and in working order, and a contract for the Manchester Corporation is being executed.

I.E.C. High-Voltage Wall Plug.—The change from low-voltage to high-voltage supply has required that special attention should be given to accessories suitable for the increased voltage, and for a new wall plug manufactured by the International Electric Co., 55, Redcross-street, Barbican, London, E.C. It is claimed that, as far as insulation is concerned, it will answer the most stringent requirements of central station engineers. Arcing or short-circuiting is, it is contended, an impossibility, as all the current-carrying parts are deeply embedded in and surrounded by china, there being no metal parts at the back of the china base. The plug itself is provided with this firm's patent porcelain cord grip. The price at which the plug is supplied complete to the trade is a low one, and supply station engineers can obtain samples free of charge on request.



The New I.E.C. High-Voltage Wall Plug.

Electrical Supplies.—Messrs. Krupka and Jacoby send us their latest list relating to Lessing dry batteries, carbons for arc lamps and other electrical purposes, manufactured by Dr. Alb. Lessing, of Nurnberg, for whom Messrs Krupka and Jacoby are sole agents for the United Kingdom and Colonies. The same firm send a list of "Siemens" incandescent lamps, of which a large stock is held.

Aluminium.—The display at a number of stands at the Paris Exhibition of a variety of goods manufactured from aluminium calls attention to the advance which has been made in a quiet way in this branch of industry. Apart from the excellent exhibit of the British Aluminium Co. (who, by the way, have secured a gold medal for their aluminium exhibit) there is to be seen in the exhibits of a number of leading British firms some excellent examples of repoussé and all kinds of hand-hammered aluminium work for a variety of indus-

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trial, ornamental and domestic uses. At Messrs. Thomas Bolton & Sons' stand there is a fine collection of tubes and wires in aluminium, and also a large coil fixed to a large still, of which a number have been supplied by the British Aluminium Co. for use in the making of acetic acid, aluminium having been found very suitable for this apparatus. Among the miscellaneous aluminium displays may be particularised door furniture, fittings for light vehicles, wire, bicycle parts, a ship's propeller, &c., and an interesting exhibit is a portable water steriliser made in aluminium and specially designed for use in connection with the present military operations in South Africa. This steriliser weighs only 25lb., and is capable of producing 200 gallons of good drinking water per day. It is stated that several examples of this apparatus have been used with satisfactory results. The British Aluminium Co. have two stands at the exhibition, the stand on the ground floor being confined chiefly to raw material and that on the first floor to manufactured goods. Both stands are in group XI., classes 63 and 64.

"**New Lamps for Old.**"—An interesting circular is issued by the Renewable Electric Lamp Co. (Ltd.), Brunswick-place, City-road, London, N., which lampdealers and users may wish to obtain. Copies will be forwarded free on application to the company.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 12 to Sept. 18, with the ports of destination :—

Africa—Cape Town, £620 ; Durban, £1,143 (including £442 telegraph apparatus) ; Port Elizabeth, £25. *Argentina*—Buenos Ayres, £27. *Australasia*—Adelaide, £75 ; Auckland, £86 ; Fremantle, £255 ; Melbourne, £1,070 (including £994 telegraph material) ; Sydney, £1,026 (including £624 telegraph material) ; Wellington, £2,408. *Austria*—Trieste, £365 (telegraph cable). *Belgium*—Ostend, £70. *Ceylon*—Colombo, £44. *China*—Shanghai, £165. *Denmark*—Copenhagen, £61 (telegraph wire). *Germany*—Hamburg, £110. *Gibraltar*—£20. *Holland*—Amsterdam, £160 ; Rotterdam, £74 (telegraph wire). *Hong Kong*—£304 (including £202 telegraph material). *India*—Bombay, £71 ; Calcutta, £275 ; Madras, £159. *Japan*—Kobe, £296 ; Yokohama, £13,692 (including £13,284 telegraph cable). *Mauritius*—£30. *Straits Settlements*—Singapore, £33. *United States*—New York, £300. Total £22,964, against £15,476 in the corresponding week last year (Sept. 13 to Sept. 19).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

July 19, 1900.

13,010. W. JAMIESON and THE SCOTTISH WIRELESS ELECTRIC SYNDICATE (LTD.). Glasgow. Improvements in high-voltage fuses.
13,014. H. OPPENHEIMER. London. Improvements in and connected with fuses or cutouts for high-voltage circuits. (Actiengesellschaft Mix and Genest, Germany.)
13,015. H. OPPENHEIMER. London. Improvements in and connected with insulated bases for switches. (Actiengesellschaft Mix and Genest, Germany.)
13,020. E. VAN HAANEN. Manchester. Apparatus for generating dynamical electricity by means of the direct influence of steam.
13,021. E. GARDNER, T. H. GARDNER, and L. GARDNER. Manchester Improvements in electric ignition devices for internal explosion engines.
13,024. A. E. SEGNITZ. Birmingham. Improved means for starting and stopping electro motors.
13,031. A. REAME and C. WOKES. London. An improvement in or connected with laminated electric switches.
13,035. A. E. BEST. London. Improvements in or connected with apparatus for electrically igniting miners' safety lamps.
13,036. H. F. JOEL. London. Improvements in dynamo electric machines and electric motors.
13,044. SIEMENS BROS. & CO. (LTD.). London. An improvement in electric railways in which transformers are carried on the train. (Siemens and Halske Aktien Gesellschaft, Germany.)*
13,048. W. B. ELLIOTT and J. W. ESKHOLME. London. Improvements in and relating to means for controlling the speed of electro motors.*
13,049. E. SCHATTNER. London. Improvements in maximum demand electricity indicators.

July 20, 1900.

13,081. P. J. PURDY. Manchester. Improvements in means for grinding and truing up dynamo commutators and the like.
13,085. A. PARIETTI and A. R. DURANTE. Manchester. Improvements in the method of, and means for, sounding alarms on electric tram and motor cars.
13,095. R. MACRAE and H. C. MACRAE. London. Storage battery electrode.*
13,102. W. A. PHILLIPS and C. E. KENT. London. Improvements in and relating to electrical conductors.
13,103. W. A. PHILLIPS and C. E. KENT. London. A new or improved method and means for fire-proofing insulated wires and cables.
13,104. W. A. PHILLIPS and C. E. KENT. London. Improvements in means for covering wires and cables.
13,105. W. A. PHILLIPS and C. E. KENT. London. Improvements relating to the covering of electrical conductors.
13,106. F. T. HOLLINS. London. Improvements in safety devices for electric interlocking or block signalling apparatus.
13,125. R. HACKING. London. Improvements in automatic cutouts or combined cutout and shunt switches for overhead trolley wires for electric traction overhead electric cables or the like.
13,134. A. H. WALTON. London. Improvements in and relating to electric arc lamps. (Date applied for under Patents, &c., Act, 1883, sec. 103, Dec. 21, 1899, being date of application in United States.)*
13,143. THE THOMSON-DAVIS TELEPHONE SYSTEMS (LTD.) and A. T. M. THOMSON. London. Improvements in telephonic signalling apparatus applicable also to other purposes.

July 21, 1900.

13,184. A. BROOK. London. The Elland electric "railway" fog signal.
13,195. G. H. SMITH. London. Improvements in electrolytic apparatus for the production of caustic soda.
13,198. B. CRUVELLIER. London. Improvements in electric traction.*

July 23, 1900.

13,237. A. SOUTH. London. Improvements in electrical tatooing apparatus also applicable to stencilling or engraving.
13,249. W. FRIESE-GREENE. London. Improvements in and connected with the electrical transmission of images and in the recording of images.
13,280. J. F. ACKERMANN. London. Improvements in arc lamps.*

July 24, 1900.

13,344. T. B. LAMBERT. London. Improvements in the process of and apparatus for reproducing phonographic records.*
13,356. W. P. THOMPSON. Liverpool. Improvements in telephonic relays. (J. Tice, W. G. Urmson, J. W. Parsons, and H. A. Bell, United States.)*

July 25, 1900.

13,375. H. F. ATKINS. Coventry. Improvements in or relating to electric ignition plugs.
13,385. C. T. DRIGGS. Kingston. Improvements in the method of and means for medically applying electricity.
13,401. C. D. ABEL. London. An improved electrical converting transformer. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)
13,415. C. A. LÓPEZ. London. Improvements in and in the manufacture of electric insulators.*

July 26, 1900.

13,447. C. CAREY-GIBSON. London. An improved electric tramway system employing alternating currents, preferably polyphase.
13,448. A. T. WEDELIN. London. Electricity used in tanning.
13,472. A. MUIRHEAD. London. Improvements in telegraphic transmitting, receiving and translating arrangements.
13,478. H. F. HUNT. Birmingham. Improvements in electric motor starting and regulating switches and cutouts.
13,479. J. T. ARMSTRONG and A. ORLING. London. Improvements in and relating to aerial conductors and like apparatus for transmitting and receiving electromagnetic impulses.
13,482. E. BEDE. London. Improvements in current collectors for electric traction.

July 27, 1900.

13,496. W. F. JONES. London. Improvements in electric switches.
13,515. R. HACKING. London. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables or the like.
13,533. E. DRAULLETTE. London. Improvements relating to electric motor vehicles.
13,538. J. G. LORRAIN. London. Improvements in or connected with current arresters. (P. C. Burns, United States.)*
13,539. J. G. LORRAIN. London. Improvements in or connected with current arresters and alarms. (P. C. Burns, United States.)*
13,540. P. MANGUIN. London. Improvements in electric igniting arrangements for internal combustion engines.

July 28, 1900.

13,573. E. T. PARKER. Wolverhampton. Improvements in apparatus for electrically lighting railway trains.
13,585. P. MANGUIN. London. Improvements in electric ignition devices for internal combustion motors.
13,592. H. HILL. London. London. Improvements in or relating to electric light fittings.
13,608. G. NAST. London. A new or improved current receiver or trolley for electric railways with overhead-current conducting system.

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July 30, 1900.

13,636. W. E. Cocks. London. Combined electric alarm switch and air-brake coupling.
13,637. A. Schoeller. London. An improvement in inductors or like apparatus having an oscillating armature.
13,639. A. G. Bloxam. London. An improved electric motor. (La Société Ch. Mildé Fils & Cie., France.)
13,643. C. Maréchal, J. Michel, and E. Dervin. London. Improvements in wireless telegraphy.*
13,652. R. J. Gülcher. London. Improvements in and in the construction of electrodes.
13,656. R. W. James. London. Improvements in and relating to the electrodes of accumulators and the manufacture thereof. (J. J. Heilmann, France.)
13,661. W. R. Renshaw. London. Improvements in tramcars, railway cars, or locomotives and the like, driven by electric or other motors.

July 31, 1900.

13,679. B. M. Drake, E. G. Sheppard, and The Nernst Electric Light Co. (Ltd.). London. Improvements in holders for electrolytic incandescent lamps.
13,680. S. L. Powell and The Nernst Electric Light Co. (Ltd.). London. Improvements in series resistances for electrolytic lamps.
13,692. T. A. Edison. London. Phonographic recorder.*
13,693. T. A. Edison. London. Process of and apparatus for duplicating phonographic records, also applicable for other purposes.*
13,709. H. Oppenheimer. London. Improvements in and connected with index arrangement for telephone subscribers. (Actiengesellschaft, Mix and Genest, Germany.)
13,720. The British Thomson-Houston Co (Ltd.). London. Improvements in methods of operating dynamo-electric machines. (F. G. Berg, United States).*
13,721. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electric motor control. (C. L. Perry, United States.)*
13,722. A. W. Staveley and I. H. Parsons, trading as Gent & Co. London. Improvements in contact devices chiefly designed for use in connection with electrical counting or recording devices.
13,732. W. M. Mordey and G. C. Fricker. London. Improvements in electricity meters.
13,751. C. Sintas and E. E. Schultz. London. A new or improved automatic device for the safe operation of electric conductors with or without guard wires.*
13,758. T. H. Hill. London. Improvements in incandescent electric safety lamps.
13,765. J. Shoecraft and C. C. Gardiner. London. Improvements in automatic electric block systems for railroads.

August 1, 1900.

13,805. G. Wright and C. Aalborg. London. Improvements in insulating supports for electrical conductors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, Jan. 2, 1900, being date of application in United States.)
13,810. A. Bosshardt. Manchester. Improvements in trolleys for electric traction having three wires for triphane currents. (L. Gerard, Belgium.)
13,811. H. Hillischer. London. Improvements relating to underground electric conduits.
13,816. W. O. Rooper. London. Improvements in or connected with storage batteries.*
13,820. E. F. Moy and P. H. Bastie. London. Improvements in or relating to starting switches and automatic controllers of electromotors.
13,822. F. M. Lewis. London. Improvements in alternating-current electro-motors.

August 2, 1900.

13,839. E. M. Drake and The Nernst Electric Light Co. (Ltd.). London. Improvements in glow bodies and heaters for electrolytic incandescent lamps.
13,860. T. S. Perkins. London. Improvements in controllers for electric motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, Jan. 13, 1900, being date of application in United States.)
13,873. G. H. Whittingham. London. Improvements in electric switches.*
13,874. G. H. Whittingham. London. Improvements in automatic circuit controllers.*
13,892. V. I. Feeny. London. Process for the production of heating bodies for exciting electrical incandescence bodies made of second-class conductors. (Allgemeine Elektricitats Gesellschaft, Germany.)*
13,911. J. R. Dick and The Reason Manufacturing Co. (Ltd.). London. Improvements in electrical demand indicators. (Partly by A. Wright, on the high seas.)

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

18,414. Greil and Audiger. Electric contacts or current-taking devices.
18,475. Tidswell. Guards for electric tramcars and other tramway vehicles.
18,555. Slack. Splicing ears and terminals for overhead electric trolley wires employed on electric tramways.
18,892. Johnson (Hartmann and Braun). Electrical damping apparatus.
20,214. Vogelsang. Electrolytic bleaching of baled yarns.
20,227. Taylor. Collectors and conduits for electric tramways.
20,587. Maxim. Electric railway conduit systems.
21,302. Sondermann and Berlow. Electricity measuring instruments.
21,470. Mühlberg. Automatic charging device for electric motor carriages.
21,773. Rowntree. Electrically controlled elevators or lifts.
22,607. Beckmann. Manufacture of lead peroxide, and its application to electrical storage batteries.
23,497. Von Madaler. Gramophones.
23,877. De Thiersant and Norballe. Electric gas lighters.
24,536. Gottscho. Thermo-electric piles.
25,362. Thompson (Sinding-Larsen). Method of telegraphing on telephone lines, and telegraphic recorders for use in connection therewith.

NEW COMPANIES, STATUTORY RETURNS, &c.

ACCUMULATOR INDUSTRIES (LTD.)—This company was registered on Sept. 12, with a capital of £10,000 in £1 shares, to adopt certain agreements, and to carry on the business of electrical and general engineers, manufacturers of electrical accumulators, motors, controllers and vehicles, dynamo manufacturers, wire drawers, electro-platers, &c. The first directors are H. Leitner and B. Kuttner.

BRITISH POWER, TRACTION AND LIGHTING CO. (LTD.)—This company was registered on Sept. 15, with a capital of £52,000, in £1 shares, to take over certain businesses (including that of the Eclipse Brass and Copper Co. (Ltd.) and the Power Transmission and Traction Co.), and to carry on the business of electrical and general engineers, motor, motor car, crane, and lift manufacturers, &c.

ELECTRO-CERAMIC SYNDICATE (LTD.)—This company was registered on Sept. 11, with a capital of £2,000, in £1 shares, to acquire from Mr F. J. Shippey and Messrs. Shippey Bros. (Ltd.) the benefit of certain inventions and processes relating to electro-ceramic photography, chinagraphy, &c., and to manufacture and deal in photographic china plaques, electro-ceramic china, china and glass ware of all kinds, electrical and scientific apparatus, &c. The first directors are E. B. Koopman, W. T. Smedley, and A. Shippey.

MEYRA ELECTRIC CO. (LTD.)—This company was registered on Sept. 12 with a capital of £10,000, in £1 shares, to enter into an agreement with P. Meyer, to acquire the trade mark "Meyra," and certain inventions and processes relating to galvanic and dry batteries, and to carry on the business of electrical and general engineers, founders, chemists, &c. The subscribers are G. T. B. Cobbett, P. Meyer (electrician), O. Kopp (electrician), R. S. White, O. Percy, G. H. Homan, and S. Bridgwater (engineer). The first directors are G. T. B. Cobbett, O. Kopp, S. Bridgwater, and P. Meyer.

SUNBEAM LAMP CO. (LTD.)—The annual return to Aug. 24 has been filed. The capital is £25,000, in £10 shares, 1,765 of which have been taken up. £10 has been called up and paid on each of 908 shares, and £8,570 is considered as paid on the remainder.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28⅛d. per oz. (Sept. 20). Consols (2¾ per cent.) 98⅛—98⅜ for money, 98⅜—98½ for account; 2½ per cent. 97—97¼ (Sept. 20). Stocks and Shares Continuation Days, Sept. 26 and Oct. 10; Ticket Days, Sept. 27 and Oct. 11; Pay Days, Sept. 28 and Oct. 12; Mining Share Carry-over Days, Sept. 25 and Oct. 9.

BRITISH ELECTRIC WORKS CO. (LTD.)—The first annual meeting of this company was held on the 11th inst., when the following report of the directors to June 30 was presented. The accounts covered a period of 16½ months, as the company had to take over the works and business from Feb. 15, 1899, but the company's beneficial occupation did not commence until May 11, 1899, and it was some months before they could be said to be in working order, after the almost entire cessation of business during a long period. The company had to embark upon a new line of business, to get out new patterns and tools for it, to organise the departments, employ travellers and agents, advertise largely, and incur other expenses incidental to working up a new connection. The profit from the trading account (£6,482. 13s. 11d.) had thus been absorbed in the larger expenditure for these purposes. As the plant with which the factory was equipped was largely adapted for the production of cycle parts it was decided to continue this branch of work while the company's business was being established in other directions. The past year, however, was a very bad one in the cycle trade, and the directors have now entirely given it up, and are disposing of the whole of the cycle stock. The directors have succeeded in establishing a new and very satisfactory class of business in the manufacture of ammunition for Her Majesty's Government. Large contracts for this have been taken, and are now being executed. Steady progress is being made in the electrical business, but it was found that it was no use, commercially, for the company to have only two or three new and improved articles for sale, but that they must be ready to supply all that an ordinary

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customer would be likely to require. This again has meant delay and expense in preparing patterns and producing satisfactory samples, which has now been done. The directors considered it desirable for the company to manufacture its own porcelain for electrical fittings, and accordingly purchased works at Hanley, which are proving a valuable adjunct to the Birmingeam works. The manufacture of a new electricity meter has been undertaken by the company on advantageous lines, which the directors expect will prove a large and profitable business. The orders on hand amount to over £50,000, and if it had been possible to get the preparations for the Government work completed sooner, the accounts would have shown a much better result.

GENERAL ELECTRIC CO. (U.S.A.)—A quarterly dividend of 2 per cent. on the common stock has been declared.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.)—An extraordinary meeting of this company will be held on 21st inst. to approve the Kidderminster and Bewdley light railway order.

MERSEY RAILWAY CO.—In the report just issued the directors regret that the result of the working for the past half-year shows no substantial improvement, the working expenses having reached 77·97 per cent. of the receipts, against 76·67 for the corresponding period last year. Last Session the company obtained powers to adopt electric traction, and to raise the necessary capital for providing the generating plant, &c.

MIRRLEES-WATSON CO. (LTD.)—This company (formerly the Mirrlees, Watson and Yaryan Co., Ltd.) has presented a petition to the Court of Session for an order confirming resolutions reducing the capital from £500,000 to £125,000.

STOCK EXCHANGE NOTICE. — The Stock Exchange committee has been asked to allow 125,000 ordinary £1 fully-paid shares (Nos. 1 to 125,000) of the *Aron Electricity Meter (Ltd.)* to be quoted in the Official List.

VERA CRUZ (MEXICO) RAILWAYS (LTD.)—This is the name of a company inviting subscriptions to a share capital of £750,000. Sir Weetman D. Pearson, Bart., M.P. (president of the well-known firm of contractors—S. Pearson & Son, of Westminster) is chairman of the company, which acquires, in addition to a number of railway lines, the tramways of Vera Cruz, 12 miles in length, at present worked by animal traction. It is proposed to construct about 4 miles of extension lines and to introduce electric traction and an accelerated service. A new concession of the tramways for 99 years has been secured by the company.

WILLANS AND ROBINSON (LTD.)—The registers of transfers and members of this company are closed from 19th inst to Oct. 3 inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks.	Aggregate. Amount.	Aggregate. Inc or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Sept. 15	4,580	+ 140	10	45,614	+ 1,756
Blackpool Corporation...	„ 13	1,492	+ 526	24	22,030	+ 5,236
Blackpool and Fleetwood	„ 17	1,329	+ 193	11	15,850	- 81
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 16	605	+ 209	24	12,327	+ 2,396
Brisbane Trams	Aug. 1	1,773	+ 356	4	6,568	+ 1,075
*Bristol Trams & Carriage	Sept. 14	3,683	+ 323	11	39,313	- 382
*Buenos Ayres & Belgrano	Aug. 19	2,253	+ 355	7	15,039	- 442
Central London Railway	Sept. 15	4,833	...	7	32,308	...
City & South London Ry.	„ 16	1,506	+ 638	11	16,528	+ 6,221
Cork Elec. Trams	„ 13	503	+ 8	37	15,246	+ 1,231
Dover Corporation	„ 15	275	- 33	24	5,823	+ 285
Dublin & Lucan Rly. ...	...	...	...	...	...	...
Dublin United	„ 14	3,869	+ 698	11	43,090	+ 5035
Dublin Southern Dist....	„ 14	1,079	+ 187	11	12,845	
*Glasgow Corporation ...	„ 15	9,933	+ 342	...	...	...
Hull Corporation	„ 15	1,326	+ 696	11	14,651	+ 8,118
*Liverpool Corporation...	„ 8	9,129	+ 1,241	36	277,210	+ 31,442
Liverpool Overhead Rly.	„ 16	1,719	+ 235	11	19,206	+ 453
*Sheffield Tramways	„ 16	2,645	+ 971	37	81,059	+ 28,831

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 12.	Price Wednesday, Sept. 19.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 19. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£96,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	...	...	...	June and December	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£822,720	Stock	15/0	Anglo-American	58 61	59 62	5 13 3	Feb., May, Aug., Nov.	60	...
£3,088,640	Stock	30/0	Do. Preferred	110½ 111½	110½ 111½	5 7 7	„ „	111½	110½
£3,088,640	Stock	27/0	Do. Deferred	11¼ 12¼	11⅜ 12⅛	11 0 5	„ „	12⅛	12
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	102⅜	102
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	6⅝	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100⅞ 104⅞	100⅞ 104⅞	4 6 7	January and July	...	...
60,710	20	5/0	Direct United States Cable	10¾ 11¼	10¾ 11¼	6 4 5	Jan., Apr., July, Oct.	11⅛	10 13/16
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	149 154	149 154	4 11 6	Jan., Apr., July, Oct.	151½	149
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	99 102	99 102	3 9 0	„ „	100	99
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	114 119	114 119	3 8 1	May and November	117	115
250,000	10	2/6	Eastern Extension	15 15½	15 15½	4 10 4	Jan., Apr., July, Oct.	15⅜	15 5/8
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 118	113 118	3 8 6	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	99 102	3 18 6	February and August	101¾	100
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100⅞ 103⅞	100⅞ 103⅞	3 17 8	May and November	...	...
180,237	10	4/6	Globe Telegraph and Trust	11 11½	11 11½	4 11 10	Jan., Apr., July, Oct.	11 1/16	11
180,042	10	3/0	Do. 6 per Cent. Preference	14¾ 15½	14¾ 15½	3 19 0	„ „	15 3/16	14 13/16
150,000	10	5/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	98 101	98 101	4 9 1	June and December	...	...
17,000	25	37/6	Indo-European	51 55	50 54	4 12 7	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	103 106	103 106	5 13 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December	...	...
11,839	8	4/0	Reuter's	7½ 8½	7 8	5 0 0	April and October	7⅛	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	128 131	4 13 5	„ „	127½	126½
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	93 101	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 13 7	January and July	103	...
88,321	10	1/0	West India and Panama	¾ 1	¾ 1	...	May and November	1 1/16	¾
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	5½ 6½	6 7	8 11 6	„ „	...	...
£30,000	100	5%	* Do. 5 per Cent. Debentures	104 107	105 108	4 13 6	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	15⅜	14 7/8
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December	...	...
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ½	½ ½	5 0 0	November	...	...
88,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
590,000	5	3/0	National	4⅜ 4⅞	4⅜ 4⅞	6 6 4	February and August	4⅞	4⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13 15	13 15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	13 15	13 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5 5¼	5 5¼	4 15 3	„ „	5⅜	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	98 101	3 9 8	June and December	...	...
171,504	1	0/3	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October	...	...
58,000	5	4/6	United River Plate	4¾ 5¼	4¾ 5¼	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	...	...
£.79,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 12.		Price Wednesday, Sept. 19.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Sept. 19. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	El'ekh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	⅞	⅞	⅞	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	3 11 8	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red)	100	103	100	103	4 7 5	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½	6¾	6½	6¾	...	...	...	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp.	9	10	9	10	4 12 6	February and August	9⅝	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	5¾	5½	5¾	3 18 3	" "	5¾	5⅝
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½	7½	6½	7½	4 0 0	March	7⅛	7
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	103	111	109	112	4 1 0	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) xd	100	110	100	110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8	9	9	10	4 0 0	February and August	10	9⅜
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12½	13½	4 9 0	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124	129	124	129	3 18 2	June and December	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9½	8½	9½	6 6 4	...	9	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11	12	11	12	5 0 0	March and September	...	...
£300,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107	110	107	110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½	7	6½	7	4 2 7	January and July	...	...
110,000	1	...	London Electric Supply Ordinary	1½	1¾	1½	2½	...	...	2	1¾
49,840	5	3/0	Do. 6 per Cent. Preference	4	5	4½	5½	5 9 1	...	4⅝	...
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	99	101	100	102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord. ...ex rights	14	15	13	14	3 18 7	April and October	14	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111	114	111	114	3 18 11	June and December	111½	...
£350,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93	98	96	99	3 11 6	" "	97⅛	97
6,452	10	6/0	Notting Hill Electric Ordinary	14½	15½	14½	15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5½	6½	5½	6½	3 16 11	"	...	...
300,000	1	1/6	Rand Electric	⅞	1	⅞	1	12 0 0	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'st'n, Ltd., 6% 1st Mor. Deb.	75	85	75	85	6 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares ...xd	165	175	165	185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	107	104	107	4 4 1	" "	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14	15	14½	15½	4 13 7	February and August	15	...
20,000	5	3/6	Do. 7 per Cent. Preference	8	9	8	9	3 17 8	" "	8½	...
13,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85	95	85	95	4 4 8	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3	4	3	4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12	13	12	13	5 0 0	March and September	12⅝	12⅛
29,487	5	...	Do. £2 10s. paid	8½	9½	8½	9½	...	...	9	8½
			ELECTRIC MANUFACTURING &c. COMPANIES.								
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	⅞	1½	⅞	1½	4 8 11	...	...	...
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞	⅞	⅞	⅞	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	...	...	...	...	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅞	⅞	⅞	1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	...	...	97	99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	11⅛	1⅛
40,000	5	3/0	Do. 6 per Cent. Preference	5½	6½	5½	6½	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4½	5½	4½	5½	...	...	...	...
90,060	2	1/2½	Brush Electrical Engineering	1⅝	1⅞	1⅝	2	4 0 0	September	1⅞	1⅝
90,000	2	1/2½	Do. 5 per Cent. Pref. Non-Cum.	2⅛	2⅜	2⅛	2⅜	5 1 1	"	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	106	111	106	111	4 0 11	February and August	...	...
£108,710	Stock	4½%	* Do. 2nd Debenture Stock (red.) ...xd	101	103	101	103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	12½	13½	12½	13½	5 11 1	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5	5½	5	5½	4 10 11	" "	5⅛	5½
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	114	110	114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	6 8 0	...	1⅜	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97	100	97	100	4 10 0	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	⅜	1	⅜	1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅜	1½	⅜	1½	5 6 8	...	...	...
54,000	5	2/6⅜	Crompton and Co. (Nos. 1 to 32,098)	3½	4½	3½	4½	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	102	99	102	4 19 0	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref. xd	⅜	1½	⅜	1½	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	1½	2½	1½	2½	8 0 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½	4½	3½	4½	6 13 4	" "	4⅜	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	90	92	90	92	4 7 5	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	68	72	63	72	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4½	5	4½	5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	1⅞	2⅛	1⅞	2⅛	5 12 11	January and July	2⅛	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅜	3⅛	2⅜	3⅛	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102	105	102	105	3 16 2	January and July	...	...
30,000	5	4/0	Henley's Telegraph Works Ordinary	12	13	11½	12½	5 15 5	February and August	12⅜	12⅛
30,000	5	2/3	Do. 4½ per Cent. Preference	5	5½	5	5½	4 1 10	" "	5⅛	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	108	112	108	112	4 0 4	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	20½	21½	3 9 9	" "	21⅛	20½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101	104	101	104	3 17 10	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	35	38	35	38	4 13 4	March and July	36½	35
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101	104	101	104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½	11½	10½	11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	5½	5½	5½	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½	11½	10½	11½	5 4 4	April and October	11	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½	7	6½	7	4 5 9	" "	7	6⅞
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	105	107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	4/0	Blackpool and Fleetwood Tramways	14	16	14	16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103	105	103	105	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	21½	23½	21½	22½	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10½	11½	10½	12½	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	120	118	120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10	10½	10	10½	4 15 3	May and November	...	...
45,000	10	11/0	British Elec. Trac. Ord.	14½	15½	14½	15½	6 9 0	...	15⅛	15
50,000	10	6/0	Do. 6% Cum. Pref.	12	13	12	13	4 12 4	February and August	12⅝	12⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123	125	123	125	4 0 4	...	...	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	121	124	122	125	...	...	121½	121½
40,000	5	2/8½	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4¼	5¼	4¼	5¼	5 17 1	...	...	...
27,500	5	...	Do. "B"	3¼	4¼	3¼	4¼	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	105	103	106	4 15 0	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	96	99	96	99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10	10½	10	10½	2 17 2	June and December	10⅜	10⅛
£955,000	Stock	1½%	City and South London Railway Con. Ordinary	57	61	53	61	2 5 2	February and August	...	...
37,500	10	1/5⅛	Do. (Nos. 23,501 to 60,000)	5	6	5	6	2 9 4	" "	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	138	143	138	143	3 9 11	" "	...	...
£200,000	Stock	5%	Do. (1896)	130	135	130	135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120	125	120	125	3 4 5	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	21	23	21	23	3 12 9	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½	15	14½	15	3 18 8	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'st'n 5% Pref.	9⅜	10½	9⅜	10½	4 17 7	May and November	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary	8½	9	8½	8½	4 9 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	104	106	104	106	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	3¾	3½	3¾	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½	5	4½	5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18	19	18	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜	10⅝	10⅛	10⅝	4 13 0	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...	...	...	...
30,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9½	10½	4 15 3	February and August	...	...
£135,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	...	...	104	107	...	...	...	...
£47,000	Stock	3%	Waterloo and City Ordinary	93	95	92	95	3 3 7	June and December	93	92

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,167. [No. 23. Vol. XLV.] FRIDAY, SEPTEMBER 28, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 80c., or 70pf.

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NOTES.

ON another page of this issue will be found an abstract of a Paper upon "Electric Furnaces," read by M. KELLER before the Congress of Electricians recently held in Paris. His Paper does not contain anything strikingly new, but it is a useful summary of recent progress in this branch of electrical science, and as an appendix to the works of MOISSAN and BORCHERS upon the same subject it will be of value for reference purposes. For this reason we have given a copious abstract of the Paper. M. KELLER, being a Frenchman, naturally claims for MOISSAN an important place in connection with the development of the electric furnace, but we think he is incorrect in putting forward the Moissan laboratory furnace as a type from which forms now in use for industrial purposes have been derived. MOISSAN carried out his most valuable and classical laboratory researches upon high-temperature reactions in the years 1893 and 1894, and it is only just to point out that SIEMENS had devised and experimented with an electric-arc furnace 15 years earlier—namely, in 1878–79,—and that the Cowles furnace was used upon an industrial scale in America in 1885, and in this country one year later. These two furnaces, the Siemens and the Cowles, are, therefore, the original types upon which all later forms of arc and resistance furnaces have been based. M. KELLER, in pressing MOISSAN's claims to be the inventor of a furnace which others have copied and turned to industrial uses, is therefore claiming for the latter a position which we are disposed to think the noted French chemist would hardly claim for himself.

IT is interesting to note that, although arc-heating is still employed in many carbide works, furnaces using this method of heating are condemned, since they produce an unnecessarily high temperature and lead to loss of raw materials, and to decomposition of carbide already formed. Resistance heating as applied in the Heroult or Cowles type of furnace is therefore recommended for carbide manufacture and similar purposes, and polyphase currents are advised because the dynamos producing these are more simple in construction and less liable to damage through sudden changes in load than continuous-current generators.

M. KELLER closes his Paper by stating that 230,000 H.P. are now employed industrially in manufactures dependent upon the use of the electric furnace, and that over one-fourth of this total is accounted for by the French carbide industry. We are inclined to consider both these totals too high, if they refer to the average power employed. Reliable estimates in our possession show a much lower total; but doubtless M. KELLER's figures represent the power which is *available* in all the works for electro-thermal purposes during the springtime of the year, when the rivers everywhere are in flood. We know that at other periods of the year, especially in France, the power available for electro-chemical and electro-metallurgical operations is greatly diminished, and the carbide industry is also subjected to a further cause of disturbance owing to the fluctuating demand for the manufactured product. It is satisfactory to learn that the yield of carbide per kilowatt day of 24 hours in the latest form of furnace has been increased to 6·2kg. The theoretical yield is fixed, however, by some authorities at 10kg. The thermal efficiency of the best type of furnace is therefore only 62 per cent., and a wide margin exists for further improvements in design and operation.

THOSE disciples of RUSKIN who collectively form the Ruskin Union, in congress assembled, have recently taken upon themselves to denounce "light railways and electric traction," believing themselves to be "acting in harmony with Mr. RUSKIN's life-long endeavour to keep Lake-land in a pure

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and wholesome condition for the recreation and enjoyment of the whole nation." The Windermere scheme just abandoned by the British Electric Traction Co. furnished them with their text and pretext. We totally dissent from their denunciation, believing it to be quite out of harmony with the spirit of Mr. RUSKIN'S own writings. Let the æsthetic objectors to the scream of the steam locomotive and the begriming smoke of its furnace rather welcome than condemn a system of traction that is silent and cleanly, and one that withal causes less offence to the eye than innumerable other necessaries of material civilisation. If the "whole nation," or any considerable part of it, is to enjoy Lake-land, as these hysterical clamourers profess to desire, must there not be railways of some sort to convey it thither and bring it home again? And what can better meet the case than the despised "light railways and electric traction."

NOT the Artist but the "Egoist" is the master of these selfish persons, who seek to disguise their anxiety to keep back the crowd under a cloak of affected horror at the prospect of natural beauty being desecrated. To quote from another of MEREDITH'S works: "The courtship of solitude wanes when we are haunted by a second person in pursuit of it; he is discolouring matter in our pure crystal cup. Such is the worship of the picturesque." And such, too, is the secret of much of the local opposition to the introduction of "light railways and electric traction" into picturesque rural districts.

The Times of the 22nd inst. prints an article "from a correspondent," on the well-nigh threadbare topic of the "Comparative Electrical Development in Great Britain and America." We are told therein that there are only 800 miles of electric street railways in the United Kingdom, while in the United States no less than 18,000 miles have been constructed. Bald statements of this sort ignore the relative dimensions of the two territories: there is not room for 18,000 miles of tramways in the United Kingdom. Better far than making gloomy and misleading contrasts, would it be to note the fact that—however belated—electric traction is making remarkably rapid headway in this country, and there are indications that in the next few years the mileage of electric lines will have increased tenfold, if not more.

ON one point, however, we are in harmony with the writer in *The Times*. Quoting from the report of Mr. MARSHAL HALSTEAD, American Consul at Birmingham, he casts ridicule on the widespread tendency of British local authorities to make separate experiments for each town, instead of relying immediately on the experience gained in other places. "Birmingham cares nothing for the newly-acquired tramway experience of Liverpool"; "Glasgow sent a commission to study the street car systems of the cities of the United States, Germany, France and Austria-Hungary, and . . . built merely an experimental line." In the truly experimental days of electric traction this sort of thing was justifiable, apart from the pleasant holiday it afforded the peripatetic deputations; but nowadays, to look outside the United Kingdom for examples of electric tramway traction is as unnecessary and absurd as to send a municipal deputation round the globe before deciding upon the architecture for a town hall, or the construction of waterworks. In quality if not quantity of electric traction, Great Britain takes the lead.

THE first instance, we believe, of a judicial restrainer from the use of a telephone occurred recently in the United States. A time may come when English Courts will adopt a similar form of injunction. In the American example, a man persisted in making love to a pretty dressmaker, greatly to her annoyance, by ringing her up ten or twelve times a day. He was promptly estopped by the judge. An American contemporary observes that this case emphasises the necessity for some better means of safeguarding telephone subscribers against intrusive callers. At present a telephone is a dead earth in the insulation of one's privacy—unless, indeed, the drastic practice be adopted of removing the receiver and so becoming deaf to the entire telephone world.

Telephone between London and Brussels.—It is announced that direct telephonic communication will be established between London and Brussels at the beginning of next year at the charge of 10fr. for three minutes' conversation.

Central London Railway.—The Bond-street station of this railway was opened for traffic on Monday last. Owing to delay in completing the lifts equipment, this station had remained closed for several weeks after the opening of the line.

Incorporated Association of Municipal and County Engineers.—At Tonbridge, on Friday, the 20th inst., a "Home District Meeting" of this Association was inaugurated. Among the Papers read was one on "Electricity Supply for Lighting, Power and Tramways, with Special Reference to Small Towns," by Mr. H. L. P. Boot, of Tunbridge Wells.

Central Technical College Old Students' Association.—The third annual dinner of the Association of Old Students of the Central Technical College will be held on Tuesday, October 2, at the Restaurant Frascati, Oxford-street, W. Old students can obtain further particulars from the honorary secretary, Mr. M. Solomon, 12, Edith-road, West Kensington, W., to whom all applications for tickets should be made

Cable Interruptions:—

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Tangier—Tarifa	Jan. 5, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Pernambuco—Para	Sept. 19, 1900
Zanzibar—Mombasa	Sept. 20, 1900

Errata.—In the description of the switchboard gear in the Port Dundas works at Glasgow, published in our last issue, it should have been stated that five of the feeder panels were made by the Holland House Co., and one by Messrs. James White, instead of three by each firm.——The last line of our report of the Paris International Electricity Congress in the same issue should read, "apparatus based on the electrical properties of selenium."

City and South London Railway.—About half-past six on Wednesday night an accident occurred on the City and South London Railway, between the Bank and London Bridge stations. According to the official report, a train, the engine of which had broken down, was run into by a second train. The impact was not great, and no passengers complained of injuries. Traffic, however, was a good deal disorganised, and for a considerable time the trains between Moorgate-street and London Bridge stations had to be run on a single line.

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The full service between London Bridge and Clapham was uninterrupted.

Utilisation of Waste Heat.—According to a consular report, the three large German electrical companies, Messrs. Siemens and Halske, the Union, and the Allgemeine Electricitäts Gesellschaft, have founded a company bearing the title "Abwarme Kraftmaschinen Gesellschaft" for the exploitation of patents to utilise the waste heat of exhaust steam and condensing water. The report states that should the invention fulfil the expectations of its projectors, especially with regard to machines of large dimensions now in course of construction, "it will lead to a most important, in fact epoch-making, progress in the economy of central power plants."

Para-Pernambuco-Monte Video Cable.—In connection with the laying of an additional cable by the Western Telegraph Co. from Para to Monte Video, the section from Para to Pernambuco (1,230 knots) was laid some time ago, and the Telegraph Construction and Maintenance Co.'s cable ship "Scotia" is due on October 10 from Rio de Janeiro after laying the second section from Pernambuco to Rio de Janeiro (1,867 knots). The same vessel goes out later with the remaining section from Rio to Maldonado and Monte Video (1,250 knots). This will complete the third cable of the Western Company on this route, the line being in duplicate from Para to Pernambuco, and in triplicate from Pernambuco to Monte Video.

Personal.—Mr. L. B. Stillwell, electrical director of the Niagara Falls Power Co., has resigned his position with that company and removes to New York, where he will open an office as consulting electrical engineer. Mr. Stillwell has been connected with the Niagara Falls Power Co. practically since its inception. For the past two years Mr. Stillwell has given a large part of his attention to consulting work for other electrical enterprises, notably the equipment of the elevated railway of the Manhattan Railway Co. in New York. Following Mr. Stillwell's departure from Niagara, Mr. Philip P. Barton and Mr. Paul M. Lincoln, assistant superintendents, have been promoted, Mr. Barton having been appointed superintendent of the operating department of the Power Company, and Mr. Lincoln resident electrician.

Carbon Filaments and Lightning Flashes.—A correspondent in Madison, Wis., U.S., who has apparently forgotten to append his signature, sends us the following interesting comments on this subject:—

Your editorial note in the issue of *The Electrician*, dated August 31st, upon the phenomenon observed by the electric lighting people at Calcutta when the region is visited by thunderstorms, recalls similar experiences which have been very common in the region of our plains lying east of the Rocky Mountains. In this region, thunderstorms are very severe and quite frequent, and the disturbance of the lamps, which is mentioned in your editorial note, is quite common. The brightening of the lamps may sometimes be so great as to break the filaments. The phenomenon does not wholly consist in the brightening of the lamps, but the dimming of their incandescence is equally evident.

I have always ascribed the phenomenon to the flow of the induced electric charges which gather upon overhead wires and are discharged therefrom during the various cycles of condition of the clouds overhead. When one of the conductors is grounded or for other reasons makes the most convenient path for the flow of the induced charge during its accumulation or its discharge, a current may naturally be expected to pass through the lamps from the other conductors of the systems into this convenient conductor.

The amount of current which will flow on to and then discharge off of a partially-grounded system during the passage of a heavy thunder cloud overhead is quite enormous, as is shown by the heating effect of the current flowing to the ground; and it is of ample magnitude to make a considerable disturbance of the brilliancy of the lamps when the overhead circuits cover an extensive area.

Failures of Automatic Block Signals due to Lightning.—Mr. H. D. Miles read an interesting Paper on this subject before the Railway Signalling Club at Atlantic City (N. J.) on September 11. There were, he said, two kinds of failures of automatic signals due to lightning, the failure of signals to clear, and the consequent delay to traffic; and the failure of signals to go to danger, and the consequent imperilling of train movements. The introduction of the carbon contact for relays and their use in combination with fuse wires had solved the first problem. A lightning arrester which would take care of the heavy discharges without opening the circuit, combined with the use of carbon to prevent the fusing of relay contacts by so much of the lightning current as might pass through the arrester, were apparently the devices which must be employed to solve the second problem. He believed that it was too early to say that the solution of the latter had been accomplished; nevertheless, the service rendered by the choke-coil lightning arrester encouraged the belief that it or some better device would accomplish what was desired. The fuse wire was the chief agency of their present woes, and until it was dispensed with the block signal maintainer was sure of an abundance of calls during the lightning season. The only utility of fuse wires where carbon contacts were employed was to protect the relays and signal instruments from the heavy lightning currents; if these could be diverted to the ground before reaching the instruments, the problem would be solved. The first arrester used by the Michigan Central Railroad to prevent the fusing of contacts and the burning of magnet coils was the old style saw-teeth type, the ground plate being connected with the relay wires which led to the rails of the track. The lightning currents which fused the relay points did so on account of the path afforded through the track relay, track wires and rails to ground, and as the air-gap between the contact strips and ground plate of the arrester was less than that between the armature and magnet coils of the track relay, it was naturally inferred that high-potential currents would take the path of least resistance, and thus avoid fusing the contact springs. The service rendered by this form of arrester, even when combined with fuse wire protection, did not prevent the fusing of platinum contact points, and consequently these arresters were abandoned in 1898, and carbon contact strips and ground plate arresters having a high resistance substance for making contact between the ground plate and the contact strips, which were connected to the track and line wires, were substituted. One-ampere fuse wires for track and 2-ampere fuse wires for line circuits were used in connection with these arresters. The ground plates in this case were connected with galvanised iron pipe driven in the ground, experience having proved that the use of the rails as grounds increased the number of signal failures. To guard further against the danger of fused points, carbon points were used in relays to control all line circuits, and the Buchanan back-contact shunt was applied where track circuits were controlled in order to shunt the track battery should the front contact fuse. It was considered impracticable at that time to use contact points made of carbon for controlling the low potential track currents, on account of the high resistance of that substance. Since these alterations were made there had not been a single case of a signal being held clear by fused contacts, although many instances had occurred of the signals being held at danger on account of blown fuse wires. From January 1 to August 20, 1900, 36 per cent. of the failures of signals to clear were caused by lightning, and nearly all of these failures were due to blown fuse wires. In 1899, 5 miles of the semaphore type of automatic signals were installed, carbon contacts being used to control all circuits, and 2½-ampere fuse wires and choke-coil lightning arresters being used in all line circuits, no safeguards other than carbon contacts being provided for the track circuits. In this instance, the arresters, instead of being in the relay boxes, were located in cast-iron boxes on the telegraph poles. Two types of choke coils and arresters were employed. In one, the coil of wire was wound on a hard rubber spool or cylinder, in the other the wire was wound on a porcelain spool having a hollow centre in which was inserted a soft iron core. On this latter section of blocking, no signal failures had occurred due to lightning, although lightning troubles had been experienced both east and west of this section of blocking, and the porcelain spools of three of the arresters had been shattered by lightning. It was too soon to judge of the efficiency of this method of protection, but as there were line wires throughout each block and several lightning storms had passed over this section, the inference to be drawn encouraged a fair hope for the future.

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THE INTERNATIONAL ELECTRICITY CONGRESS.

(*Continued from page 822.*)

Section II.—*Sub-section A.—Production and Mechanical Utilisation of Electricity.*

On Monday, Aug. 20, M. Bède, of Brussels, explained the tramway contact system which is under experiment in that city. The contact pieces pass through a rubber stopper, which serves at the same time as an insulating cover for the conduit, containing the conductor and as a spring to break the circuit as soon as the collector leaves the contact knob. The main cable is placed in the iron conduit parallel to the rails and separated by a slot 28mm. wide from one of them. The current collected on the car passes through this slot. At Brussels there are holes in this conduit every metre, and these are closed by the rubber stoppers mentioned. Below each of these the cable is bared, and copper saddles are connected to it. These terminate 3mm. below the bottom of the contact piece passing through the rubber. The pressure of the collector upon these contacts pushes them down against the copper saddles, and thus makes a connection between the car and the line. Good results had been obtained with this system.

M. Rey, of the firm of Sautter, Harlé & Co., then read a Paper relating how the method of predetermining the fall of potential in polyphase alternators by means of M. Blondel's "theory of two reactions" had proved most accurate in the case of a special alternator constructed by his firm. He also read a note on the "Compounding of Alternators," by M. A. Blondel, who was prevented through illness from being present himself. The system proposed by M. Blondel was to employ a continuous-current exciter whose armature is traversed by the polyphase current of the alternator itself or from a transformer in series with the main circuit of the alternator.

M. Thury spoke on the application of boosters to the automatic regulation of the E.M.F. of accumulators. M. Thury's method, which he considers of special utility in the case of so called buffer batteries in tramway power stations, is to employ an auxiliary dynamo whose field can be reversed between two limits passing gradually through zero. The difficulty due to sparking at the commutator is overcome by using machines with short armatures provided with smooth windings, and large air-gaps, and by increasing the number of poles. The automatic regulation can be facilitated by means of a compound winding, and then the reversal of polarity is more rapid.

On the Tuesday Dr. Silvanus P. Thompson read his Paper (written in French) on "Electromagnetic Mechanisms." He stated the general principle that in every electro-magnetic system, whatever the configuration traversed by an electric current, there are always mechanical forces tending to change the configuration in a manner to render the magnetic flux a maximum. This principle could be stated in a number of different ways. For instance, that the mechanism moved so as to reduce the reluctance or magnetic resistance to a minimum; that it moved in such a manner as to make the magnetising windings embrace as many lines of magnetic force as possible; or, again, that the tendency was to increase the product of the current and the magnetic flux with which it is interlaced. This latter way of putting it may be expressed by the formula

$$f = \mathrm{IS}\,(\Psi_1 - \Psi_0)/l,$$

where I is the current in the conductor, S the number of turns, l the relative displacement of the members of the mechanism, f the mean force exerted between them, and the expression in the bracket the increase in magnetic flux. This may be stated more generally $f = \mathrm{I}\frac{d\Psi}{dx}$, f being now the force tending to produce displacement per winding of the circuit.

While the magnetic circuit always tends to improve itself, the circuit of the current has, on the other had, a tendency to extend so as to take up as much room as possible. The two phenomena follow from the same principle, as the electric circuit, by enlarging, increases the section of the magnetic circuit in the ambient medium and, in consequence, the value of the flux. Dr. Thompson also pointed out that, as the potential energy of the system always tends towards a minimum value and the tendency of masses of iron is to move in such a way as to magnetise themselves as much as possible, it follows that a mass of magnetised iron possesses less potential energy than the same mass not magnetised. Consequently the specific heat of magnetisation must have a negative value. The author also alluded to an apparent paradox in the behaviour of a coil and plunger. It is well known that the plunger, if left to itself, takes up a central position in the coil, its two ends projecting to an equal extent at each end, as in this way the magnetic resistance of the circuit is at its minimum. If, however, the length of the plunger is reduced to a limiting value, and a small iron sphere is employed to explore the interior of the coil, it is found that there is no force either in the interior or exterior, but merely at the point where the ball ends or leaves the coil, because it is at this point that $d\Psi/dx$ has a maximum value. Dr. Thompson concluded his review of the present state of this branch of electro-technics by giving a classified list of electromagnetic mechanisms, the list being an extension of the one given in his book on "The Electromagnet."

M. Boucherot then read a Paper, by M. Maurice Leblanc, on the design of dynamo electric machines. M. Leblanc's Paper puts forward some new views of considerable importance, and we shall deal with it fully in a subsequent issue. The next paper was by M. Ernest Gérard, engineer-in-chief of the Belgian State Railways. He had chosen for his subject the tractive resistances of motor cars on rails. The formula customarily employed to give the resistance in tons is of the form

$$r = a + b\mathrm{V} + \frac{c\mathrm{SV}^2}{\mathrm{T}} \pm m,$$

where a, b and c are co-efficients, V is the speed in kilometres per hour, m the gradient in millimetres per metre, S the adhesion surface of the train, and T the weight of the train in tons. For trains pulled by locomotives at speeds less than 60km. per hour, the V^2 term can be neglected and the first two terms only employed. Thus the formula used by the engineers on the Eastern Railway of France reduces to $r = 1{\cdot}80 + 0{\cdot}08\mathrm{V}$, which gives a sufficient approximation. In the case of single cars, however, even at the low speeds of 30km. and 40km. per hour, the air resistance plays an important part. M. L'Hoest had made experiments on the Belgian State Railways with motor cars, and had arrived at the following formula for them:—

$$r = 1{\cdot}80 + 0{\cdot}04\mathrm{V} + \frac{0{\cdot}0415}{\mathrm{T}}\mathrm{V}_2 \pm m.$$

As the item involving V^2 no longer includes the factor S, the formula is easy of application.

M. Blondin then described the surface-contact system of traction recently devised by M. Dolter, which is being experimented with on a line at Porte Maillot 750 metres long. This system, which is, in a way, the converse of the Pollok-Binswanger system, has a rubbing contact, which is either magnetised normally by the current which feeds the motors or in certain cases by the current from a small battery of accumulators placed in the car. In passing over a knob, this collector attracts an iron cylinder, forming one arm of a crank lever, and the other arm of this lever connects two carbon contacts, one of which is connected to the feeder and the other to the knob.

On Wednesday Signor Semenza described briefly the Paderno-Milan power transmission plant, a full account of which has already appeared in *The Electrician*, and also gave some account of the working of the system since it was opened. M. Boucherot then read a Paper on the compounding of alternators, describing his compounding exciter exhibited at the exhibition in connection with a Bréguet alternator. M. Thury followed with a Paper on power transmission with high-pressure continuous current. He admitted that transmission by means of polyphase alternating currents was advantageous in most cases when the distance was not too great and when the line pressure could be directly generated by the dynamos. This latter condition limited the pressure to 15,000 volts at the

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present day for dynamos of a higher capacity than 800kw., and possibly a limit of 20,000 volts might soon be reached; but by coupling series-wound continuous-current machines in series and insulating the machines themselves much higher pressures could be attained. A continuous-current machine could, he said, be sufficiently insulated for 3,600 volts, and by employing ten 1,000 H.P. units each consisting of an engine driving two 3,000-volt generators, a total pressure of 60,000 volts with a current of 115 amperes could be produced and transmitted economically for more than 200km. The chief difficulty of this system was in the motors, for when smaller than 100 H.P. they spark considerably at light loads. This difficulty had been overcome by regulating at the same time by adjusting the field and by rotating the brushes.

On Thursday, the first Paper before this sub-section was one by M. Routin on "Compound Alternators and Stationary Transformers." One of these machines is described by our Paris Exhibition correspondent in another part of this issue, and M. Routin dealt with some types of machines built more or less with the same object. Col. Renard then made some remarks on the Paper read by M. Ernest Gérard on Tuesday, pointing out that the formula given as the results of the Belgian experiments agreed remarkably with general data regarding air resistance. He also gave some figures to show the importance of the design of the front and back of vehicles for rapid transit, on account of air resistance. Thursday's proceedings were terminated with a Paper by M. Claude on electrolysis by return tramway currents, and one by M. Léon Gérard descriptive of a three-phase system for towing boats, employed between Brussels and Charleroi, which is combined with a light and power distribution network.

On Friday M. Janet gave an account of some experiments made on an "Alioth" 15kw. rotatory converter at the Central Laboratory of Electricity. M. Janet's experiments demonstrated that there was an undulation of the pressure recovered at the brushes, and also showed the influence of the excitation on the continuous current collected at the brushes while the alternating current remained constant.

M. Lombardi then read a Paper on the employment of condensers for high pressures. He gave results of experiments made, utilising pure paraffin and ceresin for the insulating plates. One of these condensers, with a capacity of 1mf., or ½mf. at 10,000 volts, was exhibited at the exhibition. The dissipation of energy, he said, hardly exceeded 1 per cent., so that the temperature did not increase appreciably. Such plates had been tested to 17,000 volts. The price of these condensers might be as low as 50fr. per kilovolt-ampere. M. Boucherot regretted the bad reputation the condensers had acquired. An experiment was to be made, however, by the firm of Buquet of a system of series distribution with condensers and induction-coils, for public lighting in the village of Noisiel. He then spoke of a "thermo-electric chain," which it had occurred to him to test as a phase-shifter for an alternating circuit instead of a capacity. If a continuous current is passed for a certain time through a copper-iron-copper couple, and if the circuit be broken and the double couple connected to a galvanometer, a current similar to the discharge of a condenser will be observed. To try the effect of a similar device in an alternating circuit, two or three hundred iron and copper washers soldered alternately were introduced into the secondary circuit of a transformer, which gives less than one volt, and measurements were made on the 100-volt primary; but it was not possible to observe any appreciable effect. He then intended to repeat the experiment with several thousands of copper and iron washers, but he interrupted this research on finding that the theoretical shifting of phase would be $\pi/4$ and not $\pi/2$, and on taking account of the Joule effect it would be even less than $\pi/4$. M. Leblanc agreed with previous speakers that troublesome increases of voltage with condensers might be done away with by increasing the capacity of the condensers. Increases of voltage, damaging although so instantaneous as not to be measurable with ordinary apparatus, were caused by harmonics which reinforced the condensers; but he thought this could be avoided by a proper arrangement of holes in the coil discs of the dynamos. M. Leblanc also suggested a system of single-phase alternators connected in series, which, he considered, had all the advantages of the series continuous current system without some of its disadvantages.

Section II.—*Sub-section B.—Electric Lighting.*

On Monday, August 20, M. Laporte read an abstract of a Paper by M. Blondel, on progress in electric lamps. This Paper included a most excellent summary of recent work, and we shall publish an abstract of it in a future issue. The discussion was continued at intervals during Monday, Tuesday and Wednesday. M. Hippolyte Fontaine, who presided, mentioned some lamps of the Gramme motor type which had been working very well for 20 years in foundries, in spite of the dust, and he attributed this to the power of the motor. M. Mailloux spoke on American practice, and said that clockwork arc lamp mechanisms were being replaced to a large extent in the United States by simple clutch movements. In America, high pressure had been employed for arcs. They had begun at 70 volts, and had risen as high as 125 volts, and lamps with long arcs even up to 160 volts and 180 volts had been employod for connecting directly on to 230-volt and 240-volt circuits. These lamps, however, gave a very violet light. He thought there was no future for these high-pressure lamps as they were wanting in efficiency, life and light. M. de Fodor suggested that the reason we were more particular in Europe than they were in America as to the steadiness of arc lamps, was because in the latter country there was practically no competition by the incandescent gas burner. M. Bochet took exception to M. Blondel's statement that differential arc lamps cause an economy of nearly 15 per cent. He was convinced that shunt lamps with a good regulating mechanism were as efficient as differential ones. Prof. Ayrton referred to the Langhans incandescent lamps, whose filaments were made of a compound of carbon and silicon. He had tested 100-volt lamps with an efficiency of 1·13 watts to 1·7 watts per candle, but unfortunately he did not know what was the life of these lamps. The discussion extended to the 100-volt *v.* 200-volt question, and it was also relieved by a discussion on tariff systems, started by M. de Fodor, and a Paper by M. Weissmann on low-pressure incandescent lamps with thick filaments.

The most important Paper read before this section was that of Mrs. Ayrton on the continuous current electric arc, which she read in French on Thursday. From curves shown by Prof. Ayrton at Chicago in 1893 it could be seen that the candle-power of the arc increased with the length of the arc up to a certain point, and then diminished, and there was a definite maximum point on the curve for each particular current. On making other observations in this direction, a distinct minimum and a second maximum were detected. In her present Paper Mrs. Ayrton offers an ingenious explanation of this remarkable effect. The cause of the first maximum and minimum is, by her hypothesis, the varying obstruction of light by the negative carbon, which carbon acquires a sort of supplementary point for short lengths of arc. The second maximum is occasioned by the increase in the light-absorbing properties of the mist formed by condensed carbon in the so-called gaseous part of the arc. One conclusion in her Paper should have an important practical bearing, for she points out that long arcs are uneconomical, and that the most economical arc should be a short one with large currents, although not so short as to produce hissing. We hope to publish a translation of the Paper in an early issue. In the discussion on it, M. Bochet recalled the fact that M. Blondel attributed the reduction of the intrinsic luminosity of the crater with the candle-power to the cooling which takes place when an arc is burning in the open air. M. Arnoux said that it was an important question whether, at the critical or most economical length of arc indicated by Mrs. Ayrton, the arc would be steady. With most carbons employed at present, these lengths of arc would occasion the formation of mushrooms on the negative carbon, which caused considerable unsteadiness in the light. It seemed, therefore, that not only must arc lamp makers construct mechanisms maintaining the length of arc very constant at the critical length, but also that carbon makers must endeavour to furnish carbons on which mushrooms would

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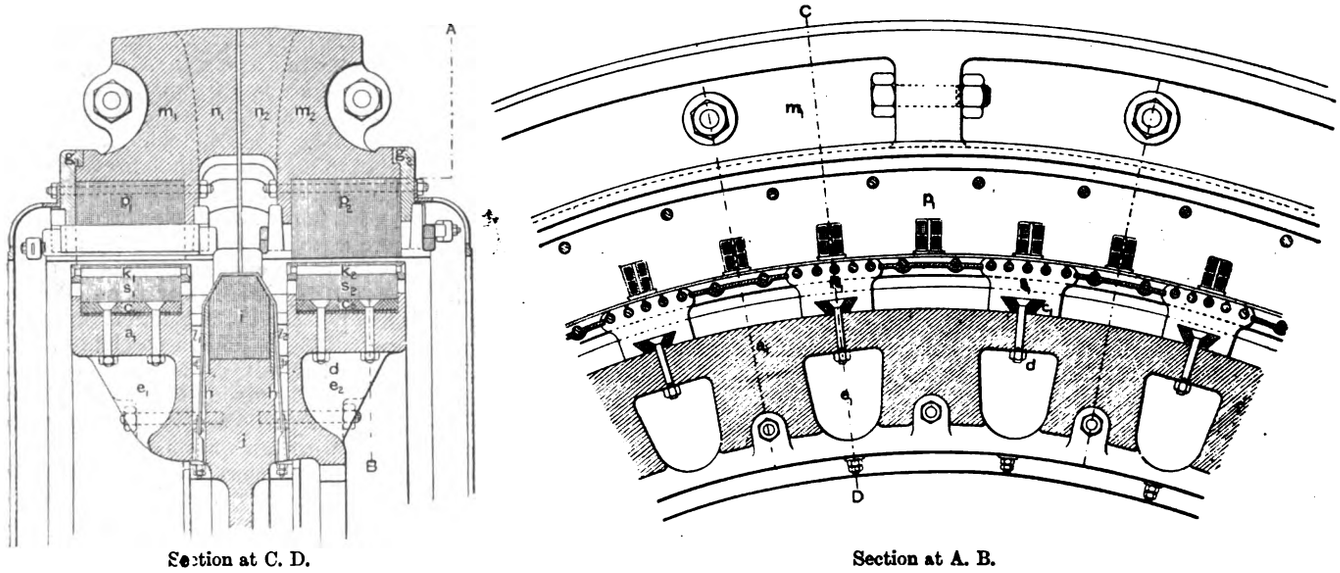
not form under these conditions. M. Fontaine emphasised the remarkable result that Mrs. Ayrton had shown, that the best efficiency would be obtained with arc lengths of about one millimetre. Dr. Silvanus Thompson said that Mrs. Ayrton's communication accounted for two hitherto unexplained phenomena. The first had been pointed out by Mr. A. P. Trotter, that when observing an arc through a slit in a rotating disc one saw something turning. This, Dr. Thompson thought, was probably due to eddies of carbon dust. The other phenomenon was the counter-E.M.F. of the arc, which he thought that the high resistance of the true carbon vapour at the surface of the crater might help to explain. A communication by MM. Blondel and Gigouzo on the subject of alternating current arc was then read and briefly discussed.

(*To be concluded.*)

THE PARIS EXHIBITION.—VII.*

(BY OUR SPECIAL CORRESPONDENT.)

The design of some of the French alternating-current machines is very interesting, and differs frequently in its fundamental principles from that of other countries. Some of these points of difference run the risk of being termed fanciful or capricious, others however, as the Hutin and Leblanc "amortisseur," are undoubtedly inventions of real value.



Section at C. D. Section at A. B.

FIG. 39.—FARCOT TWO-PHASE ALTERNATOR WITH HUTIN AND LEBLANC "AMORTISSEUR."

The boiler plate on the rotating part of the German "Helios" dynamo attracts immediate attention, and suggests other unusual features in the design of the machine, and in the same way the covering-in of the flywheel magnet of the Farcot set with wooden battens, and the gaudy brass guard which protects the ends of its armature windings (see Fig. 38),

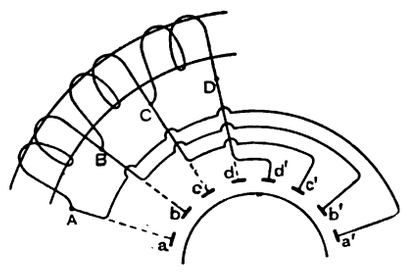


FIG. 40.

hint that there may be other and more important points of originality in this alternator. This impression is correct, for the Farcot machine is fitted with the Hutin and Leblanc amortisseur, and the construction of the armature and field magnets is original in other ways. The dynamo is two-phase, and is designed for an output of 200 amperes in each phase at a pressure of 2,200 volts, a frequency of 42 ∿ per sec., and a power factor of 0·85. Its speed is 78·5 revs. per min. and there are 82 polar projections at each side of the field magnet wheel.

In one respect the field magnets resemble those of the Mordey alternator. Instead of the now usual ring of poles, wound so as to present alternate polarity to the armature, the rotating field magnet consists of a central magnetising coil (*i* in Fig. 39) wound round the rim of the flywheel *j*, and two cast-iron rings a_1a_2 of the section shown in the left-hand view in Fig. 39, and carrying the laminated polar projections s_1 and s_2. The castings a_1 and a_2 are each in four segments. To fasten the pole pieces to the rim of the flywheel, keys c_1c_2 of swallow-tail section are fitted in to the bottom of the packets of discs, and held by bolts *d*, passing through the rim of the wheel, and secured by nuts in the niches e_1e_2. The magnetising coil is supported between the two cheeks l_1l_2 which also carry vanes to ventilate the coil and pole pieces, and the stirrups *h*, placed at intervals, help to hold the coil in place. There are 460 turns of wire 7·5mm. diameter on the coil. Its resistance is 3·5 ohms, and it carries a current of 50 amperes at full load. The total weight of the field magnet without its shaft is 50 tons, of which three only represent the winding. The woodwork on each side of the flywheel is to diminish air friction. The battens are of mahogany, and are placed radially.

The armature or stator of the machine is held in a frame composed of two circular castings m_1m_2. It carries the core discs p_1p_2, which are clamped between the cast-iron segments g_1 and g_2. The two vertical parts of the armature serve each for one phase, and where they are juxtaposed the castings m_1m_2 have projections n_1n_2 whose number is the same as that of the armature coils—viz., 64. The intervals between these projections allow for the efficient ventilation of the field magnet. Each of the two armature rings is therefore wound with 64 coils as an ordinary single-phase circuit. The coils have each ten turns, and are connected in series. As is seen in the illustration, the coils are wound in two layers (of five turns each) and are placed in wide slots in the armature core. They are insulated by micanite tubes, and between the two

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, and Sept. 14.

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coils in each slot is a triangular block of paraffined wood. The section of the copper ribbon of the coils is 8·5 × 88mm., and the resistance hot of each coil is 0·113 ohms. The two armature windings are staggered, that is to say, the slots in one are facing the middle of the polar projection of the other. To enable the two parts of the armatures to be taken apart easily, a distance of a few millimetres is left between the projections n_1 and n_2, for otherwise remanent magnetism would cause them to cling together. The following are the main dimensions of the stator: External diameter of the armature 6 80 metres, internal diameter of the armature 5·515 metres, maximum width of the armature (not including the brass guards) 98cm., width of each armature core 80cm., air-gap 6·5mm., total weight of stator 60 tons.

The "amortisseurs" remain to be described. They consist merely of copper bolts k_1k_2, 28mm. in diameter, and riveted at their two extremities to copper segments. Each pole of the magnet wheel is provided with five of these bolts, and in addition, two similar bolts are riveted to the segments in each of the intervals between the poles, and hold a copper plate which is to prevent the humming of the alternator. The principle of the amotisseur, or "damping coil" was explained in *The Electrician* in 1896 (Vol. XXXVIII., p. 210), when one of the first machines constructed with it was described. The division of the armature into two parts, with one winding on each, is in order to obtain the full effect of this device, both as a means of diminishing armature reaction and facilitating parallel running. Although nowadays alternators constructed on ordinary lines run in parallel without difficulty, the latter function of the damping coils is by no means unimportant in this machine, which is driven by a single cylinder engine.

In ordinary alternators with polyphase windings, the magnetic flux due to the currents in the armature is a constant rotatory one, rotating at the same velocity as the magnetic flux of the field magnet, and in the same direction. It would not move, therefore, in relation to the damping coils, and would have no effect on them. With an ordinary single-phase winding, however, the flux due to the armature current is an alternating one, and can be conceived as being resolved into two fluxes, revolving with the velocity of synchronism, but in opposite directions. One of these will, as before, have no effect on the amortisseurs, rotating as it does at the same speed as the magnets. The other will move in relation to the magnet wheel and the amortisseurs at twice the speed of synchronism, tending to generate an electromotive force in these damping coils of twice the frequency of the alternator current. The currents thus produced in the damping coils will give rise to magnetomotive forces opposing and neutralising the second component of the magnetic flux induced by the armature reaction as already mentioned.

So much in regard to armature reaction. The explanation of the effect on parallel running is simpler. The damping coils constitute in themselves the armature of an asynchronous motor. When the alternators tend to fall out of phase these circuits react strongly, and the momentary difference in speed is limited to a slight slip of one of the alternators with respect to the other, which allows the machines to come into step again.

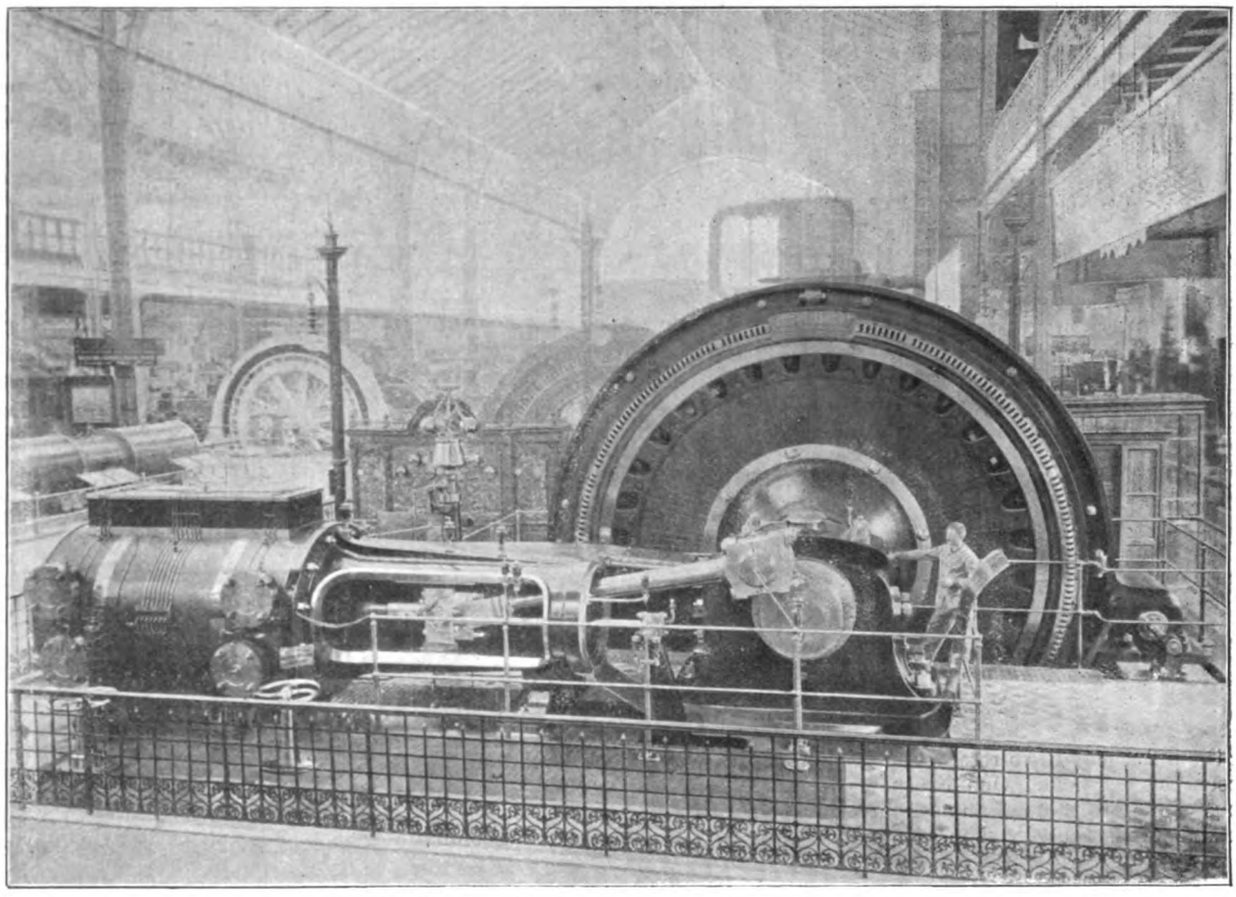

FIG. 39.—GENERAL VIEW OF FARCOT TWO-PHASE ALTERNATOR.

The exciter is fixed at the end of the alternator shaft, and generates a current of 50 amperes at 175 volts.

As already mentioned, the engine is a single-cylinder one. The diameter of the cylinder is 1 metre, the stroke 1·350 metres, and the speed 80 revs. per min. It has four Corliss valves. Running condensing and with a steam pressure of 6kg. per square centimetre, it will develop 700, 1,020, or 1,280 E.H.P., according as the cut-off is at 10, 20, or 30 per cent. of the stroke. As low a steam consumption as 5·8kg. of steam per horse-power-hour is said to have been obtained with similar engines.

At first sight there appears to be nothing more striking about the Grammont three-phase alternator than the bright copper-clad coils of its rotating flywheel magnet. On closer acquaintance, however, one finds that the chief interest attaches to its exciter, which is one of the most remarkable

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machines in the exhibition. It is wound and connected in such a manner as to compound not itself, but the alternator. This so-called compounding exciter is also the invention of MM. Hutin and Leblanc, and is designed on the following principle. Consider an ordinary continuous-current armature armature, it will be possible to obtain continuous current from fixed brushes when one of the following two equations are fulfilled,

$$n + k = a/\omega,$$
or $$n - k = a/\omega,$$

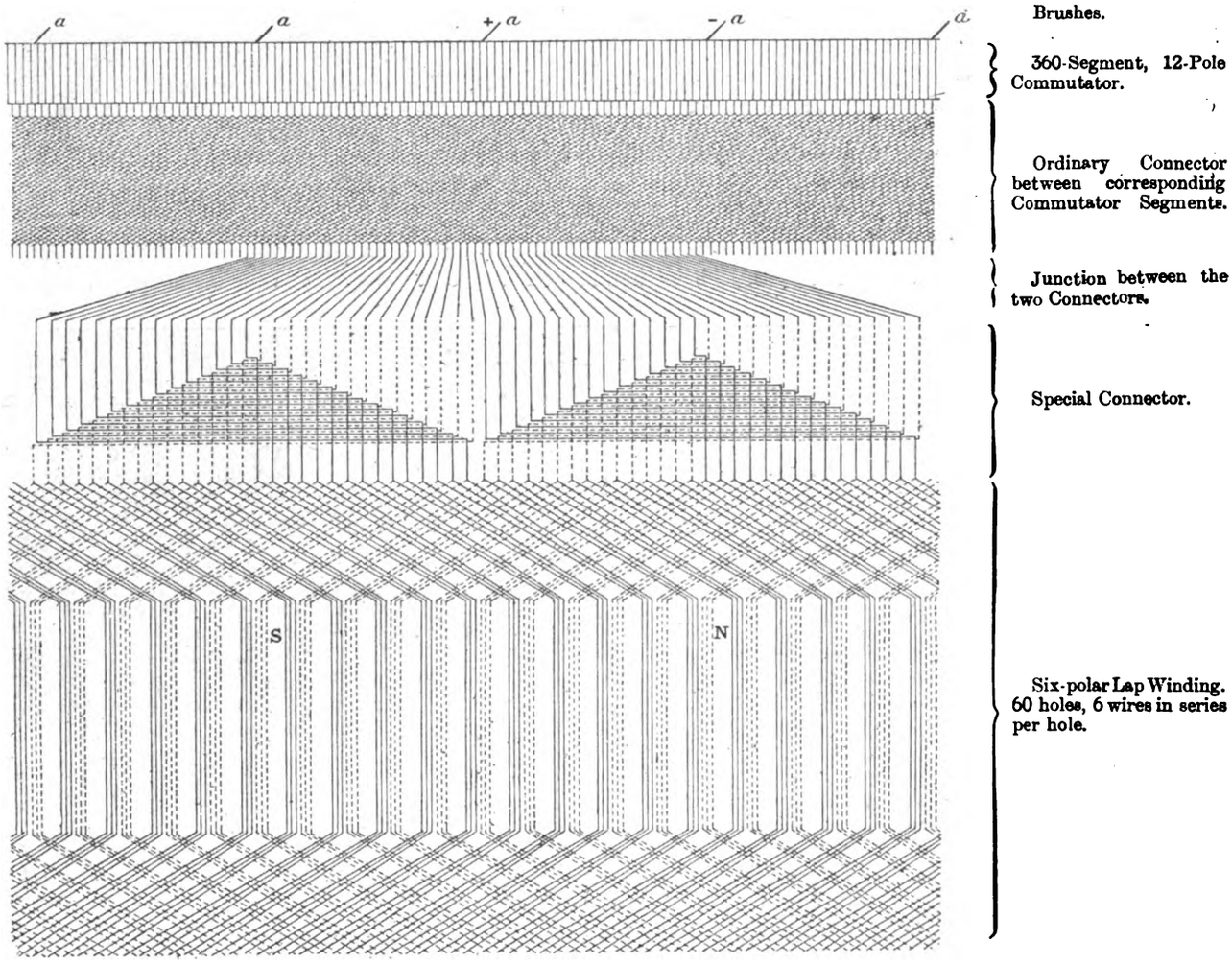

FIG. 41.—PLAN OF WINDING AND ARMATURE CONNECTIONS OF COMPOUNDING EXCITER.

under the influence of two rotatory magnetic fields instead of the usual steady field. One of these fields is excited by windings similar to those of an asynchronous motor connected in parallel with the alternator, and the other by similar windings in series with the alternator armature. Then if there are n pairs of poles for the rotating field, and k pairs of brushes; if a be the frequency of the rotatory alternating current through the field windings, and ω the speed of the according as the armature turns in the direction of the rotating field or in the inverse direction. For this, however, it is necessary that the ordinary connections between the armature coils and commutator be reversed about an axis of symmetry.

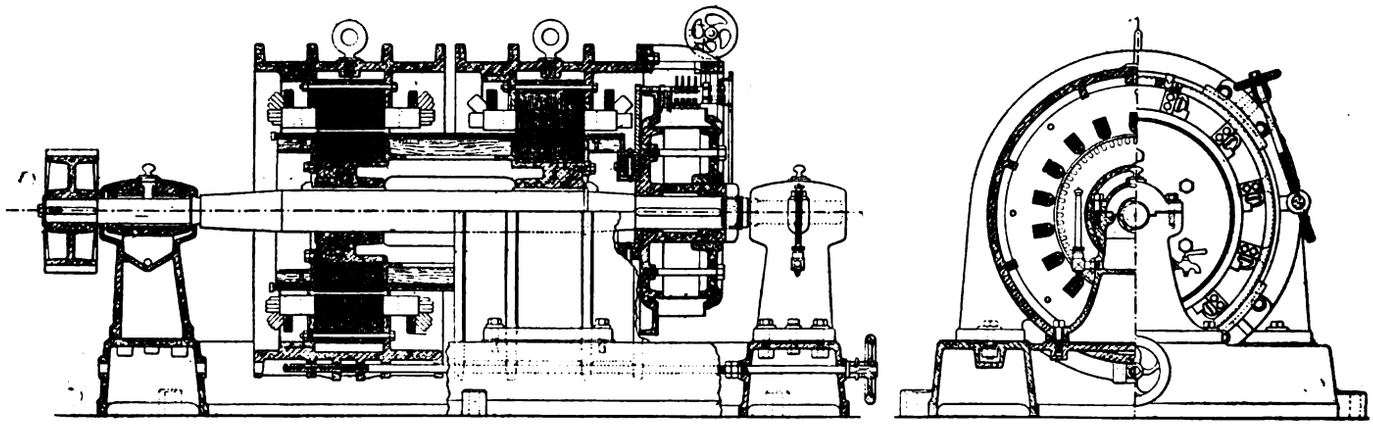

FIG. 42.—COMPOUNDING EXCITER OF GRAMMONT ALTERNATOR.

What is meant by this reversal of connections is shown in Fig. 40 (on p. 844), which for the sake of simplicity is drawn for a two-pole armature. Any diameter (a vertical one in Fig. 40) is taken as axis of symmetry, and instead of connecting A to a, as

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would be done ordinarily and as is shown by the dotted line, it is connected to a', the corresponding point on the other side of the vertical axis. Similarly B is connected to b' instead of b, and so on. Applying this to a multipolar armature, all that is necessary is to take the set of the windings corresponding to each pole by itself, and then to take in each case an axis of symmetry through the middle point of each of these sections of the armature, and to reverse the connections with respect to this axis.

To obtain the requisite ratio between the number of pairs of brushes, k, and the number of pairs of poles, n, demanded in the above equations, is a simple matter, merely requiring the parallel connection of a greater or less number of corresponding commutator segments. Fig. 41 shows the connections for a machine in which the armature and rotatory field revolve in the same direction, and in which the equation $n+k=a/\omega$ is satisfied by making $n=3$, $k=6$, and $\omega=333$, a being 50. It may be noted that the exciter armature will tend to rotate at a speed a/n, which is greater than ω, so that being geared by a wheel and pinion to the alternator shaft it actually returns work to the engine in assisting it to drive the alternator.

The general arrangement of this exciter is shown in Fig. 42, and Figs. 43 and 44 show the details of the actual connecting pieces between the armature coils and the commutator.

The alternator itself is driven by a single-cylinder horizontal Piguet engine, and is a 600kw. machine. Its whywheel-magnet casting is in two parts, and there are 64 steel poles of circular section with rectangular pole-pieces. Each pole is fastened into a recess in the flywheel rim as seen in Fig. 45. The winding is of copper strip, and the insulation is merely paper, which is sufficient as the coils are all in series and the difference of potential between adjacent windings only 0·02 volt. At the other end of the coil, facing the armature,

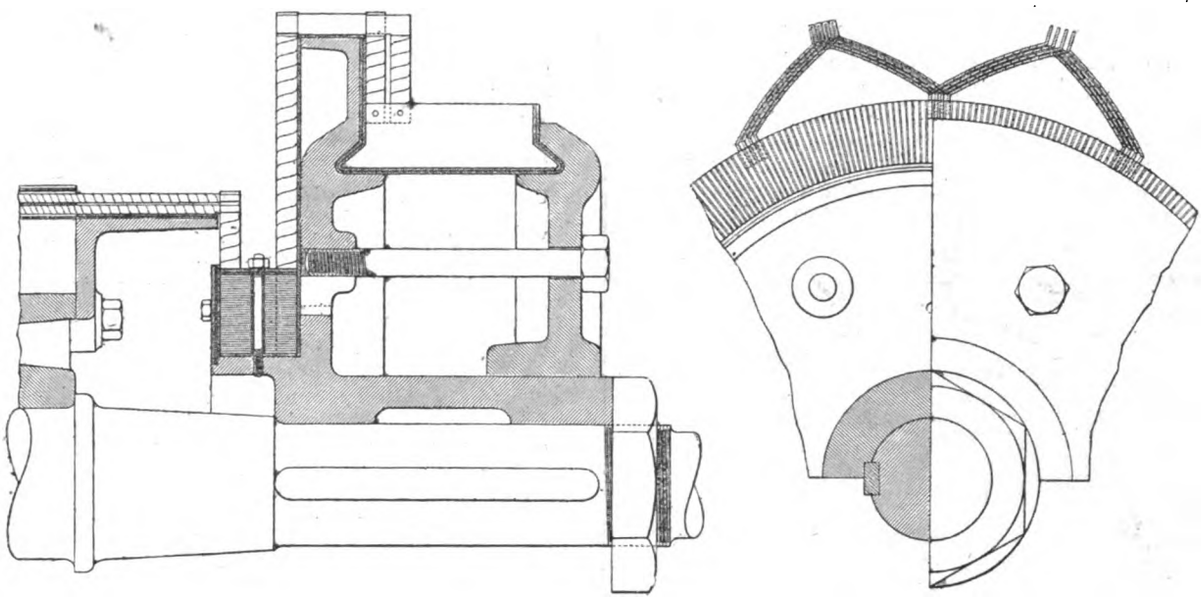

Fig. 43.—Detail of Connectors of Compounding Exciter.

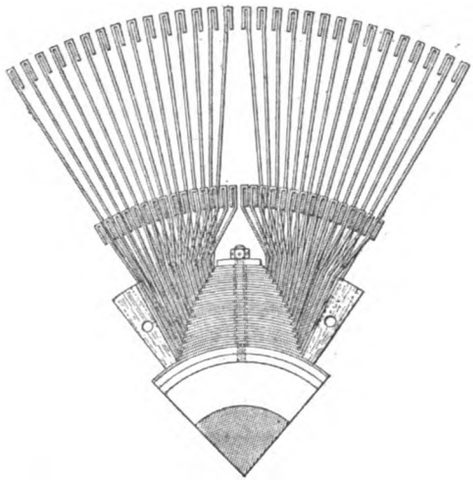

Fig. 44.—Detail of Connections of Compounding Exciter.

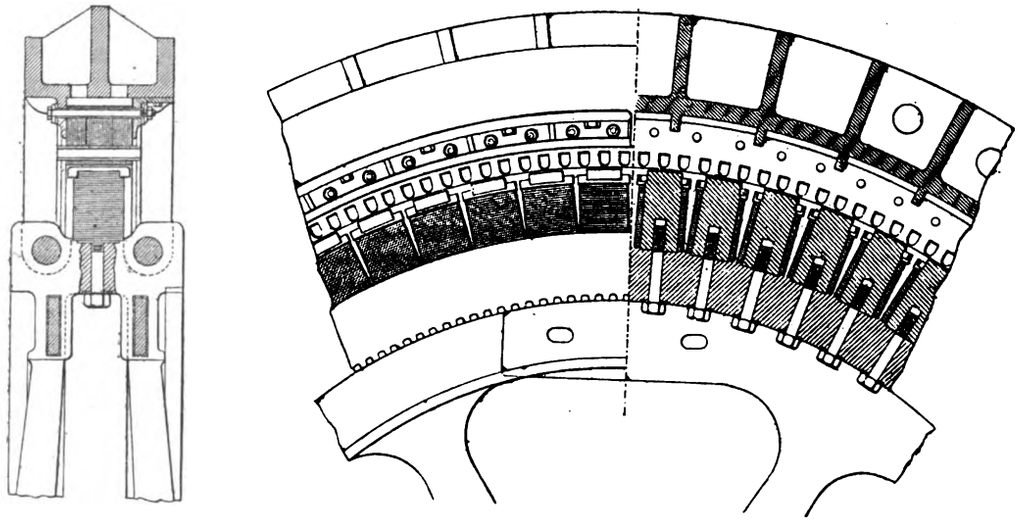

Fig. 45.—Detail of Grammont Alternator.

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the windings are held in position against the action of centrifugal force by a solid brass washer. The flywheel was designed with regard to the fact that the engine was a single-cylinder one, so that the momentary variation in the speed at a fixed load should be less than 0·4 per cent.

The armature casting differs somewhat from the usual design, and consists of three vertical rings joined together by transverse ribs. There are holes in the partitions for the ventilation of the armature core. The core discs are divided into three packets, separated by ventilating ducts, and held together by a steel piece of L-shaped section. As seen in Fig. 45, the winding is placed in holes of a peculiar shape. Cardboard and micanite tubes, tested to 20,000 volts, insulate

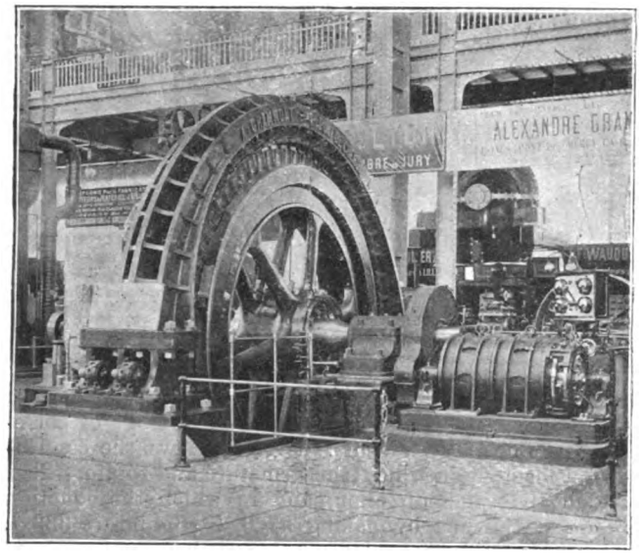

FIG. 46.—GENERAL VIEW OF GRAMMONT ALTERNATOR WITH COMPOUNDING EXCITER.

the windings. Fig. 46 is a general view of the alternator and exciter. The following table gives the chief data and dimensions of the machine :—

General Data.

Power in kw.	600
Frequency in ∿ per sec.	50
Class of armature winding	Star
Current in amperes for power factor of 1	144
Ditto ditto 0·7	206
Virtual voltage	2,400
Ditto of each winding	1,390
Number of poles	64
Speed in revs. per min.	93·75

Field Magnets.

Axial distance between two poles at the periphery, in cm.	24·6
Magnetic induction in gauss (without leakage)	12,000

Determination of Magnet Winding.

Ampere turns required for poles	1,660
Ditto ditto part of flywheel rim	98
Ditto ditto armature core between holes	180
Ditto ditto ditto beyond holes	122
Ditto ditto air gap	7,550
Total ampere turns	9,610
Armature reaction for power factor of 1	2,020
Number of turns in each coil	70
Thickness of paper insulation in mm.	0·5
Resistance in ohms	0·825
Exciting current in amperes at 120 volts	146
Maximum excitation in ampere-turns for each magnetic circuit at 120 volts	22,000
Watts expended on excitation	17,500
Cooling surface of each coil in sq. cm.	1,610
Useful cooling surface per watt in sq. cm.	5·9
Estimated heating in deg.C.	23·5

	For power factor unity.	For power factor 0·7.
Actual excitation in ampere-turns	11,630	16,410
Actual exciting current in amps.	76	117
Actual power spent in watts	4,250	11,300

Armature.

Internal diameter in cm.	500
Total width in cm.	28
Length of ventilating ducts in cm.	3
Number of holes for windings, 3×64	192
Number of conductors in each hole	7
Diameter of conductor in mm.	10·5
Ditto insulated conductor in mm.	12
Section of conductor in sq. mm.	65·4
Total length of cable in each circuit in metres	340
Total weight of cable on armature, in kg.	590
Resistance of each circuit in ohms	0·1
Loss of volts in each wire for power factor of 1	14·4
Ditto ditto ditto 0·7	20·6
Useful section of iron between the holes, in sq. cm.	186
Ditto beyond ditto	180
Volume between the holes, in c. dm.	107
Hysteresis loss at 69 watts per c. dm.	7,400
Volume beyond the holes, in c. dm.	294
Hysteresis loss at 23·75 watts per c. dm.	6,650
Total hysteresis loss in watts	14,050
C^2R loss in the armature for power-factor of 1	6,210
Ditto ditto ditto 0·7	12,700

Efficiency.

	Power factor = 1.	Power factor = 0·7.
C^2R loss in the field magnets (watts)	4,250	11,300
Ditto armature do.	6,210	12,700
Hysteresis loss do.	14,050	14,050
Mechanical friction	6,000	6,000
Total loss	30,510	44,050
Percentage efficiency	95	93·2

The Piguet single cylinder engine is horizontal and has ordinary double flat slide-valves, the governor acting on the cut-off. Its main dimensions are: Cylinder diameter, 850mm.; stroke, 1,100mm.; speed, 95 revs. per min. It is run with 8kg. per sq. cm. steam pressure, which is rather high for a single cylinder engine. The following table of output and guaranteed steam consumption is of interest :—

Cut-off (per cent).	Steam consumption (kg. per hour).	Indicated horse-power.	Effective horse-power.
6	6,550	525	460
8	6,670	610	541
10	6,860	684	612
12	6,990	757	682
15	7,400	852	774
20	7,860	1,000	916
25	...	1,117	1,028
maximum	...	1,324	1,226

A 38-Mile Electric Railway.—The longest third-rail electric railway yet built, says the *Railway and Engineering Review*, of Chicago, is about to be put into operation between Albany and Hudson, N.Y., a distance of 38 miles. The line has been built by the Albany and Hudson Railway and Power Co., on steam railway standards, a portion of the road being steam railway changed over to electric line. Power will be supplied from an 8,000 H.P. water-power plant at Stuyvesant Falls, on the Kinderhook Creek. The dynamos are 12,000-volt machines, the current being transmitted to a number of sub-stations along the line, where it will be transformed and converted to continuous current at 550 volts. The line runs through a section of fertile farm country, and will do a large freight business in connection with manufacturing industries along the route. It is also expected to handle large amounts of dairy and farm produce, as well as a large passenger business. For the protection of life and property along the route a woven wire fence of small mesh has been erected on either side of the road for its entire length. At road crossings the third rail is broken, the conductor being made continuous by means of a cable laid in an underground conduit. Signs have been posted conspicuously at all road crossings warning the public not to trespass. The electric freight locomotives will be similar to those used in the tunnel of the Baltimore and Ohio Railway at Baltimore. There appears to be an opinion in America that this railway is only part of a line to connect Albany and New York City, to be completed later on.

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THE NEW ELECTRICITY WORKS OF THE GLASGOW CORPORATION.

(*Concluded from page 812.*)

POLLOKSHAWS ROAD WORKS.

This station fronts the Pollokshaws-road, the Barrhead and Kilmarnock joint railway being at the back. The engine-house and boiler-room floors are on the same level, and the coal store is contained in an elevated mild steel tank running the whole length of the boiler-house. The railway has a siding running right into the station underneath the coal store tank, and the coal waggons are raised by screw elevators to a high-level set of rails running along the top of the coal tanks. From the coal tanks the coal is discharged through shutes into the hoppers of the automatic chain grate stokers. The boilers are of the same size and make as those at the Port Dundas works, and the ashes are handled in a similar manner. The roof of the boiler-house is formed of mild steel tanks, with the exception of a 10ft. space over the stokehold, which is roofed with glass and iron and has louvre-boarded sides for ventilation, and a 4ft. space next to the engine-house wall which is roofed in a similar manner. When complete, this boiler-house will contain 20 Babcock and Wilcox boilers of 1,100 H.P. each, placed in a single line. There will be two chimneys, only one of which is built at present however, each

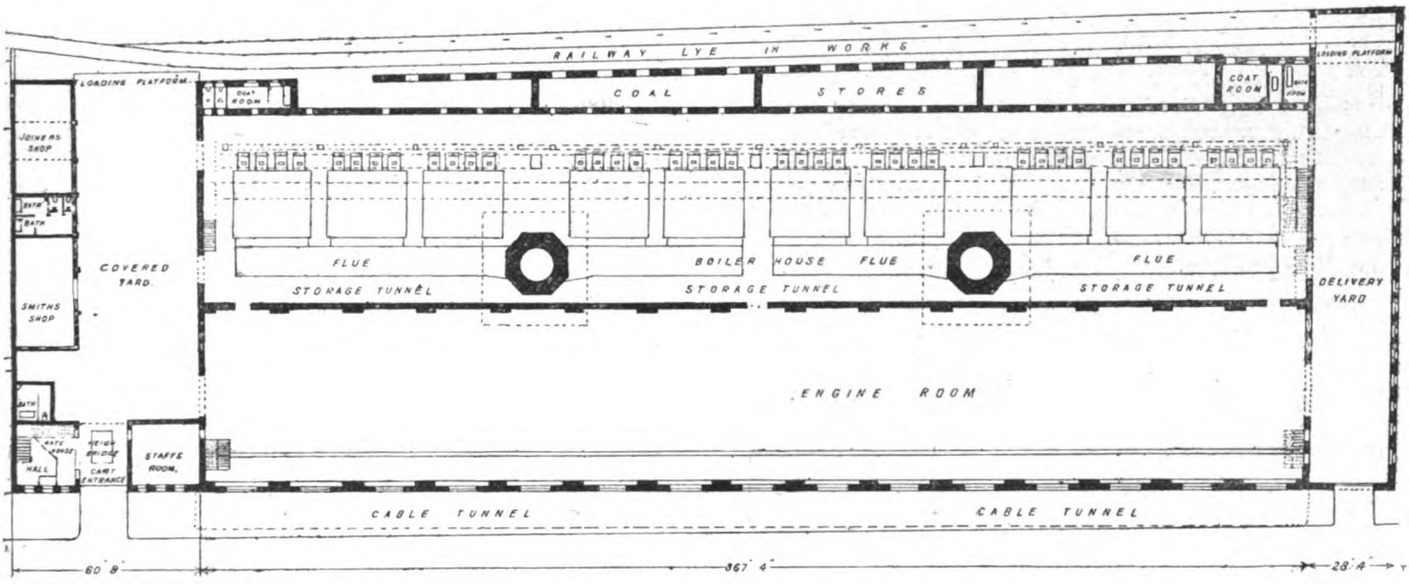
Engines and Dynamos.—One 1,100 H.P. Willans-Crompton set. Two 400 H.P. Belliss-Crompton sets. Two 200 H.P. Alley and McLellan-Mavor and Coulson sets.

Accumulators.—There are at present no accumulators at this station, but as soon as possible it is proposed to remove the two existing 200-volt Tudor batteries now in two of the sub-stations and re-erect them at this station making them up to two 250-volt batteries.

Seeing that the machinery is on exactly the same lines, and some of it exact duplicates of the plant at the Port Dundas station, no detailed description of it is necessary here. The one want at the station is a water supply for condensing purposes, but it is in contemplation to erect a cooling tower, or an evaporative condenser in the tanks already referred to over the boiler-house.

STREET WORK AND MAIN CABLES.

The laying of the supply mains in connection with the new scheme was commenced by the Corporation's own staff in June, 1898, and by June of this year 54½ miles of feeders and 63 miles of distributors had been laid, 41 miles of feeders



PLAN OF THE GENERATING STATION AT POLLOKSHAWS-ROAD.

and 47 miles of distributors being on the north side of the river, and 13½ miles of feeders and 16 miles of distributors being on the south side, the supply being extended through the more important thoroughfares over a 2-mile radius from the centre of the city.

The contract for practically the whole of the cables has been equally divided between the British Insulated Wire Co. and Callender's Construction Co. The feeders are triple concentric cables of 1, 1 and 0·3 sq. in. section, with the exception of four feeders laid in some of the residential parts of the area, which are of 0·5, 0·5 and 0·25 sq. in. section area. The 1 sq. in. triple concentric cable is, we believe, the largest cable of its class that has ever been constructed. The B.I.W. cable of this size has a diameter of $3\frac{1}{16}$in. The inner copper is composed of 91 wires, the middle conductor of 18 segmental strips, and the outer conductor of 24 segmental strips, the total weight of copper being 21 tons per mile. The total weight of lead used in the cable is nearly 19 tons per mile, and the total weight of the cable is over 44 tons per mile. The cable is manufactured in 110-yard lengths, and is packed on drums 6ft. 6in. diameter. The cable was submitted in Mr. Chamen's presence to a severe bending test, being bent backwards and forwards six times round the barrel of a drum 2ft. 6in. diameter, and it was then tested to a pressure of 30,000 volts without breaking down.

200ft. high and 11ft. diameter, and octagonal in section. If economisers are fitted they will be placed immediately over the flues.

The engine-room is 363ft. long, the same as the boiler-room, and 56ft. wide between butts, and is roofed with glass and iron and has side windows in the front wall. The interior is finished with enamelled bricks in colours, the exterior being built with red pressed bricks and red sandstone facings. The general fittings are the same as at Port Dundas, there being a 25-ton overhead electrical traveller, and a track along the side for a tank weighing machine for testing the steam consumption of the various engines. On the other side of the engine-room and running the whole length is the switchboard gallery, while underneath there is a tunnel 8ft. wide and 6ft. 9in. high (also running the whole length of the engine-room), along which all the cable connections are carried. There is another tunnel 11ft. wide on the other side of the engine-room wall and underneath the footpath. Above the delivery yard seen at the end of the works in the plan, the battery room is situated, while at the other end of the buildings there are the general offices, engineer's room, workshops and a covered yard.

The machinery whose erection is being completed is as follows :—

Boilers.—Four Babcock and Wilcox, 1,100 H.P. each.

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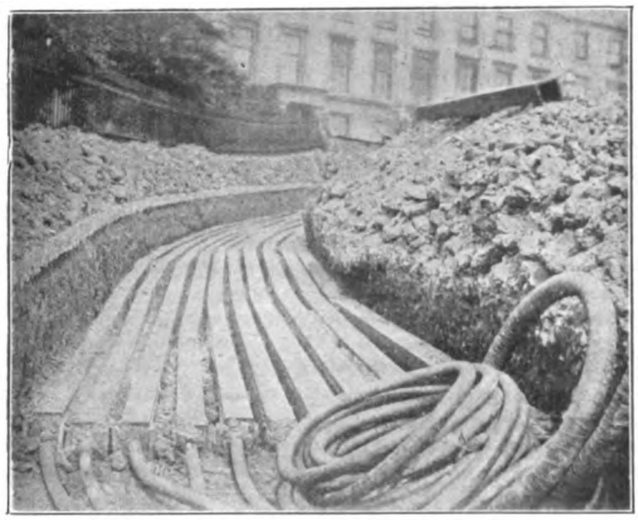
The distributors are of 0·25 sq. in. section triple concentric cable, laid in the main thoroughfares in the centre of the city, and of 0·15 sq. in. triple concentric cable throughout the rest of the area.

Both feeders and distributors are insulated with resinous paper, vulcanised bitumen, or impregnated jute, and all except the vulcanised bitumen cables are lead-covered. They are laid in iron, earthenware, or wooden troughs, and are filled in solid with a composition of the best coal tar, pitch, and asphalt oil. On the three-wire system at 250 volts and 500 volts the core of the cable is positive, the centre conductor negative, and the outer conductor neutral The sheathing of all lead-covered cables entering the stations is bonded on to earth plates put down in the ground of the stations.

The feeders are brought into tunnels in the new stations, and run on supporting brackets up to points under their respective panels erected on the gallery in the engine-room. They are turned up through the floor and connected directly with the terminals at the back of the panels. From the tunnel the feeders are run in batches of from four to six at a time through the back streets to their respective feeding points, and where a feeder is dropped at a feeding point, the others pass into the feeding point manhole and out again through disconnecting links, so that there are several points at which the feeders may be disconnected or manipulated in cases of emergency.



Batch of six 0·5 Triple Concentric Vulcanised Bitumen Distributors and four 1 sq. in. Feeders, laid in the same Trench on the way to one of the Feeding Point Manholes.

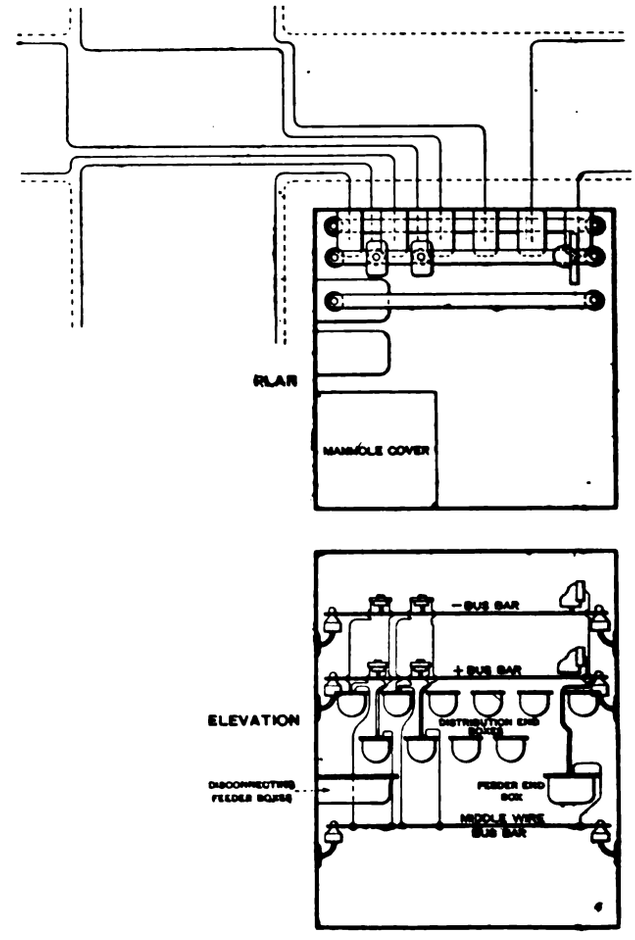
The feeding points consist of 6ft. square cast-iron chambers which are cast in eight sections and put together in position.

The cable is passed through a special design of cast-iron gland, attached to the outside of the manhole, and it terminates in a cast-iron end-connection box through which rubber connections are brought up; the positive and negative conductors being connected through fuses mounted on porcelains on to the positive and negative distributor 'bus bars. The middle wire connection is coupled directly to a middle wire 'bus bar. All three 'bus bars are mounted on porcelain insulators, but in the case of the positive and negative bars these are attached to porcelain fuse blocks, each of which is arranged for a supply to two distributors, the fuse blocks being mounted on a malleable iron bar which is supported at each end by a porcelain insulator. This arrangement tends to provide double security from any leakage taking place from either the positive or negative 'bus bars to earth. Care has been taken to abolish the use of wood, the designs for all fittings being in either iron or porcelain, thus minimising the fire risk. The distributors are brought into the manholes in an exactly similar manner to that described for the feeders, and for the positive and negative conductors the rubber connections are taken to the fuse terminals on the distributor fuse porcelains, strip tin being used for the fuses. The middle wire distributor connections are clamped directly to the middle wire 'bus bar.

The manholes are capable of receiving from eight to ten distributors, one feeder, and four sets of connecting links for other feeders. All the fittings are so arranged as to be easily dismantled or worked upon, a complete set of tools and accessories being kept in each manhole. An iron ladder gives access to the interior, and the manhole cover is designed with a view to keeping the manhole free from gas and surface water.

The plan published in our issue of Sept. 14 shows the present arrangement of feeders, the distributors on either side of the street having either one or two connecting links arranged by means of road crossings according to the length of network between the feeders.

Where one distributor joins another, a 2ft. square brick manhole is built in the footway. The distributor ends are brought into this manhole through end connection boxes of a similar design to those used at the feeding points, with the exception that the boxes have a socket end into which the



General Arrangement of Distributors at Feeding Point Manholes.

wood, earthenware or iron trough is brought, and this socket end is built into the brickwork and holds the box in position. The distributor ends are brought up to fuse terminals on porcelains, one side of the porcelain being arranged for a 'bus bar, and the other for the cable ends. All bare connections are within a few inches of the top of the box to minimise the risk of trouble should water get into the manhole.

In the case of lead-covered cables entering brick manholes, bonds are employed consisting of lead blocks in the form of a plummer block, the bonds being put round the cable inside the socket-end of the end connection box (the socket end of the box and lead of the cable being first thoroughly scraped), and an iron clamp is put round the outside of the socket and screwed down hard on to the lead bond, which is made to project slightly above the top of the socket. The end-connection box is then connected by a 10-gauge copper wire to an "earth plate," which in most cases consists of a 6ft. length of 4in. cast-iron pipe driven vertically into the soil.

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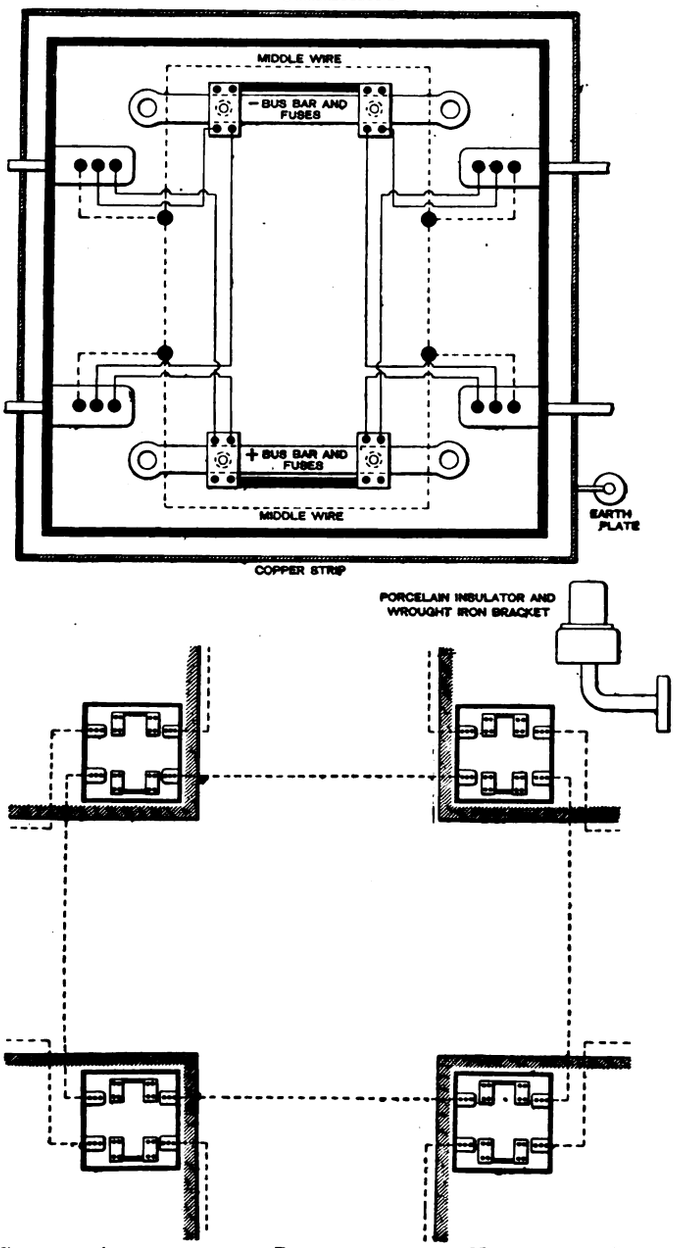
Services to consumers' installations are all put in with steel tape or lock coil armoured concentric cables, the branch joint boxes being designed with a view to facilitate the making of the joints when the cable is alive, where this is absolutely necessary. Care is taken to connect mechanically the lead covering of lead-sheathed cables across the joint box by means of the method of bonding above described, the boxes being designed with socket ends for this purpose. The service main terminates in a Corporation fuse box of two fuses, if for a concentric, or four fuses if for a triple concentric service, the four fuses being with a view to splitting a consumer's installation into two distinct circuits to meet the Board of Trade

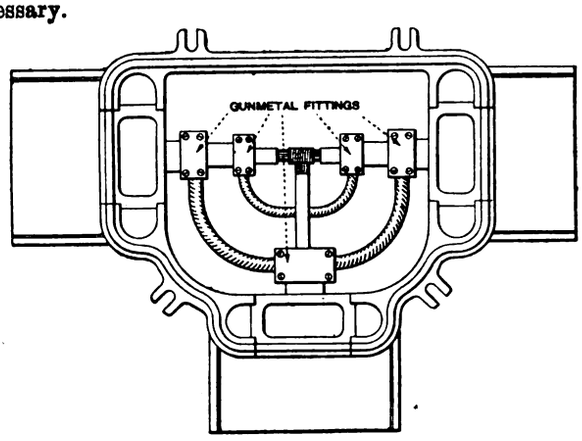
Details of General Arrangement for Distributor Manhole Connections.



General Arrangement of Distribution from Manholes at Street Corners.

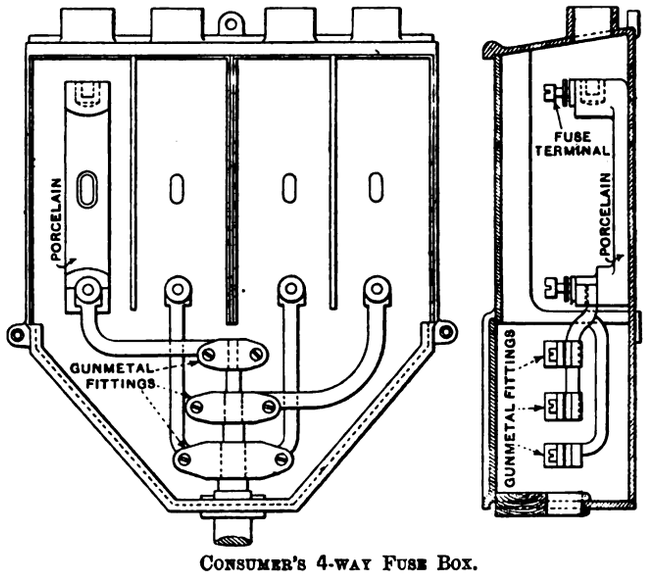
requirements where large installations are concerned. In both cases the fuses are enclosed in a cast-iron box of special design, the concentric having one and the triple concentric two lids.

One of our illustrations shows the general arrangement of the box. The porcelains are designed so that the gunmetal fittings slip into sockets at either end when sweated to the cables, each porcelain being secured in position by means of sulphur cement poured into a recess in its centre, which grips a snug forming part of the cast-iron box. The box is also cast with a fillet between porcelains holding terminals of opposite polarity, this fillet being lined with mica. The lid or lids are attached to the box by snugs, one snug for each lid being arranged to receive a lead seal, which, when in position, secures the lid. Glass fronts are fixed in the lid opposite and for the full length of each fuse, the lids being bevelled on the inside round the glass in such a manner as to ventilate the box without allowing of the fuses being tampered with. On the tops of the boxes are sockets through which the house mains pass to the fuses, the sockets being plugged with wood and sealed with compound, where wood casing is used, or provided with nipples, to which pipes may be screwed if necessary.



Plan of Cast-iron Branch Box.

The department is at present busily employed changing-over consumers from the low-pressure supply from the original stations at Waterloo-street and Kelvinside to the supply from the new stations. The last of the Kelvinside section of mains was changed over on August 3, 1900. In arranging for the change-over, the outlying districts have been attacked first, with a view to enclosing the old area and hemming it in gradually towards the old generating station at Waterloo-street. Owing, however, to the large number of new blocks of offices in the centre of the city, all of which are entirely dependent upon electricity for lighting and motive power (the motive power being at 500 volts) it has been necessary to deal with certain portions of the centre of the city without delay.



Consumer's 4-way Fuse Box.

The system is worked with the middle wire earthed through a batch of twelve 100 c.p. 250-volt incandescent lamps in series with an "earth" recording ammeter. The outer conductors of the triple concentric feeders are tested for insulation to earth once a week, and a daily test of the general insulation of the whole network is made without interrupting the supply, by noting the current passed by a few cells through the middle wire with one pole of the battery connected to the middle wire and the other to earth. By this means any defect in the insulation of the outer conductor in the triple-concentric cables is noted, and in several cases faults,

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due to pick holes, &c., have been localised before any serious results have come to the cables.

Owing to the south side generating station not yet being ready to start supply, a portion of the south side area has been supplied from the Port Dundas station through a feeder and trunk mains of 1 sq. in. section laid across Glasgow Bridge, and arrangements have been made by which the two stations can be paralleled when required through several 1 sq. in. trunk mains which cross the bridge, and from connecting links between feeding points on either side of the river. The whole of the south side distributors will be working from the Pollokshaws-road station by October of this year.

There are at present 265 public arc lamps in use and an extension consisting of another 450 lamps is in progress. The lamps are 32-hour lamps, connected in series of 10 to the outers of the 500-volt distributors. The lamps are either suspended from lamp columns erected on the sides of the streets, or from the posts carrying the overhead wires for the electric tramway system. In the bases of the columns or tramway posts, each lamp is provided with a substitutional resistance switch, and the resistances for these and in connection with the automatic cut-out on the lamps, are also mounted in the bases.

The lead between the fifth and sixth lamp in a series of 10 is taken through one of the distributor disconnecting manholes, and arranged so that by putting in a fuse between the lamp lead and the middle wire distributor, half of the lamps on the circuit may be run independently of the other, so that, in the case of a breakdown on a section of the network or arc lead, no more than five lamps need be out at a time.

All fittings for the manholes and jointings are manufactured in the Corporation workshop at 81, John-street, City, plant being put down for that purpose in the engine and boiler-house of what was the original generating station when the Corporation first started an electricity supply for public lighting. The mains department is controlled from the electricity department head offices, and the city is divided into four sections, each section being in charge of a district superintendent who has an office and stores in his particular district in telephonic communication with the head office.

We cannot conclude this account without a few words as to the *personnel* of the electricity department who have so successfully carried out this huge work. As convener of the Electricity committee, Bailie Maclay has been most energetic, and his name will be well known to our readers through the papers that he has from time to time read, dealing with the commercial aspects of electrical supply. Bailie Maclay's efforts have been well seconded by Bailie Willock, upon whom, as the convener of the Works committee, a very large proportion of the work came. As to Mr. Chamen, himself, our description of the new works describes also the efficient way in which he has executed his task. Mr. Wm. Lackie, Mr. Chamen's chief assistant, has been with the Glasgow Corporation ever since they have had an electrical department, and in fact we believe we are correct in stating that he was one of the assets taken over from Messrs. Muir, Mavor and Coulson. Owing, therefore, to his intimate knowledge of the town and its electrical undertaking, Mr. Chamen has found him invaluable in relieving him of a large amount of work. Mr. Ward, the mains superintendent, who came to Glasgow from St. Pancras, had not only to carry out the large amount of cable work described above, but to organise the department, teach the men, design all the fittings, not to mention the trouble of keeping the original rubber-covered and bare copper conductors in a workable state till they were able to be gradually replaced. As resident engineer at Port Dundas and, since Mr. Christie's promotion to Brighton, as station engineer, Mr. Poole has shown great energy, and now that the stations are opened and therefore presumably near completion, he hopes to get his staff into smooth working order under the resident engineers, Mr. Page at Port Dundas, and Mr. Thomson at Pollokshaws-road. We must not forget either Mr. McEwan, whose enthusiasm in carrying out Mr. Chamen's ideas in the design of the various switch gear was most keen. Mr. Calderwood, the chief draughtsman, has given Mr. Chamen much assistance in working out the details and superintending the installation of the new plant. We wish to express our thanks to all these gentlemen, who, in their various departments, have rendered us great assistance in compiling this article.

THE OSMOTIC PRESSURE THEORY OF PRIMARY CELLS.*

BY W. R. COOPER, B.SC.

Osmotic Pressure.—The nature of osmotic pressure will be most readily understood by referring to the following simple experiment. In Fig. 1 the vessel A is the head of an inverted thistle funnel, the stem being broken off. Across the top is stretched a piece of bladder which is tied round the funnel. In order to make a water-tight joint, the bladder should first be made wet with hot water, so as to obtain an even surface, after which it is slightly dried. The funnel is made hot, and some Chatterton insulating compound is quickly applied all round the edge. While the Chatterton is still hot, the funnel is placed top downwards upon the bladder, which is then tied round the edge. If properly carried out, a perfectly water-tight joint will result. When the vessel so formed is complete, it is filled nearly to the top of the neck with a strong solution of sugar, and joined by a good-fitting piece of rubber tubing, B, to a fine capillary glass tube, C. By slowly pushing the latter down into the vessel A the level of the sugar solution in the capillary tube may be adjusted to any desired height. The vessel A is now immersed in a beaker of water, D. For the first hour or two very little may happen. Possibly the level in the capillary tube will even fall. But at the end of a day, a very decided rise will be observed, due to what is termed the osmotic pressure of the sugar. As soon as the diaphragm assumes a steady state the rise is rapid. With a tube of about ½mm. bore and a funnel 1¼in. diameter the author has observed a rise of 11 cm. in 20 minutes.

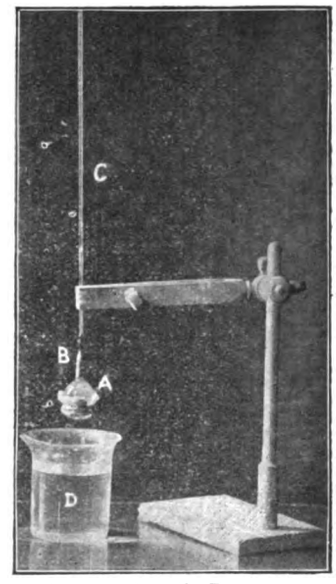

FIG. 1.—Osmotic Pressure.

This pressure is generally explained by saying that the sugar molecules are striving to pass through the membrane into the water. The membrane acts like a molecular filter, being impermeable to the sugar molecules, but permeable to the water molecules; and so the water passes inwards, but there is little or no exit of sugar if the membrane is suitable. Various membranes are employed in experiments of this kind, artificial ones being the most effective.

The pressure so observed, which may amount to several atmospheres, is generally regarded as the pressure exerted by the sugar molecules. On observing the osmotic pressures of various solutions, it is found that equi-molecular solutions exert equal osmotic pressures, irrespective of the solvent, thus showing that the pressure depends upon the number of the molecules in solution per unit volume. This result is similar to the law of Avogadro for gases, which states that equal volumes of gases measured under the same temperature and pressure contain the same number of molecules.

As the result of a number of experiments, Pfeffer found that the osmotic pressure of a solution is proportional to the concentration and to the absolute temperature. Now the concen-

* From a book on "Primary Batteries," shortly to be published by *The Electrician* Printing and Publishing Co. All rights reserved.

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tration of a solution is the reciprocal of its volume. We may therefore write this result in the form

$$P = R' \frac{1}{V} T,$$

or

$$PV = R'T,$$

in which P is the osmotic pressure, V the volume, R' a constant, and T the absolute temperature.

Van't Hoff was the first to point out the striking analogy between this result and the laws of Boyle and Charles, which are embodied in the well-known equation referring to gases, viz. :—

$$pv = RT,$$

in which the letters have similar significations to those in the previous equation, the only difference being that in the former we are dealing with a volume of solution, whereas in the latter a volume of gas is in question. Upon investigating the results of Pfeffer, van't Hoff found that the values of the constants R and R' in the two equations were practically the same, whence he came to the following remarkable conclusion: The osmotic pressure exerted by the molecules of a given weight of substance in solution is equal to the pressure which an equal weight of the substance would exert at the same temperature if it occupied a volume in the gaseous state equal to that of the solution.

It thus appears that a substance in solution (at least when *dilute*) acts in the same manner as a gas, and the laws of Avogadro, Boyle and Charles all apply to such solutions if the osmotic pressure be substituted for the gaseous pressure. It is therefore concluded that, in the process of dissolving, a substance breaks up to a very large extent into separate molecules. When the solution is sufficiently dilute all the molecules assume a separate existence, and the osmotic pressure then becomes a measure of the number of molecules present. Such, briefly, is van't Hoff's theory of solutions.

Electrolytic Solution Pressure.—When evaporation takes place from a liquid in a closed vessel, it continues until the pressure of the vapour so formed reaches a certain value, depending upon the temperature and upon the liquid. After this maximum value of the vapour pressure is reached, the condensation which then takes place is equal to the evaporation; although molecules may still be regarded as escaping from the liquid mass into the gaseous, an equal number are passing back from the vapour into the liquid, and so a state of equilibrium is established in which the vapour pressure is equal to and opposes the tendency of the liquid to pass into vapour. In the same way the osmotic pressure of a saturated solution which is in contact with some of the undissolved solid substance may be looked upon as a measure of the "solution pressure" of the substance, or of its tendency to pass into solution.

In order to account for the E.M.F., or the difference of potential, between a metal and any electrolyte in which it is immersed, Nernst introduced the idea of "electrolytic solution pressure" of the metals. This is analogous to vapour pressure, and indicates or measures the tendency of a metal to pass into free ions when placed in an electrolyte. These free ions are positively charged, and therefore also the electrolyte containing them. Since both kinds of electricity result simultaneously, the metal must be negatively electrified, and will attract the positive ions to it. What is called a "double layer" of electricities results at the surface of separation between the metal and electrolyte. As soon as the attraction of the metal for the positive ions is equal to the solution pressure, equilibrium is established, and no more ions pass into solution. If they did so, the electrostatic attraction would become greater than the solution pressure, and the reverse process would set in—viz., ions would pass back into the molecular state. Very few ions suffice to bring about this equilibrium, because the ionic charges are large.

In the case of a liquid containing no ions of the metal in question, the value of the E.M.F. depends only upon the solution pressure. But if ions of the metal are present, the solution pressure is opposed by the osmotic partial pressure of the cathions, and the E.M.F. is smaller. Let P be the solution pressure, and p the osmotic partial pressure due to the metallic ions already present. Three cases are possible. First, $P > p$: metal ions are produced and the metal becomes negatively electrified; but since the osmotic pressure opposes the solution pressure, the number of ions, and therefore also the E.M.F. so produced, is smaller than it would be if no ions were initially present. Secondly, $P = p$: in this case the metal does not become charged, because no more metallic ions can be produced, and therefore no E.M.F. results. Thirdly, $P < p$: in this case cathions are precipitated, as it were, upon the metal, to which they give up their positive charges until the electrification is sufficient to repel the remaining cathions. Consequently the metal is positively electrified and the solution negatively, an E.M.F. being produced which is opposite in sign to that in the first case, where P is greater than p.

Let us now calculate the value of this E.M.F. The ions at the surface of the metal where the "double layer" is formed may be looked upon as being under a pressure equal to the solution pressure, whereas any ions in solution are under a pressure equal to the osmotic partial pressure of those ions. If a current flows, due to the E.M.F., the ions pass from the pressure P to that of p, and in this change of pressure a certain amount of work must be done by the ions. Suppose gas under a pressure p to be confined in a cylinder, as indicated in Fig. 2, by a piston of area A. Then the total pressure outward upon the piston is pA. If the piston is allowed to move a very short distance, dx, outwards, so short that the pressure remains practically constant, the work done by the gas in so moving the piston is $pA dx$. But $A dx$ is the variation in volume, or dv, caused by the motion; and so the work done is equal to the pressure multiplied by the change in volume. The total work done in varying from a volume v_1 to v_2 is given by the sum of such quantities, or by the integral

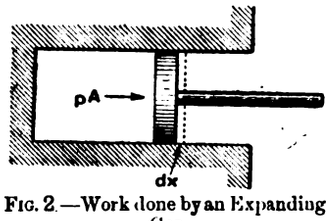

FIG. 2.—Work done by an Expanding Gas.

$$\int_{v_1}^{v_2} p\,dv.$$

Since we have in gases the relation $pv = RT$, the integral assumes the following value, viz. : —

$$RT \int_{v_1}^{v_2} \frac{dv}{v}$$

$$= RT \log \frac{v_2}{v_1} = RT \log \frac{p_1}{p_2},$$

where p_1, p_2 are the pressures corresponding with v_1, v_2. In this expression the value of the constant R depends upon the basis on which we start: it is equal to the product of a volume into a pressure divided by the absolute temperature of the gas. If a given volume of gas be taken at a given temperature, the pressure is not defined by these two quantities, because it still depends upon the mass of gas with which we are dealing. By forcing more gas into the given volume the pressure would be changed, and the apparent value of the constant would also change. It is therefore necessary to deal with a definite mass. In our case the most convenient unit of mass is the gramme molecule. It will be remembered that a gramme molecule in the gaseous state occupies a volume of 22·38 litres at the normal pressure of 760 millimetres of mercury and at the normal absolute temperature of 273deg. All our quantities are then defined, and the value of R, expressed as heat, is found on this basis to be 2 gramme-calories. With this value for R, the expressions given above represent the work done when a gramme molecule of a gas changes from the volume v_1 to v_2, or from the pressure p_1 to p_2.

We may now continue the calculation of the E.M.F. When a current flows from the metal to the solution, metallic ions pass from under a solution pressure P to the osmotic partial pressure p. If the electrolyte is a dilute salt-solution of the metal, supposed to be *monovalent*, it may be looked upon as completely ionised into equal numbers of two ions, and the value of p will then be equal to half the osmotic pressure—*i.e.*, to the whole osmotic pressure which would result if no ionisation were to take place. Since the solute in a dilute solution obeys the gaseous laws, we may apply the

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results which we have just obtained for a gas. It thus appears that when a gramme equivalent of a metal passes voltaically into solution, giving a gramme molecule of the salt, work is done to the extent of $RT \log \frac{P}{p}$. But if E is the E.M.F. at the metal-liquid junction, and the work is wholly converted into electrical energy, this work is also equal to 96,500 E, because 96,500 coulombs of electricity are required to decompose one gramme molecule. Thus we have the relation

$$96{,}500E = RT \log \frac{P}{p}.$$

The left hand side of this equation is expressed as work, and therefore R must also be expressed in that way. As already stated, it is equal to 2 gramme-calories, and thus to $2 \times 42 \times 10^6$ C.G.S. units of work. Remembering that a coulomb is $\frac{1}{10}$ of the C.G.S. unit, and that a volt is 10^8 C.G.S. units, we have for the value of the E.M.F. in volts

$$E = \frac{2 \times 42 \times 10^6}{96{,}500 \times 10^{-1} \times 10^8} T \log \frac{P}{p}$$
$$= 0{\cdot}000087 T \log \frac{P}{p}$$
$$= 0{\cdot}0002 T \log_{10} \frac{P}{p},$$

the last value being obtained by converting the logarithms to the ordinary base of 10. If the temperature is 15°C., then T = 288, and

$$E = 0{\cdot}0575 \log_{10} \frac{P}{p} \qquad \text{at } 15°C.$$

If the metal is not univalent, we have the more general formula

$$E = \frac{0\,0575}{n} \log_{10} \frac{P}{p},$$

in which n is the valency.

Now consider the E.M.F. of a reversible cell, such as a Daniell. Here we have four contacts. The metal/metal and liquid/liquid contacts only give rise to small E.M.F.s which may in the first instance be neglected. At each of the metal/liquid junctions, however, we have metallic ions seeking to pass into solution; but this can only take place at one plate, deposition being necessary at the other. Consequently the E.M.F. takes the form

$$E = 0{\cdot}0002 T \left(\frac{1}{n} \log_{10} \frac{P}{p} - \frac{1}{n'} \log_{10} \frac{P'}{p'} \right),$$

in which the two component E.M.F.s oppose each other. The sign of either term in itself depends, of course, upon the solution pressure being greater or less than the osmotic pressure. In this expression the forces are supposed to be in equilibrium. It is the E.M.F. on open circuit, in which state the solution pressure diminished by the osmotic pressure of the metallic ions is equal to the electrostatic attraction of the double layer. But when the negative charge on the zinc is removed by closing the circuit, this equilibrium ceases. The positive charge of the double layer is then no longer bound, and consequently the solution pressure gives rise to more free ions; the zinc passes voltaically into solution and a continuous current is generated.

This theory of E.M.F. has been indirectly confirmed in many ways. For example, if the valencies n and n' are the same, and if the concentration of the ions is the same for both solutions, or $p = p'$, the formula simplifies to

$$E = 0{\cdot}0002 T \log_{10} \frac{P}{P'}.$$

In such a case the E.M.F. depends only upon the solution pressures, and, if the salts are assumed to be completely ionised, it does not change when the concentration of both solutions varies in the same way. That is to say, if the E.M.F. of a Daniell cell is 1·07 volts for given concentrations, it will remain at this value if the concentrations of the zinc sulphate and copper sulphate solutions are increased or decreased by the same amount. This result is easy to understand. An increase, for instance, in the concentration diminishes the E.M.F. at both plates; but, as these E.M.F.s oppose one another, the resultant E.M.F. remains constant. This is found to be approximately the case.

(To be concluded.)

ELECTRICITY WORKS ACCOUNTS.

Bury Municipal Electric Supply Works.

The management of the Bury undertaking is to be congratulated on having brought it to a self-sustaining stage in the third year of working.

Our analysis shows the satisfactory result for the year 1899-1900 of a net profit of £183 after satisfying capital charges to the extent of 4·9 per cent. of the mean capital expended, and with the moderate total revenue from all sources of but 4·1d. per unit.

While the items of fuel and oil, waste, water, and stores have risen slightly, the remaining two items of generating costs have diminished, and all stand at figures below the average at the same output and load factor.

Owing to increases in the public lighting and distribution items the works costs show a slight upward tendency to be again more than neutralised by the drop in the management and property charges, which now show a normal figure.

The total costs, as well as the collective generating costs, are quite 0·5d. below what they might reasonably have been expected to stand at.

As for the progress made by the concern during the year, the lamp connections have increased by 43·4 per cent., and the output from 115,853 units sold to 213,395, or by 84 per cent. A most satisfactory change for the better has taken place in the load-factor, which in 1898-9 was but 9·19 per cent. Last year it worked out at 12·37 per cent. This improvement was partly due to increased street arc lighting. The private lighting load-factor was 11 per cent.

Extensions of plant have taken place by the instalment of a 30ft. by 7ft. Lancashire boiler and a 250kw. Belliss and Morcom vertical tandem compound condensing engine, combined with a Siemens two-pole dynamo for 500 amperes at 440 volts to 500 volts. This set is provided with a heavy fly-wheel for supplying energy for traction purposes, if necessary. Owing to the change to the higher pressure, the battery cells have been increased in number from 130 to 260. A balancer and booster set has also been installed. The balancing machines are capable of transferring 200 amperes at 220 volts to 250 volts from one side to the other of the three wire syetem, The two boosters are mounted on an extension of the main shaft of the balancer, and are each capable of an output of 100 amperes at 100 volts being used to give the extra pressure for charging the cells.

Pontypool Electric Light and Power Co. (Ltd.).

This little undertaking is interesting because of the disadvantageous conditions of low output and load-factor under which it is carrred out. It is seldom that we have to deal with the accounts of a concern with an output of only 58,201 units sold, in combination with a load-factor of 6·71 per cent.—a business at the same time mature in having completed its sixth year of working.

Judging the results of the year by themselves, they are in many respects excellent. Both the fuel and repairs items are considerably below what they might have been expected to be. The management and property charges are also very low considering the conditions; but, on the other hand, the oil, waste, water and stores, and the wages items are relatively heavy. The resulting works—and total—costs are most commendable, and might well have been associated with an output five times that at Pontypool.

It is a pity that the business makes such slow progress. Last year the increase in the lamp connections was only 8·17 per cent. and in the output but 13 per cent.

The load-factor at 6·71 per cent. certainly shows a slight improvement over the corresponding figure of 6·47 per cent. in 1898, but it is still abnormally low.

We are glad to note that the company have contracted to maintain six arc lamps for the District Council. This will probably help to improve the character of the load.

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	BURY.	PONTYPOOL.
Undertaking Worked by	Bury Corporation.	The Pontypool Electric Light and Power Co.
Date of Commencement of Supply	November, 1896.	August, 1893. [batteries.
System of Supply	3-wire continuous-current.	Low-pressure con. cur. 2-wire system with
Chief Engineer	S. J. Watson.	P. J. S. Tiddeman.

YEAR ENDED	MAR. 31, **1899.**	MAR. 31, **1900.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	125,922	228,546	56,400	65,850
„ SOLD (TOTAL)	115,853	213,395	51,510	58,201
„ sold to consumers	106,968	167,890	51,510	57,809
„ sold for public lighting, &c.	8,885	45,505	nil	392
„ used on works	3,872	6,939	1,927	2,878
UNITS SOLD PER 8 C.P. LAMP CAPACITY	12·2	12·3	10·2	12 3
Maximum supply demanded	144 kilowatts	197 kilowatts	91 kilowatts	99 kilowatts
Number of public lamps	18 arc	31 arc	nil	2 arc
Number of consumers	144	198	87	—
Connections to mains in 8-c.p. lamps	10,275	14,733	5,194	5,618
CAPACITY OF PLANT IN 8-C.P. LAMPS	9,500	17,300	5,032	4.720
CAPACITY OF PLANT IN KILOWATTS	304	554	161	151
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£30,000 / £98·7	£50,000 / £90·3	— / —	— / —
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	30,000 / 98·7	50,000 / 90·3	— / —	— / —
RECEIVED (TOTAL)	29,245 / 96·2	34,395 / 62·1	£10.241 / £63·6	£10.241 / £67·8
Share	— / —	— / —	5,241 / 32·5	5,241 / 34·7
Loan (including Debenture charges)	29,245 / 96·2	34,395 / 62·1	5,000 / 31·0	5,000 / 33·2
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	755 / 2·48	15,605 / 28·2	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	755 / 2·48	15,605 / 28·2	— / —	— / —
REPAID (TOTAL)	326 / 1·07	1,426 / 2·57	— / —	— / —
RESERVE OR SINKING FUND	1,085 / 3·57	829 / 1·50	254 / 1·58	454[e] / 3·01
DEPRECIATION FUND	— / —	— / —	391 / 2·43	432 / 2·86
EXPENDED (TOTAL)	33,079 / 109	40,715 / 73·5	10,408 / 64 6	11.205 / 74·2
Lands and buildings	8,094 / 26·6	9,008 / 16·3	1,171 / 7·27	1,385 / 9·17
Plant	11,670[a] / 38·4	15,915 / 28·7	6,452 / 40·0	6,506 / 43·1
Mains	12,839 / 42·4	15,203 / 27·4	1,050 / 6·52	1,407 / 9·32
Miscellaneous	425 / 1·40	589 / 1·06	1,735 / 10·8	1,906 / 12·6
BALANCE OF CAPITAL ACCOUNT	−3,831[b] / −12·6	−6,320[b] / −11·4	−167[a] / −1·04	−964[a] / −6·39
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£2,182 / 4·520d.	£3,644 / 4·099d.	£1,321 / 6·159d.	£1,492 / 6·156d.
Revenue from supply	1,971 / 4·085d.	3,033 / 3·412d.	1,288 / 6·004d.	1,445 / 5·960d.
„ meters, &c.	81 / 0·168d.	118 / 0·133d.	24 / 0·112 l.	35 / 0·144d.
„ public lighting	130 / 0·269d.	474 / 0·533d.	— / —	4 / 0·017d.
„ sale of lamps, &c.	— / —	19 / 0·021d.	— / —	— / —
„ miscellaneous sources	— / —	— / —	9 / 0·042d.	9 / 0·037d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£1,110 / 2·300d.	£1,657 / 1·864d.	£669 / 3·118d.	£716 / 2·953d.
WORKS COSTS	566 / 1·172d.	1,053 / 1·184d.	502 / 2·340d.	549 / 2·264d.
Generation of electricity	*537 / 1·112d.*	*962 / 1·082d.*	*417 / 1·944d.*	*477 / 1·968d.*
Fuel (including cartage, &c.)	225 / 0·466d.	489 / 0·550d.	120 / 0·560d.	104 / 0·429d.
Oil, waste, water, stores	39 / 0·081d.	73 / 0·082d.	25 / 0·117d.	66 / 0·274d.
Wages at station	231 / 0·479d.	339 / 0·381d.	260 / 1·212d.	277 / 1·143d.
Repairs and maintenance at station	41 / 0·085d.	61 / 0·069d.	12 / 0·056d.	30 / 0·124d.
Distribution of electricity	*7 / 0·015d.*	*28 / 0·032d.*	*85 / 0·396d.*	*72 / 0·297d.*
Wages, &c.	7 / 0·015d.	28 / 0·022d.	60 / 0·280d.	55 / 0·227d.
Repairs, renewals of mains, &c.			25 / 0·117d.	17 / 0·070 l.
Public lighting	*22 / 0·046d.*	*63 / 0·071d.*	— / —	— / —
Attendance	11 / 0·023d.	38 / 0·043d.	— / —	— / —
Renewals	11 / 0·023d.	25 / 0·028d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	544 / 1·126d.	606 / 0·682d.	167 / 0 779d.	167 / 0·689d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*208 / 0·431d.*	*179 / 0·201d.*	*76 / 0·354d.*	*80 / 0·330d.*
Management	*336 / 0·696d.*	*427 / 0·480d.*	*91 / 0·424d.*	*87 / 0·359d.*
Salaries	279 / 0·578d.	353 / 0·397d.	40[b] / 0·187d.	40[b] / 0·165d.
Stationery, &c.	23 / 0·048d.	22 / 0·025d.	9 / 0·042d.	7 / 0·029d.
Establishment charges			16 / 0·075 l.	8 / 0·033d.
Law charges, &c.	34 / 0·071d.	52 / 0·059d.	26[c] / 0·121d.	32[f] / 0·132d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£1,072 / 3·66%	£1,987 / 5·39%	£652 / 7·17%	£776 / 7·18%
Sum carried to Depreciation Fund	— / —	— / —	100 / 1·10%	100 / 0·925%
Sum carried to Reserve or Sinking Fund	631 / 2·15%	808 / 2·19%	200[g] / 2·20%	200[g] / 1·85%
Net interest on loans (incl. Debenture charges)	776 / 2·65%	996 / 2·70%	103 / 1·13%	214 / 1·98%
BALANCE FROM LAST ACCOUNT	— / —	— / —	27 / 0·297%	13 / 0·12%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	183 / 0·496%	276 / 3·03%	275 / 2·55%
Deficit	*336[c] / 1·15%*	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	5% / —	5% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	50·9%	45·5%	50·6%	48%
Expenditure per kilowatt capacity	£3. 13s. 0 l.	£2. 19s. 10d.	£4. 3s. 0d.	£4. 14s. 10d.
REVENUE PER KILOWATT CAPACITY	£7. 3s. 8d.	£6. 11s. 7d.	£8. 4s. 1d.	£9. 17s. 7d.
Expenditure per 8-c.p. lamp capacity	2s. 4d.	1s. 11d.	2s. 8d.	3s. 0½d.
REVENUE PER 8-C.P. LAMP CAPACITY	4s. 7½d.	4s. 2½d.	5s. 3d.	6s. 4d.
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 3d.	4s. 11½d.	5s. 1d.	5s. 3¾d.
Price charged for lighting, per unit	6d. to 3d.[d]	6d. to 3d.[d]	6d.	6d.
Price charged for power, per unit	2½d. [ann.	3d. to 1d.[d] [per ann.	3d.	3d.
Price charged for public lighting	£17. 10s. per lamp per	£17. 10s. & £15 per arc	—	3d. per unit[d]

BURY.—REMARKS—*a* Includes £776 on public lamps and £1,280 on accumulators. *b* Over-expended. *c* Met by general rate. *d* By maximum demand system, 1-hour scale

PONTYPOOL.—REMARKS—*a* Over-expended. *b* Secretary's salary. *c* Includes £7 to auditing and £19 to insurance. *d* *Plus* an extra charge for hire of posts and lamps and for trimming, making a total of £15 per lamp per annum, or rather less than 4d. per unit consumed. *e* Includes £304 at credit of reserve fund, and £150 at credit of debenture redemption account. *f* Includes £8 to auditing and £24 to insurance. *g* £60 being carried to reserve and £150 to debenture redemption account.

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

All Editorial letters to be addressed to The Editor.

All letters for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

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THE MEASUREMENT OF LIGHT.

While in many fundamental physical measurements, notably those of weight, time, length, and electrical resistance, accuracy has been carried so far as to eliminate all errors exceeding one part in a million, the measurement of the intensity of light has as yet barely attained an accuracy of 99 per cent. This is due not only to the difficulty of obtaining a luminous surface of never-changing brightness, but also to the difficulty which the human eye experiences in judging whether two surfaces placed side by side have the same brightness. As long as photometry is hampered by the necessity of thus comparing two surfaces—and that is the only practical method hitherto devised—it is useless to expect a sensitiveness exceeding that of the human eye, the sole adjudicator. And there is hardly a human eye which could distinguish between a surface of brightness, say 150, and of brightness, 151. Much has been done of late, however, to aid the eye in making fine distinctions. The two surfaces to be compared have been brought into absolute contact by Lummer and Brodhun's compound prism, and unnecessary fatigue of the eye has been obviated by Mathews's recording device, which enables the observer to take his readings in the dark. But the provision of a standard of light has hardly kept pace with these improvements. In the measurement of light no standard is ready to hand, as is a certain lump of platinum in weighing, or the motion of the heavenly bodies in measurements of time. In measuring temperatures, imperfect though our methods are as yet, we have a number of fixed fusing points and boiling points always available. But stationed as we are on the earth's surface, no natural light is constant enough for comparison, and we have therefore to look out for some constant and reproducible artificial light. This, unless we adopt Henry's zinc sulphide phosphorescent screen, means high temperatures, and, since we usually require white light, it means very high temperatures. Such temperatures can as yet only be generated by flames and by electric incandescence, and we must find the method which furnishes the most trustworthy standard

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for general reproduction. M. VIOLLE's report to the Paris Electrical Congress, of which we give a full abstract in this number, forms a valuable criticism of standards and instruments so far proposed and adopted. Two things are practically required. One of them is a first-class scientific standard of light capable of being reproduced with an accuracy of one in a million. The other is an instrument capable of comparing two luminous intensities with the same accuracy. When we have those two things, a solid basis will have been laid for a sound system of photometry. After that, it will be the business of instrument makers to bring an accuracy of at least one in a thousand within the reach of every lamp manufacturer and central station engineer. How far we are still behind this demand may be seen from every line of M. VIOLLE's report. The utmost constancy attained by any of the usual standards, Hefner—Carcel, or pentane lamp—leaves errors of 1 per cent., and the utmost accuracy claimed for LUMMER and BRODHUN's prism photometer is 0·5 per cent. PETAVEL's researches hold out a hope that the most truly scientific standard yet devised, the Violle standard of fusing platinum, may be made practically available. It may also be found possible to press the incandescent lamp further into service, or to devise a flame which will always have the same shape and constitution, and be unaffected by moisture or gaseous impurities. But such progress must be accompanied by new methods of photometry. If, for instance, a selenium or other cell were discovered whose resistance was affected by light, and by light only, to precisely the same extent as is the human eye, then the high level attained in the measurement of resistance would be immediately at our command for the measurement of light. Instead of comparing the luminosities of two patches, we should, as in all accurate measurements, control the coincidence of two lines, usually a scale division and a pointer. But until that is done we must be content with the rough-and-ready methods now available, the least troublesome being perhaps the standard incandescent lamp used with an oil lamp *à la* ROWLAND, and, if possible, with a LUMMER-BRODHUN prism.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Traité de Magnétisme Terrestre. By Prof. E. MASCART. (Paris: Gauthier-Villars, 1900.) 15fr.

The author explains in his preface that this work took its origin in lectures delivered to French naval officers in 1882. These lectures he subsequently supplemented at the Collège de France and the École Supérieure de Marine. He states that his first object was to put magnetic observers in a position to understand the phenomena they have to deal with, and to use their instruments. After accomplishing this part of his programme, he found it impossible, in the limits of a single volume, to deal in detail with other than the more fundamental ideas and firmly established facts of terrestrial magnetism. This explains the relatively large amount of space devoted to preliminary matter.

Chapters I., II. and III., pp. 1-50, develop the elementary theory of bar magnets and uniformly magnetised spheres and ellipsoids; whilst Chapter IV., pp. 51-74, deals with electric currents and coils. The methods are similar to those adopted in Mascart and Joubert's treatise. Chapter V., pp. 75-133, treats of properties of magnets of which a knowledge is required in reducing magnetic observations. Chapters VI. and VII., pp. 134-188, describe a variety of instruments employed in *absolute* observations, and the procedure followed in their use. Chapter VIII., pp. 189-205, and Chapter IX., pp. 206-219, are respectively devoted to *variation* instruments and to absolute instruments suitable for travellers. Chapter X., pp. 220-304, discusses the treatment of observational results and the application of Fourier's series. Then, after a brief historical *résumé* it deals with secular variation, solar diurnal and lunar diurnal variations, disturbances, the interrelationships of magnetic and sun-spot phenomena and some minor problems. Chapter XI., pp. 305-342, treats of magnetic charts, surveys, disturbed areas, and the general theory of a magnetic potential. Chapter XII., pp. 343-376, discusses the potential more fully, explains the Gaussian analysis, and discusses the subject of earth-air electric currents. It contains a long mathematical calculation of the action of the sun regarded as a rotating magnet. It also explains Schuster's calculation of a diurnal variation potential and gives an account of Wilde's "Magnetarium." Chapter XIII., pp. 377-401, deals in a summary fashion with atmospheric electricity, aurora, earth currents, disturbance from industrial currents, and earth tremors. Chapter XIV., pp. 402-436, is devoted to ships' magnetism. A table of contents completes the book.

An experimental matter treated with unusual fullness in Chapter V. is the *temporary* induction in bar magnets. The author holds (Arts. 27, 46) that in a bar magnet vibrating in the earth's field the transverse magnetisation is likely to be appreciable unless the length equals 20 or 30 diameters; also that the temporary magnetisation is greater when the earth's field opposes than when it reinforces the permanent moment. The latter conclusion seems based on Lamont's experiments, but it is opposed to more recent experiments in Germany by Kohlrausch and others. A second important subject dealt with in Chapter V. is the action between two magnets. Each is supposed replaceable by a pair of poles. When the magnets are in the position usually adopted in the deflection part of a horizontal force experiment the couple between them is $2MM'R^{-3}(1+pR^{-2}+qR^{-4}+\ldots)$, where M and M' are the moments of the magnets, R the distance between their centres, and p, q constants. As it is customary to neglect qR^{-4}, it is desirable that q should be small. According to Lamont's analysis, which the author adopts, q vanishes when the polar distance of the deflecting magnet is longer than that of the deflected in the ratio 2·15:1. This result is given correctly (p. 115), but still the most desirable ratio of the lengths is said to be 2:1. Whether the statement is intended for an approximation, or is due to a confusion between Lamont's two fundamental positions, is, perhaps, rather an academic question, in view of the author's statement (p. 84) that he has observed the polar distance of a magnet decrease from 0·88 to 0 69 of its length as its magnetisation was diminished. Another point of interest is the best ratio between the two distances at which deflection observations are taken. A mathematical investigation on p. 118 makes the ratio 1·29:1, while Maxwell, following Airy, makes it 1·3189:1. The discrepancy arises, apparently, from the different ways of interpreting the physical problem mathematically.

Amongst the instruments described in Chaps. VI. to IX. are representatives of the old style with large magnets, Kew-pattern instruments, and modern French instruments, including an earth inductor. The descriptions, combined with the excellent illustrations, should suffice for the ordinary reader, but observers such as naval officers might possibly profit more from a minuter study of the particular instruments they have to use (*c.f.* Stewart and Gee's "Practical Physics," Vol. II., Chap. VI.). With reference to Fig. 49 and the accompanying remarks on the Kew-pattern magnetograph, it may be explained that eye-reading telescopes are not an essential part, being, in fact, non-existent in the Kew magnetic chamber itself. The arrangements there differ in some other details from Fig. 49, and the curves—especially those of vertical force—are less easily standardised than the remarks on p. 202 would suggest. In the Mascart magnetograph a single sheet of paper suffices for the declination, horizontal force, and vertical force traces, and only one lamp is used. The author regards the three lights and three sheets which he supposes daily used at Kew as "*Une dépense . . . qu'il est utile de réduire*"; and he takes a somewhat similar view on p. 199 of Wild's arrangements for securing uniform temperature at Pawlowsk. As a matter of fact, two days' traces are taken on

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each sheet with the Kew magnetograph, and most of the recently-built magnetic chambers—*e.g.*, those at Potsdam, Washington, and Utrecht—are evidence that Wild's views are those generally held. The elimination of the annual temperature variation has at least many points in its favour, and a description of a thoroughly up-to-date magnetic chamber would have been useful.

Chapter X. is practically the first dealing with observational results. Its discussion of secular variation is somewhat slight, but is supplemented to some extent in later chapters. More space is devoted to diurnal variation (solar and lunar) and to the periodic phenomena of disturbances. Numerical data are taken from a variety of sources, notably the recent valuable analyses of Parc St. Maur (Paris) results by Moureaux, and of Batavia results by Van der Stok and Figee, and the older British and Colonial data discussed by Sabine, which figure so prominently in Walker's "Terrestrial and Cosmical Magnetism" and Balfour Stewart's article in the "Encyclopædia Britannica."

In his tables and curves of diurnal variation the author sometimes takes westerly declination as positive, and sometimes easterly, following apparently the practice of the original publication. An explicit statement as to which direction is positive seems sometimes wanting, and even a careful reader will occasionally experience a doubt.

The solar diurnal variation is illustrated by curves of three types. The first has times for abscissæ and magnetic variations for ordinates. The second type is a plane orthogonal projection of the spherical curve traced by one end of a magnet free to turn about its centre; its first use is ascribed to Sabine. The third type, due to Airy, is a polar curve, whose radius vector represents the horizontal component of the force to which the variation may be ascribed. On pp. 260, 261, and 262 are reproductions of vectorial curves by Airy, showing the mean diurnal variation at Greenwich for each of the years 1848 to 1857, with corresponding curves for Parc St. Maur for each of the years 1883 to 1897, and curves showing the mean diurnal variation at Parc St. Maur for each separate month of the year. The author points out that the mean annual Paris curves are all similar in type (though variable of course in area), whilst the Greenwich curves vary conspicuously in type.

A second instance of divergence between older and more recent observations is supplied by the *annual* variation of declination. This is the variation shown by the mean monthly values after allowance is made for a uniformly progressing secular variation. The *types* of this variation at Paris for the epochs 1821-30 and 1888-97 and at Kew for the epochs 1858-62 and 1890-94 are similar; but the *amplitudes* of the earlier and later epochs are respectively 129″ and 20″ at Paris and 120″ and 74″ at Kew.* We share the author's opinion that the question merits a critical examination.

Chapter XI. gives copies of some of Neumayer's world charts for the epoch 1885; they are, however, on a somewhat small scale compared to the copies of the English Admiralty charts included in Vol. II. of Adams's papers. Fig. 78 is an isogonal chart of France for 1896; though also on a small scale it shows very clearly the interesting anomaly in the Paris basin discovered by Moureaux. The description of the Gaussian analysis in Chapter XII. will probably be found ample except by the exceptional individual who desires to calculate Gaussian constants for a particular epoch. A convenient table on p. 352 gives the values found for the first order Gaussian constants at various epochs, with the corresponding co-ordinates of the northern end of the magnetic axis and the values of the moment of the so-called "normal" distribution. It may be worth mentioning† that the data ascribed to Adams are not those which he obtained when he limited himself like Gauss to 24 constants, also that the longitude of the end of the magnetic axis in 1880 as calculated from Adams' data is not 63°39′, as stated, but 68°4′. Article 184 refers to Schmidt's calculations of earth-air currents. The line integral of magnetic force round a parallel of (northern) latitude from west to east equals 4π times the total earth-air current (taken positively upwards) over the included portion of the northern hemisphere. The author (p. 371) describes the positive direction of the current as "from north to south," having in view presumably the return path in the atmosphere. Whilst regarding earth-air currents as not antecedently improbable—especially during aurora—the author regards their existence as not yet *demonstrated* by the established facts of terrestrial magnetism.

The discussion of atmospheric electricity in Chapter XIII. seems to attach considerable weight to Chauveau's recent theory that the diurnal variation of potential has normally but a single maximum and minimum, and that a double oscillation occurs only at low-level stations, and even there tends to become a single oscillation in winter. It also comments favourably on the ultra-violet light theory of the origin of atmospheric electricity, in view more especially of Buisson's recent experiments on electrified ice.

In treating of industrial currents (Article 146) the author calculates the magnetic force arising from two equal, but opposite, currents along infinite parallel wires close together. The magnetic force then diminishes as the inverse square of the distance. As the author, however, remarks, the result would lead to too optimistic views if applied to trolley lines. Owing to leakage, the currents in the wire and in the rails are unequal, leaving a considerable uncompensated current whose disturbing effect on magnetic instruments diminishes only as the inverse first power of the distance, whilst the action of the leakage currents is decided largely by local peculiarities.

The treatment of ships' magnetism in Chapter XIV. is exceptionally full, and the mathematical analysis is, in general, extremely neat.

As is almost invariably the case in the first edition of a comprehensive work, there are a considerable number of errata, especially in the later chapters. These are, however, mostly printer's errors of an obvious kind, and their enumeration would unduly occupy space. The numerical tables seem carefully compiled, if one may judge from a comparison of a good many of them with original sources, and the presentation of facts seems both clear and discriminating. The authors of some recent work, especially those fond of speculation, may feel somewhat neglected, but the policy of touching very lightly on hypotheses which are likely to undergo considerable transformation before general acceptance has a good deal to be said in its favour. One aspect of the book that should recommend it in this country is its full recognition of English work both ancient and modern. Whilst we have ventured on a few criticisms we regard the book as an excellent one, likely to enhance the author's long-established reputation. He is to be congratulated on the energy that has enabled him to compile and co-ordinate so successfully the multifarious facts of "Terrestrial Magnetism," notwithstanding the claims of the important official duties which he discharges.

CHARLES CHREE.

* Some of the amplitude data on p. 267 are incorrect, owing chiefly to the printer confusing seconds and decimals of a minute.

† We also differ in the coefficient of e^2 from the result obtained in Article 126, and from the formulæ in Article 133 for ϕ'_e, g'_e, h'_e, and F'_e. The *general* conclusions remain, however, unaffected.

PHOTOMETRY.*

BY J. VIOLLE.

The International Electrical Congress of Geneva, 1896, adopted the following resolutions with regard to photometric quantities and standards of light:—

1. The international photometric standards have for their basis the luminous intensity of a point source. They are embodied in the following table:—

Quantity.	Name.	Definition.
Intensity of light	Candle	I
Luminous flux	Lumen	$\Phi = I\Omega$
Illumination	Lux = Lumen/square metre.	$E = \Phi/s$
Brightness	Candles per square metre	$e = I/s$
Lighting	Lumen-hours	$Q = \Phi T$

2. The unit of intensity is the decimal candle.

3. Provisionally, the decimal candle may, for industrial purposes, be represented by the horizontal intensity of the Hefner lamp, subject to the necessary corrections.

* Abstract of a Report presented to the International Electricity Congress at Paris.

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Incandescence Standards.

I. The international platinum standard has, notably at the Geneva Congress, been subject to criticism which appears hardly justified. Some time after the congress we enumerated the conditions which should be observed in using this standard. The platinum should be perfectly pure, and so should the lime of the crucible. In a work on the standards of light, which is of fundamental importance,* M. Petavel gives preference to the Violle standard, employed under the following conditions :—

1. The platinum must be chemically pure.
2. The crucible must be made of pure lime (prepared by calcination of the carbonate) obtained by precipitating calcium nitrate by ammonium carbonate.
3. The hydrogen burnt must not contain hydrocarbons.
4. The gases must be in the proportion of four volumes of hydrogen to three of oxygen, mixed by passing the oxygen both through an inner tube and through an annular space outside the hydrogen tube.

Under these conditions, the platinum is carried to a temperature little over the fusing point, and the luminosity of the metal is not altered by a combination with carbon.

The apparatus constructed by M. Petavel permits a single experimenter to conduct the whole operation. The expenditure of hydrogen being brought to 0·8 cubic ft. per minute, combustion is carried on for 15min. At the end of that time the two currents of gas are stopped by an electromagnetic device, and a diaphragm is placed over the platinum instead of the blow-pipe. After centreing the cover, measurements can begin. After another heating of 15min. readings are taken every 10sec., marked by a bell. The positions of the photometer index are marked, and subsequently read at leisure.

The luminous intensity falls very rapidly at first, then suddenly rises with a flash, and varies very slowly for 40sec. or 50sec., after which the fall is accelerated. M. Petavel enters the readings corresponding to the slow variation on squared paper. The points so obtained are sensibly on a straight line, and that line is produced up to the abscissa corresponding to the flash. The value thus found is called the intensity at the moment of solidification. The experimental error is about 1 per cent. at the most.

When the platinum is heated electrically, the lime crucible is rapidly deformed. It is therefore better to fuse the platinum in a nickel crucible kept cool by a current of water. The platinum remains solid where it touches the nickel, and the latter is not heated to redness at any point.

II. Messrs. Lummer and Kurlbaum propose to employ incandescent platinum at a temperature below that of fusion, and defined by the condition that nine-tenths of the energy radiated are to be absorbed by a layer of water 2cm. thick. In the apparatus used at the Reichsanstalt at Charlottenburg, the source is a sheet of platinum 25mm. broad and 0·015mm. thick, brought to incandescence by a current of about 80 amperes. The energy radiated is measured by a bolometer designed specially for this work. Though the author's method is a valuable application of physical precision to photometry, the employment of a shunted galvanometer introduces the risk of thermo-electric forces and other complications, and on account of the low temperature chosen, the light is too red for photometric purposes. Although, therefore, this modified platinum standard may serve as an intermediate standard, as for verifying the Hefner lamp, it is hardly available as an ultimate standard.

III. Another constant and very high temperature is given us in the crater of the positive arc carbon. Electricians have known for some time that the area of the crater varies nearly as the current intensity, and that the luminosity follows nearly the same law. I have shown that the brightness remains strictly constant when the power varies from 500 watts to 34,000 watts. This constancy shows that the temperature of the positive carbon is unchangeable, and confirms the old hypothesis of the volatilisation of the carbon in the arc. Messrs. Le Chatelier and Blondel have proved, on carbons of very different make, that the brightness is the same whatever their density or molecular state, so long as they are pure enough.

Utilising these results, M. Blondel has constructed an apparatus permitting the use of a known area of the crater as a source of light. Messrs. Abney, Swinburne and Silvanus Thompson had already endeavoured to base a secondary standard on the same principle, and I have made attempts in the same direction. These attempts have not yet furnished absolutely satisfactory results. One of the causes of the lack of success is the fact that when the arc hisses the most brilliant region is displaced periodically on the surface of the carbon ; and even when the arc is silent the immobility of the useful spot is not all that could be desired. M. Petavel, who also studied the positive carbon with a view towards its utilisation as a standard of light, did not succeed in obtaining perfectly concordant values for the brightness of the crater. The mean result was 147 c.p. per square millimetre, which is in fair agreement with the 158 found by Blondel. The confirmation of the essential result, viz., the constancy of the brightness of the most luminous part of the crater, justifies the hope that after all the positive carbon may furnish a practical standard. M. Petavel had already obtained more satisfactory results by arranging three negative carbons along the edges of a regular pyramid having the crater for its apex. He only abandoned this device owing to its complication, which did not allow him to observe by himself. The doubts produced by the extreme results obtained by M. Petavel are lessened by noticing with him that they are due to a difference of temperature between 3,935deg. and 4,018deg. It is reasonable to believe that further researches will narrow even this small interval.

IV. The study of incandescent lamps, apart from its practical importance, presents a great interest since their utilisation as intermediate standards in photometry. Numerous experiments have shown that these standards may be brought to a definite luminosity if the pressure at the terminals is carefully regulated. This regulation must be very precise, since the luminous intensity changes much more rapidly than the voltage (5·5 times, according to Liebenthal).

Constancy is not obtained in these standards except by using rays emitted in a direction in the neighbourhood of which the intensity does not vary much. The work of M. Liebenthal furnishes us a collection of precious documents for the study of the different forms of lamps in different directions. The author distinguishes four types of incandescent filaments : (1) The straight filament along the axis of the lamp. (2) The filament composed of two straight parts united by a curved portion which is a semi-circle, or slightly more than that (the filament may be simple or double, and the diameter of the curve larger or smaller in comparison with the total length).

3. The filament in which two rectilinear portions are joined by a curve whose projection on to the medial plane presents one, two, or three double points ; in the case of one double point the lamp may contain two similar filaments.

4. The filaments which describe round a left-handed curve semi-circular festoons whose plan is parallel to the axis of the lamp near the points of attachment, and normal to it in the middle portions.

The study of the horizontal intensity, by 40 measurements at intervals of 9deg. of circular measure, shows that reflections on the walls of the bulb, especially in type 3, may cause very considerable local anomalies. It is therefore necessary to choose a unique direction if we wish to calculate the mean horizontal intensity from a single determination. Experiment shows that, generally speaking, the intensity passes through a maximum in a direction perpendicular to the mean plane of the filament in types 2 and 3, and in the plane of symmetry in type 4.

The following coefficients enable one to find the mean horizontal intensity from that of the maximum :—

Type 2.	Straight parts close together..	0·99
„ 2.	Straight parts far apart, curved filament	0·88
„ 3.	Single loop between straight parts	0·94
„ 3.	Two or three loops	0·90
„ 4.	.....	0·73

Two measurements in mutually perpendicular directions do not as a rule give a satisfactory mean value. Three equidistant measurements might suffice, but the error may exceed 2 per cent.

An exact value of the mean horizontal intensity is always found by receiving the rays reflected by an unsilvered glass revolving about the axis of the lamp, with which it makes an angle of 45deg. This mirror might be replaced by a fixed pyramid of 10 glass plates.

The Union of German electricians has adopted as the horizontal intensity the mean of the intensities in three directions. The photometer receives the rays emanating directly from the lamp, and the rays reflected by two mirrors suitably inclined. The mean error amounts to 1·9 per cent. when the straight line joining the points of attachment of the filament is normal to the axis of the photometer.

M. Liebenthal concludes that the method recommended by the German Union for lamps without loops, or with a single loop, may be applied with sufficient approximation for practical purposes to other types, provided that the lamp to be tested and the standard lamp are of the same species and arranged as described. One may even employ the loopless lamps, which show a very constant distribution of intensity for standardising looped, filaments. Equality of intensity is not absolutely necessary ; a lamp of 10 c.p. or 25 c.p. may be compared with one of 16 c.p.

The American Institute of Electrical Engineers recommends, for determining the mean horizontal intensity, the method of turning the lamp upon its axis at the rate of two revolutions per second. That speed seems small enough to avoid the noxious effects of centrifugal force, and permits the application of the method proposed a long time ago by M. Crova.

M. Liebenthal's studies of the distribution of light outside the horizontal plane have shown him that the mean spherical intensity of the different types of incandescent lamp is equal to the mean intensity measured in a direction making an angle of 46deg. to 53deg. with the axis. This result is in good agreement with that of the committee of the American Electric Light Association. Mr. Bell, in his report, proposes to obtain the mean spherical intensity by observing the intensity of a lamp turning about an axis inclined 45deg. to the vertical.

* J. E. Petavel, *Proc.*, Roy. Soc., 65, pp. 469-503, Jan., 1900.

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Flame Standards.

The chief flame standards are: The Carcel lamp, prescribed in France for gas tests; the Vernon-Harcourt pentane lamp, employed in England in two forms, one of which now represents the English c.p.; and Von Hefner-Alteneck's amyl-acetate lamp, which is the legal standard in Germany, where it has replaced the Union paraffin candle.

The regulations for the use of the Carcel lamp continue to be applied as formulated by Dumas and Regnault. The Hefner and Vernon-Harcourt lamps have been, during these last years, the objects of important works, which we shall proceed to summarise.

I. The Hefner standard comprises a cylindrical receptacle and a wick tube of minutely regulated dimensions, together with a mechanism for regulating the height of the flame. The Reichsanstalt furnishes with every lamp a certificate of guarantee, setting forth that the dimensions are correctly observed, and giving the luminosities observed with the two wick-tubes and the two flame regulators supplied with each lamp. The height of the flame must be 60mm. A difference in the height, amounting to 1mm., produces a difference in the luminosity amounting to 3 per cent.

M. Liebenthal's researches show that the intensity of the Hefner lamp is, on the average, several per cent. greater in winter than in summer. This effect is chiefly due to water vapour. Allowing for this vapour in accordance with Liebenthal's formula, the error is reduced to 0·41 per cent. The effect of change of barometric pressure is not great, as it does not exceed 0·4 per cent. for a difference of pressure of 40mm.

If x is the number of litres of water vapour in 1 cubic metre of air, and x^1 the number of litres of CO_2, the intensity varies according to the formulæ,

$$y = 1{\cdot}049\ (1 - 0{\cdot}0053x).$$
$$y = 1{\cdot}012 - 0{\cdot}0072\ x^1.$$

The superior influence of the water vapour is due to its greater specific heat. Since a prolonged use of the lamp also reduces the proportion of oxygen to nitrogen, a further error is introduced, which may amount to 2 per cent. if 1 litre of oxygen is withdrawn from every cubic metre.

The red tint of the flame and its inferior luminosity are its great drawbacks. Moreover, the mobility of the flame often necessitates an assistant observer. Otherwise the lamp gives very consistent values.

In 1891 the author found the value of 1·026 decimal candles for the Hefner lamp. More recent measurements, undertaken by M. Laporte* at the Central Electrical Laboratory, with Hefner lamps properly standardised, gave the very different value of 0·885 decimal candles. This was based upon a Carcel lamp, whose value the author had found to be 9·6 decimal candles.

II. In the 1 c.p. pentane standard the liquid pentane contained in a recipient is evaporated by a wick placed inside a tube projecting beyond it by several centimetres, so that the wick is not charred. The flame burns in the open air; its upper part enters a chimney, which reduces its mobility and gives it a whiter tint. A small window gives a view of the point of the flame, which must be kept in the centre of the window. The intensity of the visible part of the flame, between the burner and the lower edge of the chimney, is then of the value of 1 English c.p. According to M. Vernon-Harcourt the flame is steady after a quarter of an hour, any further variations rarely attaining 2 per cent.

In another type, represented by the 10 c.p. lamp prescribed in England for gas testing, the lamp is fed by a current of air charged with pentane vapour in its passage through a saturator. The mixture descends, under the influence of its weight, through a caoutchouc tube into a ring-shaped steatite burner. The chimney is surrounded by a brass tube, in which an ascending current of air is produced, and this air is brought back to the base of the flame by a central tube. In a Paper read before the Institution of Gas Engineers in June, 1898, M. Vernon-Harcourt showed that the intensities of the two standards described do not differ by more than 1 per cent.

M. Liebenthal has subjected the pentane standard to a study similar to that carried out on the Hefner standard. He found that the height of the flame must be regulated exactly. When the point is in the middle of the window the intensity passes through a maximum. It diminishes by 2·5 per cent. or 2·1 per cent. when the point is at the bottom or at the top of the window respectively. The flame does not reach its maximum intensity till half-an-hour after lighting.

The pentane lamp, though having a much stiffer flame than the Hefner, requires more attention. The influence of moisture is sensibly the same as for the Hefner lamp. The pressure, however, produces a much greater effect, and is regulated by the formula

$$\Delta y = 0{\cdot}00049(b - 760)$$

according to which a change of pressure of 40mm. brings about a variation of 2 per cent. It is therefore necessary to allow for altitude above sea level. This is a grave fault, but for all that the superiority of the Hefner over the pentane lamp as a standard is not clearly proved.

III. Dibdin's apparatus, recommended by the report of the Photometric Committee, has been the object of a study by Mr. Grafton. In this apparatus, the air carburates itself by its passage through pentane in a reservoir forming the base of the apparatus. But the proportion of air and pentane varies with the temperature and moisture in the room.

On the other hand, Methven's standard with pentane carburator fed by coal gas, and with a diaphragm before the flame, has given very good results. Moisture and temperature would not produce variations beyond 0·5 per cent. But this figure must be accepted with caution.

IV. Various flame standards have recently been proposed, but have not yet been adopted in practice; notably acetylene standards.

In 1893, the Dutch Photometric Commission recommended the employment of a lamp of the Vernon-Harcourt type slightly modified, in which a mixture of nine parts benzine with 100 parts of ether should be burnt. The intensity was to be 1·48 English c.p.

By burning acetylene under a pressure of 30cm. of water in a burner which spreads it out into a broad thin sheet, the author obtained in 1895 a perfectly steady flame, whose intensity surpassed 100 c.p. for an expenditure of 58 litres per hour. The brightness is uniform over a large area. In the type constructed by M. Carpentier the acetylene enters by a small conical orifice, draws the necessary air along with it, penetrates into a narrow mixing tube, and issues through a batswing burner. The flame is enclosed in a box, one of the faces of which carries an iris diaphragm, while the other receives diaphragms with perforations calibrated in advance.

The flame is of remarkable whiteness. Spectro-photometric measurements have shown that in the whole range of the visible spectrum the acetylene light differs little from that of fused platinum. M. Fery burns acetylene at the end of a thermometer tube about 0·5mm. in diameter. The height of the flame varies from 5mm. to 35mm., when the consumption of gas increases from 1·25 litres to 6 litres per hour. Between 10mm. and 25mm. the intensity is sensibly a linear function of the height of the flame. The diameter of the flame varies very slightly.

The inconvenience presented by the combustion of acetylene of producing a deposit which obstructs the passage would be avoided, according to Blondel,* if pure ethylene were burnt in pure oxygen.

Another acetylene standard has been constructed in America by Mr. Fessenden. The Committee of the American Institution of Electrical Engineers burns a mixture of two parts of acetylene and one part of hydrogen in a current of pure oxygen.

M. Blondel has constructed a chimney lamp burning a mixture of alcohol and crystallisable benzine, and M. Broca has proposed an "albo-carbon" lamp burning naphthalene, which is supposed to give a very constant intensity.

V. The above descriptions show sufficiently clearly how difficult it is to obtain satisfactory results with flame standards. The greatest errors are due to variations in the height of the flames, which may amount to as much as 24 per cent. With a careful regulation of the height, the intensity of the Hefner lamp may be kept within 2 per cent. of its standard value. But the old Carcel lamp appears to be the steadiest of all, since with careful handling the error may be kept below 0·8 per cent.

Photometers.

I. The principle of Bunsen's photometer has been utilised by Messrs. Lummer and Brodhun for constructing an apparatus which is greatly superior to those which had preceded it. The opaque part of the screen is constituted by a portion of the hypothenuse face of a total-reflection prism, which throws back the rays coming from one of the sources. The middle region is, on the other hand, deprived of reflecting power by having another prism of equal refractivity pressed against it. The contact surface is circular, and lies in the plane of symmetry of the photometer. Two white screens, illuminated by the two sources, are seen side by side by the two alternative paths, and their equality is tested by the disappearance of the circle of contact. The great superiority of this photometer over the older forms lies in the sharpness of the dividing line between the two illuminated surfaces. When the two sources have slightly different tints, equality of brightness produces a continuous gradation which cannot be mistaken. A variation of 1·5 per cent. in the brightness of a source is distinctly traceable, and the mean error of a reading is less than 0·5 per cent. But an unexplained imperfection lies in the fact that when the two sources are reversed differences as high as 3 per cent. are often indicated. This may be due to some hitherto unknown peculiarity of "total" reflection.

The same apparatus may be employed if we adopt the principle of contrast instead of the principle of equality. Interposing in the half of each of the beams a plate of glass, four patches are obtained, and the distances may be so regulated that the contrast is the same in each pair. In the latest model, the field of vision is limited by an

* F. Laporte, *Elettricità*, Milan, 17, pp. 755 and 775, 1898.

* Report on Photometric Units, International Electrical Congress Geneva, 1896.

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elliptic curve with its longest axis vertical. To the right and left, trapezoid areas detach themselves, which, at the time of adjustment, must appear darker than the semi-ellipses which surround them, and the contrast must be the same.

II. MM. Blondel and Broca have constructed a univeral photometer which allows the performance of all the measurements required in photometry, such as intensity, luminosity, and brightness, both for near and distant sources. The apparatus is symmetrical, and carries two translucent diffusing screens which are binocularly observed by means of two mirrors at right angles to each other, and inclined at 45deg. to the rays. This part of the apparatus may take the place of a Bunsen or Violle photometer. Luminosity measurements are made as in Mascart's photometer. For intrinsic brightness, real images are produced on the screens, and the method of Cornu's microphotometer is followed.

III. M. Blondel's "photomesometer" applies the principle of Allard's method for determining the mean intensity, *i.e.*, the quantity

$$I_m = \tfrac{1}{2}\int_0^{\pi} I_a \sin a \, da.$$

where a is the angle between a fixed ray and a straight line which grazes the plane in which the observations are made.

M. Blondel sends the rays of the arc back to the photometer by means of a reflector formed by 24 mirrors arranged as a truncated regular pyramid. To measure the mean intensity, the arc is placed at the centre of a sphere provided with openings in the shape of windows bordered by meridians and subtending horizontal angles proportional to sin a. This sphere is made to turn at a rate of 200 revs. per min.

IV. In M. Blondel's luminometer the geometrical centre of the source to be studied coincides with the centre of figure of a sphere cut in two opposite directions along sectors of 18deg. each. The rays fall upon an ellipsoidal mirror which makes them converge on a diffusing screen. There they produce a luminous patch 20cm. to 50cm. in diameter, the intensity of which is determined by means of a photometer placed at a distance of 2m. to 5m. If the source is symmetrical a single reading suffices to determine the total luminous flux.

V. As regards colour photometry, it has been shown by Lummer and Murphy that there is no strict relation between the width of slit and the luminosity obtained in any region of the spectrum. Polychrome photometry is not facilitated, on the other hand, by reducing the intensities of the different colours, since the sensitiveness of the eye diminishes in the same proportion.

VI. The rotating sector, which is often used in spectrum photometry, does not give accurate results unless each flash of light has a duration of less than 0·01 second. This has been shown by Charpentier's investigation of the properties of the retina.

VII. MM. Lummer and Brodhun have constructed a spectrophotometer, in which the superposition of the rays proceeding from two collimators at right angles is effected by a system of two total-reflection prisms with vertical edges. The hypothenuse surfaces are plane as in the contrast photometer. On one of them the surface layer is removed along strips normal to the edge. Mr. Brace has since constructed a simpler apparatus on the same principle.

VIII. Colour photometry seems to have made considerable progress since the application of a method proposed by M. Charpentier and Mr. Rood. This method is based upon the fact that when two surfaces of different tints are alternately brought before the eye in rapid succession, a flickering sensation is produced until the intensities are adjusted to a certain ratio. The point thus attained might be used to define "equal intensities." Unfortunately, when the two intensities are then reduced or increased in the same ratio, the flickering often re-appears.

ELECTRIC FURNACES.*

BY M. KELLER.

The author takes as archetypes of all modern electric furnaces those of Siemens & Huntingdon and Moissan. The first of these consisted of a crucible of some refractory earth, receiving current at its base, a movable carbon pencil fixed within it acting as the second electrode. The arc was thus formed between the lower point of this carbon electrode and the surface of the materials contained within the crucible. The Moissan furnace consisted of a block of lime, hollowed out at its centre to receive the materials to be heated, and provided with horizontal channels for reception of the two carbon pencils conveying the current. A second block of lime, fitting over the first, completed this furnace, and served to retain the heat emitted by the arc which formed between the points of the two carbon pencils when the electric current was passed along them. The materials in this furnace were placed in the hollow cavity in the centre of the block and the arc played *over* their surface.

The first of the electric furnaces developed from the above laboratory types for industrial purposes was that of the brothers Cowles. In this furnace the material to be treated was placed between two conducting surfaces, which conveyed the current, and was surrounded by non-conducting finely-divided material. The current was thus obliged to traverse the material lying between the two electrodes, and if this in the unfused state was a non-conductor of electricity, movable carbon electrodes were used in order to form an arc above the furnace contents, and bring them to the fused condition. This furnace, invented in 1885, and improved in 1887, was used at Milton in Staffordshire for reduction of aluminium oxide, and for production of aluminium alloys.

The Héroult furnace introduced at a later date for obtaining alloys of aluminium with copper, was based upon the same principle as that of the Cowles brothers. This furnace has been used at Froges and at Neuhausen for production of aluminium, and more recently for the production of calcium carbide. The modified form adopted for the latter manufacture consists of a box mounted upon wheels, the base of which is of carbon, and the sides of some non-conducting material. The base of this box acts as one electrode, and a carbon rod, subject to a vertical up-and-down movement, forms the second. The furnace body is thus movable, and can be wheeled away when the reaction is completed, in order to be replaced by a newly-charged one.

The author next classifies the furnaces designed for calcium carbide manufacture as: (1) Arc furnaces (based on the Moissan and Siemens type); (2) Resistance furnaces (based on the Héroult type); (3) Incandescence furnaces (based on the Cowles type).

Arc furnaces may be again sub-divided into three classes, according to the mobility of one or both electrodes and the number of carbons used. The furnaces designed by Patin, by the Deutsche Gold und Silberscheide Anstalt, and by Street, have both electrodes movable, and thus come under sub-division I.

A very large number of furnaces fall into the second group, having one electrode fixed—generally as hearth or floor of the furnace. The furnaces exhibited by the Société des Carbures Métalliques at the Exhibition, and those designed by Siemens and Halske, Schuckert, and other well-known firms for carbide production, are of this type.

To the third sub-division belong all forms of the multiple arc furnace, which has lately become much used, because it enables the area of arc heating to be greatly extended. The Gin and Leleux, Bertolus, Memmo, Nicolai, and Bovy furnaces are leading examples of this type. In most of these furnaces the floor of the furnace acts as the common secondary electrode for the arcs which form between it and the three or more primary electrodes fixed around it. Polyphase currents are generally used with these furnaces.

In all arc furnaces the temperature attained varies with the intensity of the current used, but as in any case the temperature of the arc is very high and considerably above that required, loss of energy follows from arc heating in carbide production. There is also considerable loss of material, owing to the finer material charged being carried away by the "blowing" of the furnace. For these and other reasons arc furnaces are not suitable for carbide production.

Class II.—Resistance furnaces resemble in form and construction arc furnaces, but they work with a lower E.M.F., as the materials charged into the furnace body act as intermediate conductor between the two terminal carbons. The work done can be calculated by aid of the Joule formula $W = RI^2$, and the temperature attained is directly related to the sectional area of the electrodes. In this type of furnace the fusion of the materials is tranquil, and is unaccompanied by violent evolutions of gas. For carbide production an E.M.F. of 20 volts to 25 volts suffices, but heavier currents are requisite than with the arc furnaces, and conductors of larger sectional area must therefore be provided. The new furnace of the Compagnie Electrométallurgique des Procédés Gin and Leleux is of this type, and is employed in a large number of carbide works.

In the third class of furnace—incandescence furnaces—the intermediate conductor between the ends of the two electrodes is formed by a succession of small pieces of coke or other form of carbon. The passage of the current causes this bed of coke to attain a high temperature, and the materials placed upon it or mixed with it in their turn are raised to the same temperature. This type of furnace permits the utilisation within a limited area of the greatest amount of energy, and avoids the grave defect of the second type, namely, that the currents must always traverse the whole depth of the layer of materials already fused.

The author then passes on to consider electric furnaces under another classification, namely, that of the kind of current employed. Furnaces using continuous current have been sometimes called electrolytic furnaces, because in these not only thermal but chemical effects may be produced. Alternating current furnaces have latterly been widely adopted, because the dynamos yielding monophase or

* Abstract of a Paper read before the International Electricity Congress at Paris.

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polyphase currents are better adapted to stand the resistance variations incidental to electric furnace operations.

The furnaces employing mono-phase currents are best arranged in series, for in this case it is possible to utilise a higher E.M.F. and to save copper in the necessary leads. If, however, arc-heating is being employed, it is better to connect the furnaces in parallel.

Bertolus, in 1897, was one of the first to patent the application of polyphase currents to furnace work. In the furnace designed by Bertolus tri-phase current was used, and three carbon electrodes were connected to the three terminals of the dynamo, while the hearth of the furnace itself provided the common return electrode. In later forms, the three different phases of the current have been utilised in separate furnaces, and these therefore each operate as though worked with mono-phase current.

Electrodes.—The difficulty of obtaining carbon electrodes of suitable size and length has for a long time hindered the increase of the size of the furnaces. Engineers have, however, given much attention to this question, which for the carbide industry is of considerable economic importance.

For those furnaces in which vertical electrodes are used, the carbon is generally formed square or rectangular in section, and undergoes special treatment in order to increase its conductivity, while for the other types of furnace carbons are usually made round.

In order to protect the carbon at the point where it entered the furnace, it was at one time customary to use water for cooling purposes, but this proved dangerous, and it has been given up for cold air, or some form of protecting composition.

Regulating the Electric Current.—In the modern forms of furnace for carbide production, working with relatively low E.M.F.s, it is usual to find currents of 8,000 amperes to 10,000 amperes employed. With such currents it is impossible to use ordinary cut-outs, and it is customary to make the movable electrode of the furnace act as circuit breaker. On account of the accidents which may occur to the dynamo, steam engine, or turbine, when a single furnace is worked in this manner on an electric circuit, it is advisable to work several furnaces in parallel from the one dynamo.

Current Pressure.—The E.M.F. required in arc furnaces varies greatly, and depends upon the conductivity of the gases which are emitted from the heated substances. In the manufacture of carbide of calcium, an E.M.F. of 50 volts to 60 volts is required, in that of corrundum 50 volts suffices, while the electro-thermal method for production of iron only requires 20 volts.

In resistance furnaces a lower E.M.F. is generally sufficient, and carbide of calcium can be manufactured in the Héroult type of furnace with a current of only 25 volts pressure. Aluminium can be produced in the same furnace with a pressure of from 20 volts to 25 volts.

The third type of furnace, "incandescence furnace," can work with practically any E.M.F. up to 80 volts or 100 volts, for the resistance increases with the increase of the length of the bed of materials through which the current has to pass, and this may be varied at will.

Current.—In the Cowles type of furnace currents of 5,000 amperes at 50 volts to 60 volts have been used. In the Héroult furnace currents of 6,000 amperes are used. For carbide production it is more customary to use currents of from 1,000 amperes to 2,500 amperes with single pairs of electrodes, but where several pairs of electrodes are used for arc heating in the same furnace, this current may be doubled, trebled, or quadrupled. Furnaces with a single arc, and one movable electrode are, however, now being worked with currents of 5,000 amperes to 6,000 amperes. The Gin and Leleux type of resistance furnace can be worked with currents up to 10,000 amperes, and the same amount of current can be utilised in the incandesence furnace, which, working with a higher E.M.F. than the resistance furnace is able to utilise for thermal purposes, no less than 1,000kw. electrical energy.

Developments of the Electric Furnace Industry.—Recent estimates have placed the total energy employed in electric furnace operations at 230,000 H.P., of which total, calcium carbide accounts for 185,000 H.P. aluminium for 27 000 H.P., copper for 11,000 H.P., and carborundum for 2,000 H.P. In France alone it is estimated that 60,000 H.P. are employed in the carbide manufacture; while the production of phosphorus, vanadium, and ferro-chromium are more recent thermo-chemical industries started in Savoy.

The improvements made in electric furnaces in recent years have resulted in a greatly improved output of carbide per kilowatt hour, and in the latest form of the Gin and Leleux furnace it is now possible to obtain 6·20kg. carbide per kilowatt day of 24 hours. This corresponds to a thermal efficiency of 75 per cent.

The Paper closes with a few details concerning the electric furnaces which are exhibited in the electro-chemical section of the exhibition. Three of these are shown in operation, and comprise a Moissan furnace, a Bullier furnace, and a small model of the Gin and Leleux type of furnace. The first consumes 40kw., and the second and third 70kw. electrical energy when in operation.

A COMBINATION INTEGRATING WATTMETER AND MAXIMUM DEMAND INDICATOR.*

BY JOHN H. BARKER.

This system has been at work for some years with marked success, but it has been necessary to use two separate meters—one to integrate the total number of units consumed, and the second to record the maximum demand; both meters absorb energy from the supply to the detriment of the light. In conjunction with Prof. Ewing the author has invented a meter which will combine the functions of the previous two. The maximum demand device can be attached to meters of the magnetic brake type, a prominent example of which is the meter sold by the Thomson-Houston Co. (Ltd.). The meter is essentially a motor and a magnetic brake; the latter consists of a copper disc revolving in a horizontal plane between the poles of the permanent magnets, the magnets set up eddy currents in the disc and produce a drag which is proportional to the speed of the rotation. In carrying out the invention this drag is made use of. The two magnets are supported on a beam and suspended in such a manner that they tend to follow the rotation of the disc. A steel wire enclosed within a tube is fixed at its upper end to a screw; at its lower extremity it is secured to the beam itself. The torsion of the steel wire acts as a spring and controls the distance through which the suspended system moves. The spring or other controlling force is made comparatively strong in order that the motion of the magnet poles may be so small as not to affect the rate of the meter, and also in order that the period of oscillation of the suspended system may be short. When a sudden increase takes place in the demand for current, and consequently in the rate of supply, the magnetic brake would tend to swing beyond the position proper to the new rate of supply if its period of oscillation were not short in relation to the time taken by the revolving parts of the meter to acquire their new velocity. This tendency is obviated by making the period of oscillation of the brake sufficiently short in relation to the time during which the disc is undergoing acceleration when the current is suddenly applied or suddenly increased. Further advantages of the strong controlling force, and consequently small movement of the brake, are that the brake may be pivotted eccentrically to the disc without causing its motion to affect the rate of the meter, and also that there is no necessity for the use of a dash-pot or similar arrangement to check the oscillations, although such means may be used if desired. Again, the small motion of the brake assists in preventing disturbance of the indications through the direct effect of the motor coils in cases where continuous currents are used, and the field of the motor is produced by current in coils. The motion of the brake is multiplied and actuates the indicator. A light ratchet and pawl is fixed at one end of the beam, and retains the system at its point of maximum deflection; a lever with a sealing device passes through the outside of the case, and enables the meter inspector to reset the indicator at the end of each quarter or half-year as the case may be. In meters for measuring supply by continuous currents, care must be taken to arrange the magnetic brake so that the electric currents in the meter do not directly tend to displace it. For this purpose it is preferable to invert one of the two magnets forming the brake, so that the pair shall constitute an astatic, or nearly astatic, system. When this is done it may in some cases occur that the stray field from the magnets constituting the brake affects the field of the motor, and consequently disturbs the rate of the meter. This may be compensated for by several devices, such as introducing a separate compensating magnet to balance on the motor armature, the field produced by the magnets of the brake, or using a shunt field coil in the motor for the same purpose. The scales for all sizes of meters are made the same, and the readings follow a straight line law; the divisions of the scale are given in percentages of full load of the meter, and a table is fixed to the front of each case, giving at a glance the maximum demand corresponding to any reading, as well as the number of units which must be consumed before the lower rate is charged. There is also a meter adapted for use on a switchboard; it integrates the amount of current which has passed through any feeder or from any dynamo, and informs the attendant the quantity passing through at any moment, obviating the use of an ammeter (more properly speaking a wattmeter). It differs from the ordinary meter, inasmuch as it has no ratchet and pawl, and is free to return to its zero position on the stoppage of current through the instrument.

There are many advantages claimed for this form of demand indicator: (*a*) It combines in one instrument the dual function of integrating and of recording the maximum demand; (*b*) as an indicator it absorbs no energy from the supply; (*c*) it contains no liquid or injurious acid; (*d*) it is not affected by any ordinary short circuit; (*e*) it records alternating or direct current; in the case of alternating current it records true watts and not apparent watts, an important item in respect of supply to motors and arc lamps; (*f*) it is

* Abstract of a Paper read before Section G of the British Association at Bradford, Sept. 10.

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extremely accurate. Mr. Reginald P. Wilson some few years ago devised a maximum demand indicator embodying the same principle. The difficulty in this form was that the swing of the suspended system was sufficient to carry the pointer beyond its correct reading if a larger amount of current than a very small fraction of its full load were switched on at any one time, and the meter was never in commercial use. The inventors of the Barker and Ewing meter were unaware of Wilson's patent until their own was in its final form.

THE MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.*

I.—BY SIR W. H. PREECE, F.R.S.

A mono-rail line has been projected by Mr. Behr between Manchester and Liverpool to accommodate express passenger traffic alone between those two cities. It is to be worked by electric traction, and to attain very high speeds. The train is to consist of only one coach weighing 45 tons and seating 64 passengers. Starting at every 10min., and travelling at the mean rate of 110 miles an hour, it will do the distance of 34½ miles in 20min. The fares will be slightly lower than those charged at present. There will be no intermediate stations, no points nor crossings. There will thus be no necessity for signals to protect the line during other operations. Signals would be needed only to secure a perfect block system of working the line. The mono-rail railway was projected by Lartigue in 1882. We have only one example of this system of railway in the United Kingdom, viz., between Listowel and Ballybunion, in County Kerry, Ireland. This line was designed and engineered by Mr. Behr. The act was obtained in 1887 and the line was opened for traffic in February, 1888, and it has been running ever since.

The line is 9¼ miles long. It has one intermediate station, Liselton. There are 42 level and farm crossings. It is worked by steam. The train consists of a locomotive and four coaches. It cost £33,000 to build, or £3,060 per mile. When I inspected the line in the early part of this year there had never been a Board of Trade enquiry into any accident. The maintenance of the structure had been effective. No rail had ever been turned. The mechanical structure had exhibited no defects, but several breakdowns had occurred in the locomotive and rolling stock. There are three locomotives, 11 passenger coaches, and two brake vans. They had, however, continued to work the line uninterruptedly for 12 years, and there had been no renewals or new stock. Its main principle is the suspension of the coaches on a single elevated rail so that their centres of gravity are below the rail. Each coach sits the rail like a saddle. The rail is fixed on trestles which are tied and braced together, the tie bars being light rails against which guide wheels roll.

The Manchester and Liverpool express is intended to be more massively and rigidly built. Derailment on such a structure is impossible, and curves of comparatively small radius can be passed with safety at high speeds. Vibrations and noise will be reduced and travelling will be conducted with greater comfort than at present. It is proposed to fix the generating station midway at Warrington, and to transmit the electric energy at high pressure (10,000) volts to each terminal station. There would be sub-stations along the line at distances apart of 4 miles, where the 10,000 volts would be brought down to 1,000 volts, at which pressure it would be picked up by the motors on the coach.

The speed which a train can acquire on a railway depends on the power that can be continuously applied at the tread of the driving wheel. Electricity enables the engineer to apply instantaneously to light loads a power which steam cannot supply. Hence speeds are possible with electricity which are unattainable with steam. A coach weighing 45 tons can easily and quickly attain 110 miles an hour. 1,600 H.P. will accelerate the coach so as to attain this speed in 110sec., and 500 H.P. will maintain this speed on the level. Electricity has two advantages over steam. It enables us to obtain an acceleration of 1½ft. per second, which is virtually the limit that can be obtained without causing discomfort to the passengers, and, secondly, it applies a continuous and constant torque instead of the variable one due to the reciprocating action of the ordinary steam locomotive. Hence it not only enables us to maintain high speeds on long through lines like the proposed Manchester and Liverpool Express, but it enables us to attain high speeds with greater rapidity on short lines having frequent stoppages, like the metropolitan railways of London, and thus increase the capacity of the line for traffic. The chief causes of accident on ordinary railways, viz., collision, derailmement, points, and the human error of the signalman will be removed from lines. Hence travelling will be much safer. Mr. Behr has prepared a short Paper on brakes and signals.

* Abstracts of two Papers read before Section G of the British Association at Bradford.

II.—BRAKES AND SIGNALS.

BY F. J. BEHR.

The question of brakes and signals are so intimately connected that the one cannot be treated separately from the other. The most perfect condition under which a railway could be worked, would be that in which both brakes and signals could be dispensed with, therefore it follows that the fewer the occasions for using either, the better.

Now as to brakes, there is a limitation of their application, which depends not so much on the mechanical appliances themselves as on the endurance of the human bodies in the trains. It was stated by an eminent railway official that with the Westinghouse brake, a train travelling at 60 miles an hour could be stopped, as an emergency brake, within 360 yards without inflicting too great a shock on the passengers. In the same way, a train travelling at 110 miles an hour could be stopped within 500 yards, and probably in a shorter distance, as in the latter case electrical means are at hand, such as the reversal of the motors, so as to turn them into dynamos. More rapid stoppage could only be made with great discomfort to the passengers. Now in the ordinary way of working our railways at present, there are many occasions in which it might be important to stop the train as rapidly as possible, for instance, if a train in front should be seen, or some shunting operations were not completed, or many others too many to enumerate; but no brake, however powerful, would be of the slightest use to-day to avoid a sudden obstacle, such as a stone placed on the rail, or a broken rail, for it is impossible for the driver to be aware of such obstacles until he is practically upon them. For these cases of great emergency, therefore, the stoppage at 300 yards, or 200 yards, or even 100 yards is quite useless.

What I wish to show now is that on the proposed high-speed electrical railways, though it is quite possible to brake the train within less than 500 yards, it never can be necessary to bring it to a standstill at even a much longer distance. On the proposed railway there are no level crossings, no switches, no shunting operations, and in fact nothing that will require the train to be brought to a standstill, except in the event that a preceding train should break down. Besides this one case, the brakes can only be used for stopping as you approach the stations. A broken rail offers no danger in this case whatever, for the train would run over it without any danger or difficulty. This can easily be shown by carefully considering the relative position of the wheels in the carriages to the rails over which they travel. I now, therefore, have only to explain the manner in which it is arranged that the driver of each train shall be informed of the possible stoppage of the train in front of him. No second train will leave the station at Manchester or Liverpool until the first has reached Warrington, a distance of just 17 miles. We sub-divide the line for the purpose of signalling into eight sections of 4·3 miles each. As trains leave Manchester station a danger signal is put up automatically at that station, a second similar danger signal is put up in the same way at 4·3 miles off, the first remaining at danger. The train travels on until it reaches 8·6 miles, when it puts up a third danger signal, and simultaneously the signal is lowered at Manchester or Liverpool station, so that the second train can leave when the time comes.

Now, we will assume that the first train has met with an accident after passing point 8·6 miles, the second train would travel at a higher speed right on, but when it passes point 4·3 miles, the danger signal at that point not having been removed by the first train, as this never reached point 13 miles, the driver of the second train would be informed that the first train had met with an accident beyond 8·6 miles, and therefore that he had to slow down, but that for such lowering of his speed he had a clear run of over 4 miles. Therefore, there could be no difficulty in any case to stop even without using the brake at all, by simply cutting off the current.

Whenever a train passes over a point where the danger signal is put up this is also produced, either electrically or mechanically, by a very simple and inexpensive contrivance in the cabin of the electrician, so that he should be perfectly able to see it without difficulty even if there was a thick fog. Under these conditions of travelling, it seems, therefore, superfluous to have any emergency brakes, and though we shall be able to stop the trains within 500 yards, no case can be imagined in which it would be useful or necessary to resort to such a stoppage. A 6-minute service of trains can be established without any alteration in the proposed arrangement, and if a 3-minute service was required, the blocks would have to be reduced to 2-mile sections, giving a clear run of 2 miles in case of a breakdown.

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THE DESIGN AND LOCATION OF ELECTRIC GENERATING STATIONS.*

BY ALFRED H. GIBBINGS, M.INST.E.E.

The term "central station" is gradually being supplanted by more comprehensive designations. All design and arrangement in regard to electric works must be with a view to securing the highest *average* efficiency together with reliability in operation. Electric works at present do not fulfil these conditions, but that may excusably be accounted for, because it was impossible to foresee modern developments. Electricity, as first used for lighting only, has now come to be used in the form of electric motive power, and electric traction. The attempt to supply all these from one generating station, has led to the use of unsuitable plant, to confusion in the station itself, but at the same time to a reduction in prices charged. It has also resulted in a large variation in capital cost per kilowatt of plant. Small and isolated undertakings try to attain equally successful results by other experiments, but fail. Economical production is only possible where both the generating costs and the standing charges are reduced together as the load increases and the system extends. To effect this generating works must in future be constructed and located with a view to include the supply of energy for motive power, tramways, and electro-chemical purposes. Details of such construction and location should embody the following points:—(1) The machinery must be designed to generate at high voltage, differing according to the extent of the area and the nature of the system, but it must be suitable for transformation at sub-stations to meet all possible requirements. (2) The type of all boilers, engines, electric generators, switchboards, &c., must be simple and mechanically reliable even at the sacrifice of some slight maximum economy. (3) All complicated gear and fanciful combinations, such as might lead to possible breakdown, must be avoided throughout the entire arrangement. (4) As far as possible the different units of the respective types of plant should be uniform in design and arrangement and made to one standard size, thus economising in labour, avoiding large "stand-by" plant and spare gear. (5) The buildings should be devoid of all unnecessary embellishments, nor should an attempt be made to confine too many departments under one roof. (6) The location should be such as to ensure a cheap and ready supply and delivery of fuel, and where condensing can be accomplished efficiently and inexpensively.

THE USE OF MULTIPLE SPACE IN APPLIED MATHEMATICS.†

BY H. S. CARSLAW.

The ordinary method of images may be used in the solution of problems in electrostatics, &c., when the bounding planes meet at an angle, π/m, but it fails when the angle of inclination is $n\pi/m$ (n, m positive integers). Illustrations: π/m ($m=1, 2$); $n\pi/m$ ($m=1$, $n=2$: $m=2$, $n=3$). So far as I can learn it was first pointed out by Sommerfeld‡ that a Riemann's surface might be here employed, and with the help of a multiple space problems in electrostatics, electric conduction, hydrodynamics, sound, and conduction of heat, in which the boundaries are planes meeting at an angle, $n\pi/m$, have now been solved by images. The ideas involved may be illustrated by the potential problem in which the boundary is the semi-infinite plane $\theta=0$. There is nothing to prevent us assuming that in this case the space with which we have to deal is defined by the range of $0<\theta<2\pi$, and the behaviour of the solution of the equation $\nabla^2 u=0$, outside that range need not concern us. It is found§ that the periodic function

$$u=\frac{2}{\pi R}\tan^{-1}\sqrt{\frac{\sigma+r}{\sigma-r}},$$

where
$$R^2=r^2+r'^2-2rr'\cos(\theta-\theta')+(z-z')^2,$$
$$2rr'\cosh\alpha_1=r^2+r'^2+(z-z')^2,$$
$$\sigma=\cosh\alpha_1/2,$$
and $$r=\cos(\theta-\theta'/2),$$

is a solution of the equation $\nabla^2 u=0$, with the required properties, its only singularity, in the range $-2\pi<\theta<2\pi$, being at (r', θ', z'). Calling this the solution corresponding to a pole at (θ'), if we associate with it that due to a pole at $(-\theta')$, we obtain a function, satisfying the boundary conditions, with only the one singularity in the range with which we are concerned. Similar ideas enter into the solution of the other questions of this nature: where the ordinary image method would reproduce singularities in the original space, by taking a function of a suitable period (a Riemann's space of the proper order) this result is avoided. The problems in potential involving spherical boundaries may be solved by inversion from the above. Hobson has considered,* by discussion in series, the direct solution of the cases of the circular disc and spherical bowl. By a method similar to Sommerfeld's, I have found the solution for the general case. Taking the co-ordinate system employed by Hobson, in which the position of the point P is defined by $\rho=\log PA/PB$, $\theta=\angle APB$, $\phi=$azimuthal angle, the boundary $\theta=$constant, represents a portion of a spherical surface of which the rim of the circular disc, whose diameter is AB, is the base. If we are dealing with the space bounded by an infinite plane with a circular hole we define this region by $0<\theta<2\pi$, and associate with it that defined by $-2\pi<\theta<0$. Corresponding to the singularity at (θ'), we shall have one at $(-\theta')$.

When the boundary is the infinite plane with hemisperical bowl we consider our physical space as given by $0<\theta<3\pi/2$, and require three revolutions of the radius vector to complete our multiple space. The poles will now be at $(\pm\theta')$, $(\pm(3\pi+\theta'))$.

The general solution (of period $2n\pi$) required for such problems is given by

$$u=\frac{1}{n\pi\sqrt{2}}\sqrt{\cos h\rho-\cos\theta.\cos h\rho'-\cos\theta}\int_a^\infty\frac{1}{\sqrt{\cos ha-\cos h\alpha}}\frac{\sin h\frac{a}{n}}{\cos h\frac{a}{n}-\cos\frac{\theta-\theta'}{n}}da,$$

where $$\cos h\alpha=\cos h\rho\cos h\rho'-\sin h\rho\sin h\rho'\cos(\phi-\phi').$$

ON THE SIMILARITY OF EFFECT OF ELECTRICAL STIMULUS ON INORGANIC AND LIVING SUBSTANCES.†

BY PROF. J. CHUNDER BOSE, D.SC.

(*Continued from page 777*).

5. *Effect of Temperature in Hastening the Recovery.*—(*a*) I give below two curves which clearly show the effect of temperature in hastening the recovery. For the sensitive substance I took magnetic oxide of iron, Fe_3O_4. Curve (*a*), Fig. 5, represents the effect of Fe_3O_4 when *cold*. The increase of galvanometer deflection due to a single flash of radiation was 150 divisions; the after recovery was very slow, the deflection falling through only 30 divisions in 75sec; the rate of subsequent fall was still slower.‡

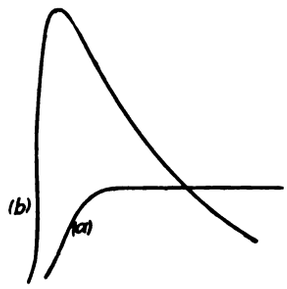
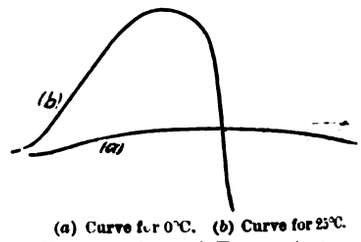


FIG. 5.—Effect of Temperature in hastening the Recovery.



(*a*) Curve for 0°C. (*b*) Curve for 25°C.

FIG. 6.—Effect of Temperature on the Muscle Curve.

I now warmed the substance over 100°C.; the response was slight and the recovery also very feeble. I now allowed the temperature of the substance to fall very gradually, and took observations for intermediate temperatures. The curve (*b*) is for a temperature of about 15°C. above the temperature of the room. It will be noticed that the sensitiveness of the substance is very much increased; a flash of radiation now produced a deflection of 400 divisions, the sensitiveness having thus been increased nearly threefold. The recovery is rapid, especially in the first part of the fall, the substance recovering completely in 75sec.

It is thus seen that an increase of temperature up to a certain limit increases the sensibility and hastens the recovery, but beyond this limit the sensitiveness and the quickness of recovery are both diminished. A remarkable parallel to the above is seen in the influence of temperature on the muscles curve (see above).

* Abstract of a Paper read before Section G. of the British Association at Bradford.

† Abstract of a Paper read before Section A of the British Association at Bradford.

‡ *Math. Ann.*, B., XLV.

§ *Proc.* Lond. Math. Soc., XXVIII., p. 413.

* *Trans.* Camb. Phil. Soc., Vol. XVIII.

† Paper read before Section A of the British Association at Bradford.

‡ The galvanometer used in these investigations is a dead-beat D'Arsonval; the natural time of return of the coil to equilibrium position is very quick. The sensitive substance was so chosen that the cycle of conductivity changes should occupy a comparatively long time—about two minutes.

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It appears probable that for each sensitive substance there is an optimum temperature for which the sensitiveness is a maximum.

(*b*). In muscles the effects are exactly similar (see Fig. 6). Increase of temperature up to a certain limit is found to increase the response (the height of contraction) and hastens the recovery, but beyond this limit the contractions are lessened in height.

6. *Distortion beyond the Elastic Limit: Fatigue.*—It was mentioned that a substance is more or less permanently distorted by a stimulus (1) if the limit of electric elasticity of the substance is narrow, or (2) if the intensity of stimulus is very great. Imagine a substance so distorted. It was shown (see 2) that after a stimulus has produced the maximum effect on a sensitive substance, there is no further action on it by the superposition of a second stimulus, *unless the substance has meanwhile recovered from the state of strain.* In the case of overstrain there is no immediate recovery owing to molecular friction; hence there is no further action of stimulus on an overstrained substance; the latter is then said to be fatigued. Imagine a galvonometer needle violently deflected by a strong transient current sticking to the side of the coil and prevented by friction from returning to the equilibrium position. In the distorted and constrained position the needle responds no longer, gentle taps release the needle and the galvanometer is again made responsive. If we wish to remove the fatigue of the substance and make it responsive, we have to release the strained particles by vibration—by mechanical taps or by gentle application of heat. Now it is well known how tapping restores the sensitiveness of a molecular receiver. It has also been shown how a slight rise of temperature hastens the recovery, and is thus effective in the rapid removal of fatigue. I shall now pass into the consideration of muscular fatigue.

(*b*) In the muscles, the cause of fatigue is obscure and is generally ascribed to the breaking down of the "material necessary for contraction" and the accumulation of "fatigue stuffs." Fatigue is removed after a period of repose, and it is supposed that the blood supply repairs the disintegrated tissues and eliminates the products of dissimilation. "But if we cut off all communication of the muscles with its nutrient vessels bringing in blood, the muscle thus

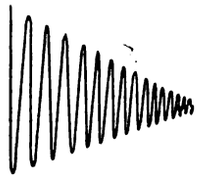


Fig. 7.—Typical Fatigue Curve of Inorganic Substances and Muscles.

reduced to the unassisted energy of its own elements will be able to pass through the alternate stages of exhaustion and to power of contraction under the influence of repose."* This shows that the primary cause of fatigue is not the accumulation of fatigue stuffs.

We have seen that in inorganic substances fatigue is due to overstrain, and that the substance recovers slowly after a period of repose, when it again becomes sensitive. It was also shown that in inorganic substances the recovery is hastened by mechanical vibration and gentle application of heat In the muscles, too, fatigue is quickly removed by mechanical vibration (massage), and the Turkish bath, which combines massage with gentle application of heat is, I believe, very effective in the quick removal of fatigue.

We must also remember that the muscles are bathed in an electrolytic medium, and certain volta-chemical action is induced as an after-effect of the strain. It is found that if two pieces of identical conducting substance are immersed in an electrolyte there is, of course, no E.M.F. between the two; but if one of them be subjected to any kind of strain, a difference of potential between the two is at once produced—a current flows from one to the other; one of the pieces will thus be dissolved (chemical combination) by the voltaic action. After this action has lasted for a considerable time, in order to maintain the efficiency of the voltaic cell it would be necessary to renovate the active plate and remove the products of chemical combination present in the electrolyte. If such an action due to unequal strain takes place in the living tissue, the regeneration of the acted tissue and the removal of chemical products may be effected by the blood supply. It will be noticed that the primary action is due to strain and the fatigue products are the secondary effects of the strain.

From what has been said above it is seen that when a sensitive inorganic substance or a muscle is subjected continuously to electric stimuli of even moderate intensity an increasing proportion of the molecule of the sensitive substance is gradually put in a state of strain, and the amplitudes of the successive response thus become smaller and smaller.

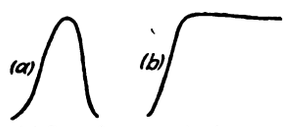
The accompanying diagrammatic curve (see Fig. 7) is typical of the fatigue curve of inorganic substances (*e.g.*, arsenic), and also of muscles.

Lagrange, "Physiology of Bodily Exercise," p. 174.

7. *Effect of Injection of Foreign Substances.*—(*a*) It has been said before that, owing probably to the mobility of its molecule, the recovery of potassium from the effect of stimulus is very rapid. If by any means, say by an admixture with a foreign substance, the viscosity is increased (or elasticity is decreased), then we may expect a retardation of recovery. I have been able to produce this retardation by mixing mercury with potassium. The nature of reaction to electric stimulus in the amalgam (a diminution of conductivity) remains the same as on pure potassium, but the power of self-recovery is lost.

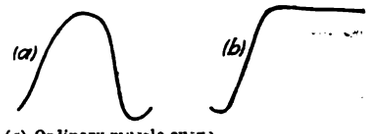
(*b*) Apparently similar to the above is the effect of various "poisons" in modifying the form and time relations of the muscle curve. Thus, veratria (and also the barium, strontium, and calcium salts) retard the self-recovery of the muscle (see Fig. 9).

From the above series of phenomena, it will be seen how great is the resemblance between the effects of electric stimulus on inorganic substances and living tissues. Still more remarkable is the resemblance when we come to study the effect of radiation on the "sensitive substance" in the retina. The theory of molecular strain will then be found highly suggestive in an attempt to explain the complex phenomenon of visual impulse and other phenomena of



(*a*) Curve for pure potassium.
(*b*) Curve for potassium amalgam.

Fig. 8.



(*a*) Ordinary muscle curve.
(*b*) Muscle curve after injection of veratria.

Fig. 9.

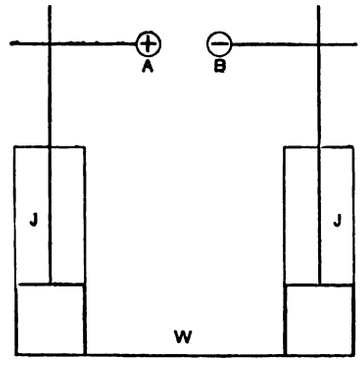
vision at present very obscure. In my next Paper I will give a brief sketch of the subject. A more complete treatment will be found in my communication to the Royal Society, of which the present Papers form an abstract.

(To be concluded.)

SPARK-LENGTH AS MODIFIED BY SOLID DIELECTRICS.*

BY W. J. HUMPHREYS.

While trying some experiments with an electrical influence machine I noticed that the spark-length was greatly increased by the presence of solid dielectrics, such as glass or ebonite, at certain



points near the positive pole. The phenomenon was entirely new to me, and as I was unable to find it described, or even mentioned, in either those books or journals to which one would go for such information I decided to publish an account of my observations. After my experiments were completed my attention was kindly directed to the fact that Messrs. Queen & Co., of Philadelphia, Pa., furnished an electrical influence machine with radically different poles—one being a metallic sphere while the other is a metal plate with an ebonite disc at its centre. I have also learned that Prof. Anthony once used a somewhat similar machine that was imported from Berlin about 1870. It seems, therefore, that the action of solid dielectrics on the spark-length has been known for a long while, at least to certain instrument makers, and I venture to publish the following account of my own experiments along this line because I have been unable, after considerable search and numerous inquiries, to find any reference in scientific literature to this interesting phenomenon.

During the course of the experiments several machines were tried and with equal success, but the one commonly used was a two-plate Wimshurst machine, the plates being 20in. in diameter, of ebonite and furnished with metallic sectors. The accompanying sketch

* From the *Physical Review.*

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shows an arrangement that gives excellent results, though, as will appear from the experiments, it may be greatly modified and the phenomenon still obtained. J, J are two small Leyden jars, W a wire joining their outer coatings, A and B discharging balls connected one to the positive the other to the negative side of an influence machine or other source of high potential, and also to the inner coating of its respective jar. Let the inner coatings of the jars be oppositely charged, as indicated, and the distance between A and B gradually increased till sparks cease to pass. If now the potential difference be maintained and a glass rod, say, be placed quite near that side of the positive pole that faces the negative, the air will in general break down and allow a full noisy spark to pass. Nothing of the kind happens when the rod is placed next the negative pole, or in fact in any part of the field other than that very near the anode.

Various solid dielectrics have been used, all giving the same general result. Among them various kinds of glass, such as lead, soda and different varieties of enamel glass, some in the form of solid rods, others as tubes, even freshly drawn glass fibres of not over three-tenths of a millimeter in diameter, sticks of sulphur, rubber tubes, rods of ebonite, different varieties of wood and finally, as an extreme case, an ordinary silk thread stretched taut and approximately at right angles to the lines of force. The increase in spark-length was usually very pronounced, often more than doubling the maximum length obtainable under ordinary conditions.

In most of my experiments the machine was kept constantly running at an approximately uniform speed, but this was simply for the purpose of holding the potential difference as nearly constant as possible, and not at all essential to the general phenomenon. The sparks of extra length could easily be obtained after the machine had come to rest, provided they were taken before the potential had fallen too low. The following are among the conditions tested:—(1) Polished poles, jars belonging to machine and their outer coatings connected, inner coatings oppositely charged. Results excellent, best obtained. (2) Polished poles, jars belonging to machine but insulated from each other, inner coatings oppositely charged. Increase in spark-length decided, but volume of spark small. (3) Polished poles of machine oppositely charged, no jars. Increase in spark-length still evident, but volume of spark of course very small. (4) Polished poles, one connected to inner the other to outer coating of a single jar. Results good. (5) Polished poles, one or more jars of large capacity. Results pronounced, but spark-length never so long or so greatly increased as with the jars belonging to the machine. (6) State of atmosphere such as to give only very short sparks. Increase in spark length decided, but not very great. (7) State of atmosphere such as to give unusually long sparks. Increase in spark length not great, but still evident. (8) Poles separated very widely, beyond the length even of the forced spark. In this case a small spark left the positive pole when the glass or other dielectric rod was brought in proper position and disappeared along numerous little branches. (9) Negative pole polished, positive pole very rough, in fact the broken end of a metal rod. Under ordinary conditions this gave only pinkish brush discharges, except when the poles were very close together, when numerous small, white and somewhat noisy sparks passed. On placing a glass rod next the positive pole, the white and noisy sparks were more than doubled in size and length. Various other more or less important combinations were made, but these are sufficient to indicate the general nature of the phenomenon, the interpretation of which is probably the same, no matter what the conditions under which it is obtained.

Just what the correct or complete interpretation really is, I do not pretend to say, but the increase of the spark-length when the discharge is between two oppositely charged jars, insulated from each other seems to preclude the assumption that it can be due to oscillations of any kind. Possibly though an explanation is found in the fact that the solid dielectrics used in these experiments have specific inductive capacities greater than that of air, and consequently produced corresponding local concentrations of the lines of force, which concentration extended to a greater or less extent to the surface of the electrode when the dielectric was in its immediate neighbourhood. It may be that the increase in the spark-length was due to this local increase of the electromotive intensity, but in framing an hypothesis to explain it the fact that this increase must be next the anode has to be kept in mind. For the sake of binding these and other experiments more or less closely together, I suggest the following hypothesis: *The dielectric between two poles is most sensitive to electrical disturbances at points next the anode.* The following are some of the facts that seem to support this idea. (*a*) The spark-length is increased by the presence of a glass rod say next the anode, but not affected when the rod is in any other part of the field. (*b*) The greater the increase of the spark-length the nearer the glass rod must be brought to the positive pole. (*c*) The greatest increase of spark-length is obtained with a glass rod of certain size, other things being equal. That is, the rod must not be either too large or too small for best results. (*d*) When glass fibres are used they must be brought very near the pole, usually nearly or quite in contact with it. (*e*) The same phenomenon follows when insulated conductors are used instead of glass or other dielectric. With the view of testing this idea I tried, among other things, the effects of dielectrics of widely different inductive capacities, but otherwise approximately equal. The substances used were: (*a*) A small thin-walled test-tube, empty. (*b*) Similar tube part filled with water. (*c*) Similar tube part filled with metal. The results were not conclusive, the increase in the spark-length remaining nearly the same, with, if anything, the advantage in favour of the tube part filled with water, but this was not sufficiently pronounced to warrant deductions. Again the fact that insulated metal rods act no better than glass rods does not seem to be fully in accordance with the above assumption. These, however, are the only experimental objections I am aware of, and it may be that they are by no means fatal. In further support of this hypothesis we have the increase of spark-length caused by a small spark drawn from the negative pole of two oppositely-charged Leyden jars when their outer coatings are connected, and also Faraday's experiments on spark-lengths between spherical electrodes of different sizes. In speaking of these experiments of Faraday, J. J. Thomson says: "We may express this result by saying that when the electric field is not uniform the gas does not break down so easily when the greatest electromotive intensity is at the cathode as it does when it is at the anode." It will be noticed that the hypothesis used to explain these experiments is only an adaptation of this sentence of Thomson's. Whatever the real action of solid dielectrics in increasing spark-length may be, it is a phenomenon of the anode, and to that extent indicates a greater sensitiveness of the air about this pole to electrical disturbances. It would be interesting, but probably of little use at present, to speculate on the cause of this localised sensitiveness in the dielectric. Possibly it is due to the formation of Grothus' chains and the clustering of different types of ions about the two poles.

ELECTRICITY VERSUS GAS FOR TRAIN LIGHTING.*

BY ALTON D. ADAMS.

Railway trains seem to be about the last important structures, where power is available, that have not generally adopted the electric light. This fact is not only to the disadvantage of the public, as to quality of service, but also to that of railway companies in the matter of operating expense. Three methods of lighting railway cars are in use, those with oil and gas, very generally, and the electric in a few cases. This condition as to the illumination of railway trains is just about that which existed in large offices, mercantile and factory buildings some 15 years ago. Since that time there has been a wide and rapid change to electric light in a large part of such buildings, and the process is still going on. While the superior qualities of electric light have been factors in its application, the actual saving in the cost of operation, over other forms of illumination, has had much to do with its very general adoption in large buildings having power plants. It seems that the advantages of electric lighting that have enabled it to displace oil and gas lamps in large buildings must ultimately bring about a like result on railway trains. So far as the public is concerned, the superior quality of electric illumination is sufficient to give it a decided preference, and its greater safety and economy should appeal to railway managers. Oil is so generally conceded to be an inferior agent for illumination, and its use in railway cars has proved so destructive to life and property, through fire, at times of accident, that a comparison between gas and electric lighting should determine the most desirable method. On the score of safety from fire, gas represents a great advance over the oil lamp, since in case of accident to a car the gas does not spread flames as quickly and the supply is more easily shut off.

Electric lighting on railway trains represents a greater advance over gas, as to immunity from fire, than does gas over the oil lamp. When a railway car, lighted by gas, is overturned, it is highly probable that the gas flames will set it on fire. If an electrically lighted car is subjected to like usage, it is most probable that it will not be set on fire. To simply overturn an electrically lighted car would have no tendency to start a fire from the lamps, and even were the car broken or crushed so as to destroy the insulation on parts of the wires, the usual result would be to blow a fuse and a fire would not probably result once in 100 times. In those cases where the electric current is derived from machinery located at some one point in a train, a derailment would be apt to break the electrical connections between cars and thus shut off the supply.

Turning from the rather remote case of accidents to the ever-present costs of operation, the electric light can be shown to be decidedly cheaper than that from gas on railway trains. Some idea of the relative costs of the gas and electric lighting systems may be gained from the materials consumed for a given lighting effect by each. The costs of operation for electric train lighting vary somewhat according to the system used. Storage batteries are the most

* From the *Western Electrician* of Chicago.

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expensive means for train lighting, not so much on account of the losses of energy in the batteries, which amount to about 15 per cent. of the energy sent into them, as from the items of interest, depreciation, labour and repairs. If electric lighting is to be generally adopted on steam-railway trains, it seems clear that the energy must be generated by dynamos on board, as this plan is at once the simplest and cheapest. With electric current generated by dynamos on the train, conditions approach very close to those that obtain in the ordinary isolated plant.

One of the most important points to be decided for electric-generating plants on railway trains is the method of driving the dynamo. Three plans for dynamo driving present themselves. Dynamos may be driven by steam from the locomotive boiler, used in a special engine ; a gasoline or oil engine may be operated for the dynamo, or it may take its power from the car axle.

Two material objections exist to the supply of power for the dynamo from the locomotive boiler ; one, that the available capacity of the boiler for hauling the train is thereby reduced, and the other and more serious objection that the dynamo can only be operated while the locomotive is connected with the train. That the reduction in the capacity of boiler available for train hauling is a small matter, may be seen from the requirements of power for lighting purposes. Allowing 30 incandescent lamps per car, each lamp consuming 50 watts, a train of 10 coaches would consume 15kw., or 20 E.H.P., with all lamps lighted. A good engine and dynamo, with capacity for this load, will show a combined efficiency of 80 per cent., as to the indicated power of the engine cylinder, and a simple engine for the purpose should not consume more than 30lb. of steam per indicated horse-power-hour at full load. The maximum demand for steam on the locomotive boiler should not, therefore, exceed $(20 \div 0{\cdot}80)\ 30 = 750$lb. per hour for electric lighting under the conditions stated. So small a per cent. of the locomotive capacity devoted to lighting purposes would not be objectionable in many cases, but might not be admissible in others. From the standpoint of lighting requirements, the necessity for locomotive connection before the dynamo can be operated is certainly objectionable, and turns attention to a system that is free from this defect.

The use of a special steam boiler on the baggage car for the purpose of electric lighting does not seem desirable, but a gasoline or oil engine may well be employed instead of a steam engine for dynamo driving. Petroleum engines, in the sizes suited for driving dynamos on railway trains, and working at from one-half to full load, may be expected to develop an indicated horse-power-hour on 0·8lb. of petroleum, or 0·6lb. of gasoline. Because of the explosive nature of gasoline vapour the petroleum is perhaps more desirable for use on railway trains. Allowing the petroleum engine and its driven dynamo to have a combined mechanical and electrical efficiency of 80 per cent., 1lb. of petroleum is consumed for each electrical horse-power-hour delivered at the dynamo terminals. Each electrical horse-power of 746 watts is sufficient to operate 15 50-watt incandescent lamps, so that the 300 lamps assumed to be necessary for a train of 10 coaches would require $300 \div 15 = 20$lb. of petroleum per hour of operation at full load. This includes no wiring or battery loss. A petroleum engine and dynamo in the baggage car would enable electric lamps to be operated in any part of the train as soon as it was made up, without regard to the presence of the locomotive.

Another method of driving dynamos on railway trains is that by which they are attached to the car axle. This plan combines the disadvantage incident to the reduced capacity of the locomotive for traction purposes, with the further one that when the train stops or has its speed reduced below a certain rate the dynamo is put out of action. In order to compensate for variations in the train speed, within certain limits, the dynamo must be of a special type, more expensive than the usual form. It seems doubtful whether any material advantage exists with a special dynamo driven by the car axle, over one with an independent engine, supplied with steam from the locomotive boiler. In order to render satisfactory lighting service, a storage battery is absolutely necessary on railway cars, where the dynamo is driven by the car axle, as the lamps must not go out when the train slows up or stops. With either a steam or petroleum engine to furnish power for the dynamo, a battery is only necessary if electric light must be had on the individual cars before they are connected with the baggage car. More battery capacity must obviously be had with a dynamo driven by the car axle than when an independent steam or petroleum engine is employed. In either case, however, the capacity of batteries is trifling compared with that necessary to light cars without the aid of a dynamo on the train. On the basis of the above figures, there must be $30 \div 0{\cdot}8 = 37{\cdot}5$lb. of steam taken from a locomotive boiler for each electrical horse-power-hour delivered at the dynamo terminals. Assuming a loss of 10 per cent., which is ample, in the car wiring, and in the auxiliary batteries, the delivery of 1 E.H.P. hour at the car lamps requires $37{\cdot}5 \div 0{\cdot}9 = 41{\cdot}6$lb. of steam from the locomotive boiler for the dynamo engine.

If the dynamo for train lighting is driven from the car axle, it seems certain that its requirement as to increase of steam in the locomotive cylinders will be at least the amount just stated. If the locomotive boiler evaporates 7lb. of water per pound of coal burned, 1 E.H.P. hour, delivered at lamp terminals, requires the consumption of $41{\cdot}6 \div 7 = 6$lb. of coal. Allowing the same loss of 10 per cent. in wiring and batteries, when a petroleum engine is used, each electrical horse-power delivered to the lamps require 1·1lb. of petroleum in the engine. As incandescent lamps of the 50-watt, or other usual size, yield one-third of a candle-power per watt, 6lb. of coal or 1·1lb. of petroleum furnish, through the agency of engine and dynamo, $746 \div 3 = 248$ c.p. hours. One thousand cubic feet of oil gas for car lighting can be produced from about 99lb. of petroleum and 96lb. of coal. This oil gas yields about 12 c.p. hours per cubic foot, in open-flame burners, or 12,000 candle hours for the 1,000 cubic ft. As the petroleum consumed to produce this 1,000 cubic ft. of oil gas is 90 times as much as that necessary to supply 1 E.H.P. hour to incandescent lamps, and the consumed coal is 16 times as great in amount, the petroleum and gas would generate $248 \times 106 = 26{,}288$ c.p. hours at electric lamps. This is more than twice the amount of light derived from this fuel when employed to generate oil gas.

The plant for oil gas production and the car equipments for its use cost probably somewhat less than do engines, dynamos, batteries and wiring for equivalent illumination, but the large saving in materials consumed, by the electric system, much more than offsets the greater first cost.

ON THE VECTOR POTENTIAL OF ELECTRIC CURRENTS IN A FIELD WHERE DISTURBANCES ARE PROPAGATED WITH FINITE VELOCITY.*

BY S. H. BURBURY, F.R.S.

1. If $u'v'w'$ be the components of the total electric current at $x'y'z$ in a homogeneous isotropic transparent medium, the components of vector potential FGH at any point xyz at a given instant are usually defined as follows :—

$$F = \iiint \frac{u'}{r}\,dx'dy'dz = \int \frac{u'}{r}\,d\tau, \text{ \&c.,}$$

where $$r = \sqrt{(x'-x)^2 + (y'-y)^2 + (z'-z)^2},$$

and the integration is over all space. Also $u'v'w'$ are the values of $u'v'w'$ at the given instant, and therefore all at the same instant. Hence follow Poisson's equations :—

$$\nabla^2 F_{xyz} = -4\pi u_{xyz}, \text{ \&c.} \quad \ldots\ldots\ldots \quad (1)$$

2. If

$$\begin{aligned} \alpha &= dH/dy - dG/dz \\ \beta &= dF/dz - dH/dx \\ \gamma &= dG/dx - dF/dy. \end{aligned} \quad \ldots\ldots\ldots \quad (2)$$

Then

$$d\gamma/dy - d\beta/dz = -\nabla^2 F + d/dx(dF/dx + dG/dy + dH/dz),$$

and if we assume

$$du'/dx + dv'/dy + dw'/dz = 0,$$

and therefore

$$dF/dx + dG/dy + dH/dz = 0 \text{ everywhere,}$$

we have

$$d\gamma/dy - d\beta/dz = -\nabla^2 F = 4\pi u. \quad \ldots\ldots\ldots \quad (3)$$

Hence is deduced

$$\nabla^2 F = K d^2 F/4\pi dt^2. \quad \ldots\ldots \quad (4)$$

where $V = 1/\sqrt{K}$ is the velocity of propagation of a disturbance. Also $\frac{1}{2}(Fu + Gv + Hw)$ is the energy per unit of volume at xyz. (5)

3. The theory in this form is open to objection. If u', the current at $x'y'z$, changes with the time, we have a corresponding change of F given by $dF/du' = 1/r$. But owing to (4) no physical quantity at xyz can be immediately affected by the change at $x'y'z$. The change can have no effect whatever at xyz till after the expiration of the time r/V. If therefore F be any physical quantity, we must have $dF/du' = 0$, which is inconsistent with our definition. If F be not a physical quantity, Fu cannot denote energy, which is inconsistent with (5).

4. The fact that V is very great, and r/V very small, does not meet the difficulty, because $\frac{r}{V}\frac{du'}{dt}$ is not generally small.

5. It is proposed to substitute for u', the current at $x'y'z'$ at the given instant u'_t, the current which did exist at $x'y'z'$ $\frac{r}{V}$ seconds ago, so that our definition will be $F_t = \int \frac{u'_t}{r}\,d\tau$. F_t is used by way of distinction from F. In this form of F the objections above taken cease to have effect.

As u' and all its derived coefficients according to the time are

* Abstract of a Paper read before Section A of the British Association at Bradford.

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supposed finite, we may write $u'_t = u' - \frac{r}{V}\frac{du'}{dt} + \frac{1}{2}\frac{r^2}{V^2}\frac{d^2u'}{dt^2}$, &c., or symbolically, for convenience only.

$$u'_t = \epsilon^{-\frac{r}{V}\frac{d}{dt}}u'$$

$$F_t = \int dr \frac{1}{r}\epsilon^{-\frac{r}{V}\frac{d}{dt}}u' \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

6. It is shown that, *prima facie*, F_t, G_t, H_t, so defined, satisfy the differential equations (1) as well as do the ordinary FGH. So as regards the differential equations the proposed substitution makes no difference in form to the theory.

7. An objection is considered that F and F_t cannot both satisfy Poisson's equations (1) because if they did we should have $\nabla^2 F = \nabla^2 F_t$, and this cannot, it is said, be true because

$$F = F_t + \int dt \frac{1}{V}\frac{du'}{dt} - \frac{1}{2}\int dt \frac{r}{V^2}\frac{d^2u'}{dt^2} + \frac{1}{2\,3}\int dt \frac{r^2}{V^3}\frac{d^3u'}{dt^3}, \text{ &c.}$$

and since $\left.\begin{matrix}\nabla^2 r^2 = 0\\ \nabla^2 r = 0\end{matrix}\right\}$ when $r = 0, \nabla^2 F = \nabla^2 F$ is not true.

If the objection be valid, it is not evident whether we should use F or F_t.

8. But Poisson's equation requires only that, however small be the radius "a" of a sphere described about xyz.

$$\int_o^a 4\pi r^2 \nabla^2 F dr = -4\pi \int_o^a 4\pi_1{}^2 u dr,$$

and that is satisfied by both F and F_t. For the purpose of Poisson's equation we may use $\nabla^2 F$ and $\nabla^2 F_t$ as interchangeable.

9. Since du'/dt has different values for different waves, F_t should be the sum of a number of terms of the form (6), each corresponding to a wave-length.

10, *et seq.*—A calculation is made of the effect of using F_t instead of F in case of a disturbance spreading in spherical waves from a source.

CORRESPONDENCE.

ELECTROLYSIS BY TRACTION CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your suggestion in your last issue of an underground insulated return connected permanently to a series of surface contact studs on the track, I think you may be interested to learn that Sir W. H. Preece and I applied in July last for a patent covering this modification of the surface-contact system, and that our application has been accepted.—Yours, &c., P. CARDEW.

London, S.W., Sept. 24.

CARBON FILAMENTS AND LIGHTNING FLASHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was very much interested in reading the editorial note in *The Electrician* of August 31 on the curious phenomenon observed in lighted glow lamps connected on the circuits of the Calcutta Electric Supply Co. I have had a long and extensive experience with incandescent lighting in this country, and have once or twice witnessed the phenomenon referred to. Each time it occurred simultaneously with an exceptionally vivid lightning flash, and in lamps connected with an overhead system of conductors. I have never before seen any printed account of this remarkable effect, and believe it to be an exceedingly rare occurrence over here.

It would be interesting to ascertain if the increased luminescence is due to the "coherer" effect, so ingeniously suggested in your note, or to an actual increase of line voltage, caused in some way by the atmospheric discharge.—Yours, &c., W. S. ANDREWS.

Schenectady, N.Y., U.S.A., Sept. 11.

[An unsigned letter on the above subject also appears in our Notes columns this week.—ED. *E.*]

Electric Tramway Working in New York.—The annual report of the Metropolitan Street Railway Co. of New York indicates a prosperous year's work and amply justifies the conversion from cable to electric traction. This conversion has been largely completed for some time, and the entire 217 miles of route will shortly be running on the conduit system. During the past year no less than 382,000,000 passengers were carried, the gross receipts being £2,944,000. The ratio of expenses to receipts was as low as 48·26 per cent.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Arbroath.—A special meeting of the Gas Corporation was held on Tuesday to consider a report from the consulting engineers (Messrs. Mathew Buchau and Hogarth) on electric lighting. Further consideration was adjourned.

Barnes (London)—A loan of £30,900 for electricity works has been obtained from the Liverpool Victoria Legal Friendly Society at 3½ per cent.

Barnsley.—The borough electrical engineer (Mr. S. E. Bastow) has been instructed to prepare specifications and to invite tenders for a steam dynamo for the 1901 winter load. Fifteen additional enclosed arc lamps are to be erected.

Barnstaple.—Mr. W. P. Adams has been appointed consulting engineer to report upon electric lighting matters.

Bath.—The Electric Lighting committee reported on Tuesday that since the last meeting the equivalent of 1,800 8 c.p. lamps additional had been connected and 1,200 more were being connected.

Birstall (Yorks.).—The Council is considering the question of applying for electric lighting powers.

Bournemouth.—In addition to deciding upon applying for powers to borrow £200,000 for electric tramways, the Council have decided to open negotiations with the Bournemouth and Poole Electricity Supply Co. for the purchase of the company's works.

Brighouse.—Owing to the increasing demand for electric current the borough electrical engineer (Mr. J. W. Garside) has been authorised to refuse applications from new consumers until extensions to the plant are made.

Bristol.—The Electrical committee reported on Friday that serious differences of opinion had arisen between the engineer and the architect with regard to the foundations for the proposed electricity station at Avonbank. The points in dispute were of an important and complicated nature, and the committee recommended that the matters in dispute be submitted to Sir Benjamin Baker for advice. The recommendation was agreed to.

Buxton.—Application is to be made for powers to borrow £25,000 for electric lighting extensions.

Cannock.—Application is to be made by the Council for a provisional order.

Cardiff.—The dispute between the members of the staff of the electric lighting department was again under discussion by the Electric Lighting committee last week. The chairman (Ald. P. W. Carey) stated, in answer to a question by Mr. Good, that the committee had instructed the town clerk to report to the Board of Trade, and no doubt the Board would hold an inquiry. He had before him a long communication from Mr. Illingworth, which he had not read, but had only seen the signature, and he would have it sealed, with their permission. There were other questions to come on connected with the department which had better be discussed at a special meeting. Mr. Illingworth's letter was sealed, and a special meeting was held yesterday (Thursday) to further consider the matter.

Carmarthen.—A committee was appointed on Tuesday to report on the question of obtaining electric lighting powers.

Chapel Lighting.—The nave of St. George's Chapel, Windsor Castle, has been fitted for the electric light.

Croydon.—The County Council have applied for sanction to borrow £3,000 for arc lighting the tramway routes.

Dundalk.—The Council recently invited tenders for the transfer of their provisional electric lighting order, but we learn that no tender was received. Dundalk is a town of about 12,500 inhabitants, and the Council's provisional order was obtained in 1897.

Dundee.—By permission of the Board of Trade the speed of the electric tramcars in the centre of the city is to be increased from 4 miles to 6 miles per hour.

Electrical Enterprise in Mexico.—Electricity is being largely adopted in the development of the industries of Mexico. In the Pachaca district it is extensively employed in mining, water-power generation being established at a considerable distance from the point of distribution. For the lighting of the chief cities of Mexico electricity has been for some time adopted, and the imports of electric incandescent lamps in 1899 reached a total value of £15,899. These lamps were chiefly of American and German make; 100 tons of storage batteries, valued at £9,372, were imported into Mexico in 1899, chiefly from the States; 105 tons of rubber belting and 76½ tons of leather belting, the whole valued at £28,000, were imported.

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The city of Tampico is lighted electrically, and the company owning the concession is now supplying current for private lighting. The Customs House and wharf are being lighted electrically, and the government is erecting its own supply station. The Customs House at Tampico is one of the finest buildings on the American continent.

At Monterey, a mining, smelting and manufacturing centre of growing importance, a project is on foot for the conversion of the street tramways from animal to electric traction. There is a suburban railroad running from Monterey to Topo Chico Hot Springs and the motive power is to be changed from animal to electric traction. The Monterey Electric Light Co. has considerably increased its plant and now supplies current for heating, cooking and motive power. The engine and boiler capacity was increased during 1899 from 300 H.P. to 750 H.P., and the station has a lamp connection of 7,800 16 c.p. A report on the trade of Mexico for 1899, from the British Consul, Mr. L. J. Jerome, should be read by all interested in Mexican trade developments.

Electric Lighting in Argentina.—It will be remembered that for some time past friction has existed between the Municipality of Rosario and the River Plate Electric Light and Traction Co. The matters in dispute were referred to arbitration. The *Review of the River Plate* for Sept. 1 announces that the Arbitration Court, which has been sitting for the past two years in the case of the Municipality of Rosario *v.* River Plate Electric Light Co. for non-fulfilment of contract, and the counterclaim of the company against the Municipality for fines unjustly imposed, has given its award. The company is ordered to put all its overhead wires, posts, &c., into proper order, and to comply with the rules of the English Board of Trade within six months; also to change all existing arc lamps for others of more modern construction, and to change the carbons at present being used. This is also to be done within six months. Any work not done within this time can be taken down by the Municipality and fines imposed for every lamp removed or not lighted at the rate of $1 gold a night. There are about 300 street lamps. Both parties are ordered to draw up regulations for interpretation of certain clauses in the contract within two months, failing which it is to be done by arbitration. The Municipality is ordered to listen to the protests of the company and to carry out the necessary tests before a fine can be imposed. Regulations for carrying out tests are also laid down. The claim of the Municipality for a return of about $200,000 for defective light and non-compliance with contract was thrown out. The counterclaim of the company for the return of fines was allowed in those cases in which it had been proved that these had been unjustly imposed. We learn, however, that nothing is known of this award at the London offices of the River Plate Company.

Electric Traction in Ceylon.—A proposal is made for the adoption of electric traction on the Uda Pussellawa Railway, and in a recent communication to the Colonial Secretary, the governor (Sir J. West Ridgeway) states that when travelling in England some time ago he had made himself acquainted with the working of the Isle of Man electric railway, and since his return he had been making inquiries as to whether electric instead of steam traction could be advantageously adopted on the Uda Pussellawa railway. Under the conditions that prevail between Nanu-oya and Uda Pussellawa, the water power of the neighbourhood, which was now absolutely wasted, might be utilised in supplying at least part of the tractive power. The Nanu-oya and two tributary streams which join it at the village of Nanu-oya represented a wasted force of about 370 H.P. in ordinary fine weather, which is much increased during the rains. The power of other streams could be utilised, and would go some way towards giving the necessary power for the scheme. The gradients were heavy, and a scheme that dispensed with the haulage of locomotives reduced the tractive power required and lessened the wear and tear of the permanent way. Judging by the gradients that were worked by the electric tramways in Genoa (Sir J. West Ridgeway continued), the road between Nanu-oya and Uda Pussellawa was practicable, but if it was considered desirable to keep away from the cart road between Nanu-oya and Nuwara Eliya, an alternative route could be chosen. A cheaper form of permanent way could be used if the rail and cart traffic were kept separate, and the alternative route would open up the opposite side of the river. This letter was referred to the consulting engineers to the Crown Agents for the Colonies (Messrs. Gregory, Eyles and Waring, of Westminster), and they report that, assuming the volume of water in the Nanu-oya, with its two tributaries, to be equal to a minimum in the driest weather of, say, 300 H.P., it would, in their opinion, afford sufficient power to generate the electric energy required to work the line without the aid of steam engines, on the supposition that there would never be more than two or at the outside three trains in motion at one time, and that all these trains were not at the same moment ascending the steepest gradients. After referring to the initial expenditure in connection with such a project, Messrs. Gregory, Eyles and Waring state that the sharp curves and steep gradients of the line would not form any obstacle to its being worked by electric power, and if, as they believed, an overhead conductor would be the best method of transmitting electric current from the generating station or stations to the motors on the trains, the numerous level crossings of the road which occur on the present route would not be affected by the substitution of electric working for steam. The report concludes as follows:—"Electric traction does not, however, lend itself to lines where the traffic is such that it could be readily dealt with by two or three trains each way per day, and the result of our investigations lead us to the conclusion that the traffic would have to be increased at least three-fold beyond the present estimate before the cost of electric traction could be reduced to that of ordinary steam locomotives. This fact in itself appears to us to point conclusively to the undesirability of adopting electricity as a motive power on the Uda Pussellawa line."

Exeter.—At present the equivalent of 20,000 8 c.p. lamps is connected to the mains, and the demand for current is being maintained in a satisfactory manner.

Folkestone.—The Council are advised by their General Purposes committee to adopt an electric tramway scheme, estimated to cost about £94,000.

Glasgow.—Messrs. Alexander Thomson & Son have been relieved of their contract for bricklaying and other work at the Pinkston power station, and the town clerk and the general manager were entrusted with the task of completing it.

Hampton.—A report has been prepared by Messrs. Handcock and Dykes, in conjunction with the surveyor (Mr. J. Kemp), in which the Council are advised to retain electric lighting powers in their own hands. The estimated cost of electricity works is put at £15,450, and of a refuse destructor at £3,425.

Hanley.—An inquiry was held here on Friday into the application of the Corporation to borrow £9,500 for refuse destructor works and £4,000 for electric lighting, the latter sum to provide two additional Lancashire boilers (£1,400), fuel economisers (£600), feed-water heater (£200), two exhaust smoke flue fans (£276), extensions of boiler-house (£800), the construction of coal bunkers, approach road and coal chutes (£585), and tiling engine room floor and contingencies (£138). The town clerk (Mr. A. Challinor) explained that owing to the increase in the price of materials, the original estimates had been exceeded. The first estimate totalled £4,000, and the amended estimates £5,000. At the meeting of the Council held on Sept. 18 application was ordered to be made for permission to borrow £7,000 for extensions of mains, transformers, meters, &c. This application would be made as soon as the detailed estimates and plans could be completed. In the meantime he applied for so much as was now required in consequence of the increased cost of materials and further requirements at the electricity works amounting to £1,000. The inspector said the resolution of February this year stated that the money was required for a chimney stack and three new boilers, whereas the specific terms of the present application were somewhat different. It was now asked for money to build two new boilers only, and the chimney stack had been dropped. The borough engineer (Mr. J. Lobley) said they were postponing the erection of the third boiler. The inspector said it was merely a technical point, but he could not hold an inquiry into an application when the specific purpose differed from the terms of the resolution passed by the Council. Mr. Lobley said application would be made to the Board later for sanction to borrow for the boiler and chimney stack. The resolution was passed before the plans and estimates were made. The present application, of course, was only for a part of the work contemplated by the Council. An objector (Dr. Adler) said he did not actually oppose, but he wished that certain conditions should be attached to the consent of the Board. The inspector said he thought the Council had better pass a fresh resolution rescinding that under which the present application was made, and then apply for £5,000 instead of £4,000. Mr. Lobley said the cost of street lighting for the year ended Dec. 31 was £1,447. There were 65 arc lamps and 80 columns fitted with incandescent lamps. The amended estimates now submitted made a total of £5,000 instead of £4,000. The extra £1,000 was for the increased cost of boilers, and also for additions not included in the first estimates. The resolution passed at the Council on Aug. 28 ordered an application to borrow £7,000 required for extension of mains, provision of transformers, &c. The additional £1,000 would be included in that £7,000. Ald. Hammersley gave figures showing the increased demand for electric current in the borough. He said demands were made upon them which they could hardly meet. Dr. Folker urged that the electricity works had been mismanaged, and a loss incurred of £2,690. No further loan should be granted until an expert had reported upon the whole question. Ald. Hammersley said that instead of a loss, they had paid off over £5,000, and the sinking fund could not be regarded as a loss. In five years they had made £3,000. There had certainly been no mismanagement. Dr. Adler said there was a feeling in the borough that the works were not being carried on with due skill, and he would grudge no money whatever for electric lighting, because he believed with

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Ald. Hammersley that there was a great future for the department. But he asked that until an expert had reported to the Council on the question sanction for the loan should be withheld. The inspector said that £4,000 as set forth in this estimate contained a good deal that was urgently required, and to call in an expert would take a considerable time. If they had to wait for that they probably would not get the necessary work done. From what he had heard and seen he thought the officers of the electricity department would themselves be more than pleased to have an expert called in. He questioned whether he had the power to order an expert to be called in. He would, however, report the objection and the suggestions to the Local Government Board.

Holyhead.—The desirability of establishing electricity works is under consideration by the Council. It is considered that water-power available in the vicinity could be utilized in the generation of current, and Mr. Thunderbolt has been requested to consider and report upon the matter.

La Plata (Buenos Ayres).—The City Council has entered into a contract with Mr. Frank R. Cassels for the erection of new electricity supply works. Mr. Cassels also proposes to construct an electric tramway to the Matadero.

Light Railways.—The Long Melford and Hadleigh Light Railway order has been submitted to the Board of Trade for confirmation. Objections by Oct. 24.

The Light Railway Commissioners will hold an inquiry on 17th inst. at Kidderminster into the application of the Kidderminster and District Electric Lighting and Traction Co. for an order to authorise the construction of the Kidderminster and Bewdley light (electric) railway.

An inquiry was held at Rhyl last week into the application of the Rhyl and Prestatyn Light Railway Co. for an order to construct an extension of the Rhyl and Prestatyn light (electric) railway authorised in April last. The company has entered into an agreement to take current from the Council's electricity works. There was no opposition, and the order was granted.

An enquiry was held at Blackburn, on Tuesday, into the application of the Auxiliary and Light Railways and Tramways Co. (Ltd.), for an order to construct the Blackburn, Whalley and Padiham district light railways. On behalf of the promoters, Mr. Balfour Browne, Q.C., said the lines were to connect Blackburn and Burnley, between which towns there were important centres of population. Beginning at Blackburn, they would run north to Rishton, thence to Clayton-le-Moors, to Harwood Bar, over Cock Bridge to Whalley, and from Whalley east to Padiham and Read. The County Council contended that certain portions of the road were too narrow, on which the promoters joined issue. Mr. C. Gradwell, engineer to the promoters, said double lines would be laid throughout. The total length would be 14 miles, and the estimated cost £154,000. For the County Council the clerk (Mr. Clare) said the real question was, who was to pay for the expenditure which must be incurred to remove inconvenience and dangers to the public which would exist if the roads and bridges were allowed to remain as at present. The principle underlying the question was that under no condition whatever should a county ratepayer be asked to subsidise a trading undertaking. If the local districts, who were so anxious for the railways, were desirous of contributing it was all right.

An inquiry was held at Wigan on Wednesday into the application of the Wigan Tramway Co. to construct light (electric) railways of a total length of about 4 miles.

Liverpool.—The Wavertree electric tramway route has been officially inspected on behalf the Board of Trade, and will be opened for traffic within a few days.

Maidstone.—Acting on the advice of their consulting engineer (Mr. S. Sellon), the Council will promote a bill for powers to construct electric tramways in this district.

Metz (Germany).—The tramways are to be converted to electric traction, and the contract has been obtained by the Union Elektricitäts Gesellschaft of Berlin.

Municipal Telephony.—In the Brighton municipal telephone licence the minimum rate for an unlimited service has been fixed at £4. 10s. per annum, for limited service £1. 10s. per annum, and toll of ¼d. per call. The charges for telephone service (limited or unlimited) applies only to subscribers not more than one mile from the nearest switch room, any excess distance to be charged a sum not exceeding £1. 5s. per quarter mile or fraction thereof per annum. The charges for the use of public call offices are to be within the following limits: Maximum 2d., minimum ½d. per message. The consulting telephone engineer (Mr. A. R. Bennett) has been requested to furnish a specification of the pipe or conduit required for the underground telephone wires and of the method of laying, with an estimate of the cost per mile.

Norton (Yorks).—The application of the Northern Counties Electricity Supply Co. for a provisional order is not to be opposed.

Nuneaton.—The Local Government Board have intimated that in regard to the Council's scheme for the extension and development of the electricity works the Board would raise no objection to the Council proceeding with the erection of the chimney shaft and ordering additional machinery. When the Board have been furnished with a copy of the resolution of the Council applying for sanction to borrow a further £2,000 sanction for the total amount required will be given.

Obituary.—The death is announced of Mr. Samuel Maquay, which took place this week at Chertsey. Mr. Maquay was an expert in primary batteries (the "Maquay" battery was on the market some years ago) and was the inventor of a miner's safety lamp.

Pontypridd.—The Council are recommended by their Electric Lighting committee to apply for a provisional order.

Provisional Orders.—The Alnwick, Anfield Plain, Benfieldside (Durham) and the Kirkheaton (Yorks.) and Bellingham (Northumberland) District Councils have consented to the applications of the Northern Counties Electricity Supply Co. of Newcastle-on-Tyne for provisional electric lighting orders.

Provisional Order Transfer.—The Harrow Council notify their intention to transfer their 1900 electric lighting order to the Harrow Electric Light and Power Co. (Ltd.). The company is to pay the cost of obtaining the order, and the right to purchase the undertaking on certain contingencies is reserved to the Council.

Ripon.—The question of establishing electricity works is under consideration, and last week a deputation visited the Harrogate electricity works. The borough electrical engineer (Mr. George Wilkinson) personally conducted the deputation and supplied technical details.

Russia.—Some time ago Messrs. Siemens and Halske secured a contract for lighting the town of Nicolaiev by electricity, overhead conductors being proposed. Owing to the delay in granting approval of the overhead system by the Department of Telegraphs the work of construction and equipment has been hampered, and little progress with the work has, we understand, been made.

Southampton.—Mr. A. P. Trotter inspected the Portswood-Docks Station section of the Corporation electric tramways on Saturday last, and the lines have been opened for traffic.

Strabane (Ireland).—An electrical engineer is to be called in to report upon the advisability of establishing electricity works.

Tonbridge (Kent).—At an inquest on the bodies of four persons burnt to death at a fire which occurred in this town recently, the coroner's jury in returning a verdict of accidental death strongly recommended the use of electric fire calls, and the evidence adduced certainly bears out the urgency of the recommendation.

Tramway Extensions in Middlesex and Surrey.—As we have already announced, the London United Tramways (Ltd.) have given notice to local authorities in Middlesex and Surrey of intention to apply next session for powers to construct additional extensions of their system of electric tramways. The extensions will include 23 miles of tramway in Surrey, 20 miles in Middlesex, and 20 miles in the County of London. Under the proposed bill the existing system is to be extended to St. Pancras, Marylebone, and Fulham, and across the Thames to Putney, northward to Willesden and Southall, and westward to Sunbury. The Surrey extensions include a length of over 4 miles, connecting Putney with Richmond. Another line will leave the southern approach to Hammersmith Bridge, and pass across Barnes Common; and there is also to be an extension from Kew Bridge to Richmond. In Middlesex lines will connect Isleworth with St. Margaret's, Hounslow and Cranford, Brentford with Ealing, and Twickenham with Hanworth and Kempton Park. Intercommunication lines are also scheduled between different parts of Kingston, Putney Hill, Surbiton, Tolworth, Hook, Long Ditton, Thames Ditton, Esher, and Hampton Court.

Tramway Strike.—The motor men and conductors of the Oldham, Ashton and Hyde electric tramway came out on strike on Saturday night, in consequence, it is alleged, of the manager's discharging union employés and replacing them by non-unionists.

Tynemouth.—Application has been made for sanction to a loan of £10,000 for refuse destructor works.

Wellington (Salop).—A provisional order is to be applied for by the Council.

Wisbech.—A unanimous resolution in favour of applying for a provisional order has been passed by the Council.

Workmen's Compensation.—At Loughborough County Court, John Knight, a mechanic employed at the Brush Company's works, applied for a declaration of liability, which the respondents admitted he was entitled to. Plaintiff's eyesight had been injured, and the company had paid him since the accident about the same wages that he was earning at the time of the occurrence. The Court was asked to make a declaration of liability on the ground that he was suffering from permanent physical injury. The company had made inquiries, and they found that the work done by plaintiff since the accident

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had been perfectly satisfactory. If it turned out that he was not able to do his work so well he might have to take less money. Judge Wightman Wood, in granting the order, said plaintiff had got all he was entitled to. At the present time he was losing nothing through the accident. If he got less he had a right to come to the Court and get the amount put in.

At the St. Helens County Court on Wednesday Judge Collier was asked to arbitrate in a claim for compensation made by George Hindle against the British Insulated Wire Co. in respect of an accident which happened on Dec 29, 1899, at the St. Helens electric tramway depot, when Hindle fell down a pit and fractured his thigh and arm. He was incapacitated for 40 weeks, and claimed 19s. 6d. per week, half his average earnings. His Honour decided that the accident did not come within the Compensation Act, because it happened in a building of which the respondents were not the occupiers. They were therefore not undertakers within the meaning of the Act.

Electro-Harmonic Society.—This society has returned to its old haunts at the St. James's Hall Restaurant, and the first (smoking) concert of the season will be given on Oct. 12 at 8 p.m. Members are desired to use their influence in introducing new members to the society. A committee meeting is to be held prior to the first concert, and the names of new candidates will be received by Mr. C. E. Grove, hon. sec., Rosedale, Selsdon-road, Wanstead, up to and including Friday, Oct. 5, in time for the issue of tickets for the first concert to all new members elected on that date. The present membership totals about 300.

EDUCATIONAL NOTICES.

Birmingham University Calendar.—We have received a copy of the first calendar of the University of Birmingham. Full particulars of the course of instruction in the faculty of science, including electrical, civil, and mechanical engineering, metallurgy, chemistry, &c., are given.

King's College (London).—The evening classes in electrical engineering commence on Oct. 8.

Morley Memorial College.—The 1900-1901 session of this College for working men and women, Waterloo-road, London, S.E., begins on Oct. 1. Some particulars of the classes, fees, &c., are given in an advertisement. Miss Emma Cons is hon. sec.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

TENDERS INVITED.

Bermondsey (London) Vestry invite tenders for steam, feed exhaust, and drain pipes, feed pumps, water storage tank and sundry ironwork, and also for steam dynamos, battery charging motor, booster, and balancer. Specifications may be inspected, but not obtained, at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. An advertisement gives further particulars, and tenders must be forwarded to the Vestry clerk (Mr. Frederick Ryall), by Oct. 15.

Swansea Corporation invite tenders for cast-iron arc and incandescent lamp standards. Specifications may be obtained at the Guildhall, Swansea, and may be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. An advertisement gives further particulars, and tenders must be forwarded to Messrs. Kincaid, Waller and Manville before noon Oct. 10.

Sunderland Corporation invite tenders for the supply of 24 car bodies, trucks, and electrical equipment. An advertisement contains further particulars, and specifications may be obtained on application to the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street. Tenders, addressed Chairman of Tramways Committee, Town Hall, Sunderland, must be sent to the town clerk (Mr. Fras. M. Bowey) by noon Oct. 15.

Warrington Corporation invite tenders for wiring the electricity station and central sanitary depôt at Howley. Specifications may be obtained from Mr. W. H. Grimsdale, Bank House, Warrington. See advertisement.

The *Secretary of State for India* invites tenders for (1) a complete electrical installation for supplying to a factory from a waterfall 3 miles distant, and (2) a complete hydraulic installation to develop about 500 H P. Further particulars are given in an advertisement, and tenders must be delivered at the India Office, Whitehall, S.W., by 2 p.m. Oct. 16.

Bootle Corporation invite tenders for a steam dynamo. An advertisement gives further particulars, and tenders, addressed Chairman of Electric Traction and Lighting committee, must be delivered at the Town Hall, Bootle, before Oct. 13.

Maidstone Corporation invite tenders for surface condenser and feed pumps. Specification, &c., may be obtained after Oct. 2 from the consulting engineers (Messrs. Stevens and Barker), St. Peter's-street, Maidstone, and tenders should be sent to the town clerk (Mr. Herbert Monckton) before 10 a.m. Oct. 16.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for supply of stores during the 12 months ending Oct. 31, 1901. Among the articles required are brake blocks, copper, india-rubber, iron castings, ironmongery, sundry tools, &c. Tenders to the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 8.

Ilford District Council invite tenders for direct-current meters and cutouts. Tenders to clerk by noon Oct. 8.

Grimsby Corporation require tenders for wiring the Free Library. Tenders to borough electrical engineer by Oct. 6.

Manchester Tramways committee invite tenders for cast-iron bases for tramway poles. Tenders to chairman of committee by Oct. 1.

Hoylake and West Kirby District Council invite tenders for "free wiring" of premises in district. Tenders to clerk, Council Offices, Hoylake, by Oct. 4.

Birkenhead Corporation invite tenders for feeder mains, &c. Tenders to town clerk (Mr. Alfred Gill) by 4 p.m. Oct. 2.

Nottingham Council invite tenders for 1,500 tons of steel girder tram rails and 76 tons of fishplates. Tenders to town clerk before Oct. 8.

Aberdeen Town Council invite offers for 25 electrical tramcars, and for equipments for six horse cars about to be converted. Tenders before noon of Oct. 17.

Bradford Corporation require tenders for an engine and dynamo, switchboard apparatus, &c., for their destructor works. Tenders to town clerk before Oct. 9.

Eray (Ireland) District Council will on Oct. 4 receive and consider tenders for electric light supplies for 12 months, including cables, house wires, switches, holders, incandescent lamps, &c. Tenders to clerk to Council, before 10 a.m. Oct. 4.

Sheffield Corporation invite tenders for: (*a*) Two 600kw. two-phase steam alternators and exciters, and (*b*) alteration of present single-

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phase plant to two-phase. Tenders to chief engineer and manager of electric supply department (Mr. S. E. Fedden) by Oct. 6.

Dublin Corporation invite tenders for power machinery at Ringsend, including pumping engines and pumps, boilers, electric motors and pumps. Tenders to town clerk by noon Oct. 3.

Dublin Electric Lighting committee invite tenders for electricity mains and accessories. Tenders to town clerk by 4 p.m. Oct. 4.

Eastbourne Corporation invite tenders for water-tube boilers, with fittings, feed pumps, &c.; 400kw. steam alternator, with exciter (vertical enclosed high-speed engine); and main switchboard and connections. Tenders to town clerk by noon Oct. 4.

Tenders are invited for the erection of machine shops, &c, at *Thornbury*, Bradford, for Rosling, Appleby, and Fynn. Tenders to S. Jackson & Son, Tanfield Chambers, Bradford, by Oct. 6.

Hackney (London) Electric Lighting committee invite tenders for electricity supply mains. Tenders to vestry clerk by 5 p.m. Oct. 3.

Tenders are invited for wiring the *Suffolk* County Asylum, Melton. Tenders to Mr. A. T. Cobbold, County Hall, Ipswich, by Oct. 5.

Belgian State Railway authorities invite tenders until Oct. 10 for 60 tons of galvanised iron wire (4mm. diameter), 15 tons (3mm. diameter), and 65,000 telephone and 20,000 telegraph porcelain insulators.

Pozuelo (Albacete, Spain) Municipal Council require tenders until Oct. 7 for the electric lighting concession for 40 years. Tenders to el Secretario del Azuntamiento.

The municipal Council of *Callosa de Ensarria* (Alicante, Spain), invite tenders until Oct. 12 for the concession for electric lighting for 50 years.

Vélez Blanco (Almeria, Spain) municipality also invite tenders until Oct. 15 for the concession for electric lighting.

Tenders are invited for the electric lighting of *Palma* (Spain) for 20 years. Tenders to Municipal Council by Oct. 30.

TENDERS RECEIVED AND ACCEPTED.

Croydon Town Council have accepted the following tenders for electric tramway work:—

British Thomson-Houston Co., car bodies, motor car equipment, feeders, overhead construction, excavating work, &c.
Leeds Steel Works, rails.
Hilton, Anderson, Brooks & Co., cement.
Bart, Boulton and Haywood (Ltd.), soft wood paving blocks.
Millar's Jarrah Forests Co., hard wood blocks.

Shipley (Yorks.) District Council have accepted the following tenders:—

John Spencer (Ltd.), steam and exhaust pipes.
Eclipse Brass and Copper Co., storage battery.
Mavor and Coulson, switchboard and connections.
Western Electric Co., cables.

Greenock Police Board have accepted the tender of Messrs. Babcock and Wilcox for the supply of water-tube boilers, and that of the Silvertown Co. for two steam dynamos (high-speed enclosed engines), boosters, switchboard, steam and exhaust pipes, &c., for their electric tramway scheme.

The contract for the storage battery required for the Witney electricity supply station has been secured by the Hart Accumulator Co.

Walsall Town Council have accepted the tender of the Electrical Power Storage Co. for extensions to their storage battery at £679. 10s.

APPOINTMENTS VACANT AND FILLED.

Barnes District Council require a clerk of works for their electricity undertaking to superintend the laying of cables and the erection of the generating plant under the consulting engineer (Mr. W. Fairley). An advertisement gives further particulars, and applications must be sent to the clerk (Mr. J. E. Anderson), Council Offices, High-street, Mortlake, S.W., by 4 p.m. Oct. 4.

The Council of Hartley College (Southampton) invite applications for the appointment of assistant lecturer in engineering. Applications to clerk (Mr. D. Kiddle) by Oct. 3. See advertisement.

Islington (London) Vestry require a draughtsman and an engine driver for their electricity department. Applications to the vestry clerk (Mr. W. F. Dewey), Vestry Hall, Upper-street, London, N., by Oct. 8. See advertisements.

An electrician is required for the County Asylum, Prestwich, near Manchester. Applications to the superintendent. See advertisement.

Manchester Tramways committee require a lady superintendent for the ticket and cash-counting department. Applications by 6th prox. See advertisement.

Bermondsey (London) Vestry require a resident electrical engineer. Applications to clerk (Mr. Frederick Ryall), Town Hall, Bermondsey, London, S.E., by noon Oct. 3.

An arc lamp trimmer, a mechanical draughtsman and a clerk are required for the Whitechapel electricity department. Applications to engineer (Mr. W. C. P. Tapper), 27, Osborn-street, London, E.

A master for experimental science and mathematics is required for Peebles County High School. Applications to clerk before 1st prox.

We are informed by the India Office that Mr. W. D. Macgregor, of Edinburgh, has been appointed an assistant superintendent in the Indian Government Telegraph Department. The appointment was advertised in *The Electrician* in May last.

Mr. R. M. Archer, A.R.C.S., has been appointed lecturer and demonstrator in physics and electrical engineering, and Mr. S. Sinkinson, B.Sc., lecturer and demonstrator in mechanical engineering, at the Derby Municipal Technical College.

Mr. A. P. Laurie, M.A., lecturer in physics and chemistry at St. Mary's Hospital, London, has been elected out of a short list of five to the principalship of the Heriot Watt College, Edinburgh, in succession to Prof. F. Grant Ogilvie, who was recently appointed director of the Museum of Science and Art.

Mr. R. S. Willows, D.Sc., B.A., has been appointed assistant lecturer in physics and electrical engineering at Battersea Polytechnic.

Mr. Wm. Irving, works manager of Messrs. James Carmichael & Co., has been appointed mechanical engineer in charge of the Pinkston power station, Port Dundas, Glasgow.

Mr. F. Dawe, Swansea, has been appointed general foreman of the Croydon Tramways.

In our last issue we referred to the appointment of a meter superintendent at Sheffield, and by a clerical error the name was given as Mr. A. J. Oridge instead of Mr. A. J. Cridge.

BUSINESS NOTICES.

Warning.—Messrs. J. A. and K. J. McMullen, consulting electrical engineers, of 17, Gracechurch-street, London, E.C., and Hornchurch, Essex, desire attention to be called to an advertisement appearing in another column warning manufacturers and dealers against supplying goods in their name to a person of the name of Harvey, trading, or pretending to trade, at Ware, Herts., under the style of "The Hertfordshire Engineering Co, Ltd." We are informed and believe that Messrs. McMullen have written authority from the man Harvey to issue this caution, and persons interested may see all the documents at the offices of Messrs. Carter and Bell, solicitors, 6, Idol-lane, Eastcheap, London, E.C.

Mr. T. Vaughan Hughes, Norwich Union Chambers, Edmund-street, Birmingham, has entered into partnership with Dr. E. A. Warrington in connection with metallurgical and analytical work, but continues his consulting electrical engineering practice at the above address.

The National Telephone Co. (Ltd.) announce that the head offices of the company have been removed to the new "Telephone House," Victoria-embankment, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

George Stegmann, electrical engineer, 45, St. John's-hill, Clapham Junction, London, S.W., has executed a deed of arrangement. Liabilities £2,440. 5s. 8d., assets £5,600. There are secured creditors to the extent of £2,241. 3s. 8d. Mr. F. W. Davis, 95 and 97, Finsbury-pavement, E.C. is trustee. The principal creditors include:—

General Electric Co.	£662	J. H. Holmes & Co.	£74
Veritye Ltd.	386	Addington Timber Co.	43
W. Rickard	229	Chloride Elec. Storage Synd.	23
S. Evans & Co.	141	Atlas Carbon Co.	20
Hart Accumulator Co.	141	Reliance Rubber Co.	19
Electrical Co.	140	Reliance Wire Co.	18
Gabriel & Angenault	128	I Frankenburg	17
Markt Bros.	126	Russell & Co.	14
Julius Sax & Co.	108	Nettlefolds	14
Elec. Power Storage Co.	106	Croggon & Co.	13
Johnstone, Benjamin & Co.	90	Simplex Steel Conduit Co.	13

A meeting of the Electrical Pioneer Syndicate (Ltd.) will be held at 39, Waterloo-street, Birmingham, on Oct. 25, to receive an account of the winding-up.

In the bankruptcy of R. Foster and W. Baker, trading as Robert Foster & Co., and the Nelson Electrical Engineering Co, at Nelson and Burnley, the first meeting of creditors will take place on 28th inst. at the Exchange Hotel, Nicholas-street, Burnley, and the public examination on the same date at the Court-house, Burnley.

Winding-Up Petition.—A petition for the winding-up of the Acetylene Light Syndicate (Ltd.) has been presented by the Brush Company, and will be heard at the Guildhall, Bath, on Oct. 18.

Engineering Works for Sale.—Our advertisement columns contain particulars of engineering works in the city of Dublin which are offered for sale by tender as a going concern owing to the death

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of the late proprietor. The works are centrally situated and have a suitable set of offices, pattern shop, machine shop and foundry, and smith's shop, together with a number of tools which are all of modern type, many of them being new. Tenders are to be addressed to Mr. A. Basil Wilson, M.I.C.E., Maryville, Malone, Belfast, from whom further particulars can be obtained.

Artistic Electric Light Fittings and Accessories.—The Electrical Co., to meet the increased demand for their manufactures, have opened an extensive range of show rooms at 162, Shaftesbury-avenue, London, W.C., for the display of new and artistic designs in electric light fittings and accessories. An immense stock of electroliers, brackets, pendants, &c., are shown in a particularly effective manner. Success in the exhibition of this class of goods is by no means general, but the method adopted by the Electrical Co. in displaying a particular class of designs and styles of fittings in rooms specially arranged for their reception, while it is not entirely novel in idea, is certainly calculated to, and does in fact, afford the best means of effective display. The range of fittings shown in the new rooms embraces those for mansions, small private residences, business offices, &c. Fittings in oxidised silver are well grouped in one of the rooms, while in another ornamental and classical figures and shades for drawing rooms, boudoirs, reception rooms, &c., make an artistic setting. Hammered iron and bronze work form a feature of another department, while an excellent selection of the newest designs in French artistic metal work should prove attractive to that large class of installation contractors engaged in the fitting up of town and country houses. Electric current is available for showing the fittings to the best advantage, and altogether the display is one which architects, contractors, and the trade generally may be advised to visit. Contracts are now being placed for this class of goods for the coming winter season, and the Electrical Co. have certainly laid themselves out for meeting to the full the most exacting requirements.

Cooling Tower Contracts.—The Wheeler Condenser and Engineering Co. have recently received orders for cooling towers from the Newcastle-on-Tyne Electric Supply Co. (2,000 H.P. capacity), Messrs. Platt Bros., Oldham (1,000 H.P.), Bromley (Kent) Electric Light and Power Co. (1,000 H.P.), and Southend Corporation power station (1,000 H.P.). In the two latter cases the contracts include equipment of condensing plants, exhaust oil separators, feed-water heaters, the cooling towers being of the fan-driven type.

4,000 H.P. Steam Set.—The Berlin Electricitätswerke Gesellschaft have added a 4,000 H.P. steam dynamo to their central station on the Upper Spree. The dynamo, which was constructed by the Allgemeine Electricitäts Gesellschaft of Berlin weighs 16 tons.

Westinghouse Plant.—Circular 1,031, issued by the British Westinghouse Co., describes and illustrates belt-driven polyphase alternators, the particular machines dealt with being 180kw. and 375kw. two-phase alternators.

Electric Heating and Cooking.—We have received from the Simplex Electrical Co., of Cambridgeport, Mass., U.S.A., a descriptive catalogue of electric heating and cooking apparatus. The value of the list is increased by a number of excellent illustrations of a large variety of apparatus manufactured by the company under the patents owned by the American Electric Heating Corporation.

Paris Exhibition Awards.—Messrs. Geipel and Lange inform us that the following specialities, for which they are agents, obtained distinction at Paris: Brown-Boveri three-phase plant (grand prix), Ward-Leonard electric controlling apparatus (gold medal), Vulcan meter (gold medal), Chapman voltage regulator (bronze medal), and Geipel trap (hors concours). Eighty of these traps were used for draining the whole of the steam piping system of the exhibition.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 19 to Sept. 25, with the ports of destination:—

Africa.—Alexandria, £140; Cape Town, £105; Durban, £517 (including £147 telegraph apparatus); Port Elizabeth, £473 (telegraph material). *Argentina*—Buenos Ayres, £937 (including £842 telegraph material). *Australasia*—Adelaide, £61; Auckland, £90; Launceston, £231; Lyttleton, £300; Melbourne, £432; Otago, £134; Sydney, £1,816 (including £120 telegraph material); Wellington, £584 (including £492 telegraph material). *Belgium*—Brussels, £36; Ostend, £274. *Canada*—Halifax, £2,690 (telegraph cable); Toronto, £20. *Chili*, £200; Valparaiso, £80 *Cochin China*, £21. *Denmark*—Copenhagen, £271 (telegraph wire). *Germany*—Hamburg, £700 (telegraph material). *Gibraltar*, £136. *Holland*—Amsterdam, £95; Rotterdam, £17 (telegraph wire). *Hong Kong*, £76. *India*—Bombay, £58; Calcutta, £336 (including £126 telegraph wire). *Japan*—Yokohama, £13,050 (telegraph material). *Mexico*—Vera Cruz, £73 (telegraph material). *Norway*—Bergen, £14,910 (telegraph cable). *Portugal*—Lisbon, £45. *Russia*—St. Petersburg, £70 (telegraph paper). *Straits Settlements*—Singapore, £40. *Sweden*—Stockholm, £233 (telegraph cable). Total £39,291, against £11,232 in the corresponding week last year (Sept. 20 to Sept. 26.)

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

August 3, 1900.

13,951. J. WEISS. London. Improvements relating to electric muffles or furnaces.

13,962. C. A. JENSEN. London. Improvements in electric signal registering systems. (The Yargae Signalphone Manufacturing Company, United States.)

13,963. E. F. CASSEL. London. Improvements in and relating to cypher code systems for use in transmission of cable, telegraphic, and other forms of written messages.*

13,966. THE BRITISH THOMSON-HOUSTON CO. (LTD.) London. Improvements in Röntgen-ray tubes. (E. Thomson, United States.)*

13,967. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electrical distribution. (E. W. Rice, jun., United States.)*

13,968. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electric motor control. (A. G. Davis, United States.)*

13,969. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in insulated electric conductors. (W. Le Roy Emmet, United States.)*

13,970. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in armatures for dynamo-electric machines. (C. P. Steinmetz, United States.)*

13,971. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in rectifiers for alternating electric currents. (E. Thomson, United States.)*

13,972. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electrical distribution. (H. D. Lunt, United States.)*

13,973. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in insulated electric conductors. (W. Le Roy Emmet, United States.)*

13,974. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in rail bonds for electric railroads. (J. R. Lovejoy, United States.)*

13,975. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems for controlling electric motors. (C. E. Barry, United States.)*

13,999. L. BÉNARD. London. Improvements in arc lamps.

August 4, 1900.

14,037. H. T. DAWSON and H. A. DAWSON. Coventry. Improvements in or relating to electrical transmission gear for motor cars and other machinery.

14,053. C. R. CORMAC. London. A lightning protector for telephones.

14,054. J. SAX & CO. (LTD.) and J. AIRD. London. Improvements in indicators for electric bells and the like.*

14,063. G. C. PILLINGER and A. VANDAM. London. Improvements in and connected with combined switches and fuses.

14,067. W. S. SIMPSON. London. Apparatus for generating and utilizing electric energy.

August 7, 1900.

14,086. A. C. BROWN. London. Improvements in wireless or Hertzian telegraphy.

14,101. W. G. HEYS. Manchester. Improvements in coils or helices for electrical purposes. (J. Scott, R. Varley, and J. C. Anderson, United States.)*

14,104. O. LANCKNER. London. Improvements in electrodes for the use in electro-chemical processes. (A. Vogelsang, Germany.)*

14,134. E. J. PENNINGTON. London. Improvements in or relating to electrical traction.

14,139. W. B. PURVIS. London. Improvements relating to electric railway systems.*

August 8, 1900.

14,170. H. H. HILL. Middlesex. A quick make-and-break switch for electrical purposes.

14,212. A. J. BOULT. London. Improvements in or relating to electric furnaces. (The Union Carbide Co., United States.)*

14,215. J. KÖRNER, P. KÖRNER and E. MAHLA. London. Means of fixing electrical appliances to ceilings, walls, furniture and the like.

14,237. C. ZIMMERMANN. London. A safety device or fender for electric tramways or the like.

August 9, 1900.

14,248. A. ECKSTEIN and A. E. MITCHELL. Manchester. An improved electrical replacement indicator.

14,275. G. C. DYMOND. Liverpool. Improvements in and relating to electro-chemical or copying telegraphs. (The Kopier-Telegraph Gesellschaft mit beschränkter Haftung, Germany.)*

14,281. G. FERRIÉ. London. Improvements in telegraphy by means of alternating currents and imperfect contacts. (Date applied for under Patents, &c., Act, 1883, sec. 103, 1900, being date of application.)

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

12,566. ABEL (Karmin). Arrangement and connections of the windings of dynamo machines.
14,572. ROSENFELD, ZELENAY, and DULAIT. System of electro-dynamic propulsion.
14,703. BREMER. Carbon electrodes for arc lamps.
14,806. MAGINI. Counter or meter for electric lamps, motors, and other electric apparatus.
14,878. COLLEY. Covering electrical and other wires and apparatus therefor.
15,017. WEYMERSCH. Electric accumulators or secondary batteries.
15,207. NEUMANN. Production of battery plates or other articles by electrolytic or chemical depositions of spongy metal.
15,268. BRITISH THOMSON-HOUSTON CO. (LTD.) (Rice). Electric lamps.
15,418. EDMUNDS. Insulated electrical conductors or cables.
15,816. WILDE. Electromagnetic rail brakes.
15,882. LUCAS. Apparatus for operating two or more electrical regulating switches or resistance devices together or separately.
15,911. JONES. Electro-magnetic apparatus.
16,055. JONES. Electric switches.
16,083. CUÉNOD. Controlling devices for electric currents.
16,091. RICHARDSON and RAMSBOTTOM. Electrical apparatus suitable for lighting, cauterising and other purposes.
15,199. OPPENHEIMER (Actiengesellschaft Mix and Genest). Switches for high voltage.
16,267. LOCK and MILNER. Electrical apparatus for sorting articles according to one of their dimensions.
16,293. DAVIES. Manufacture of leaden plates for secondary batteries or accumulators, and in moulds and tools to be employed in such manufacture.
16,382. LORRAIN (Sawyer and Robb). Spindles and the driving of the same by electricity.
16,395. WAHLSTRÖM. Arrangement for controlling electric elevators.
16,824. GRAUER. Apparatus for electro-chemical and electro-thermic melting operations, especially for the production of calcium carbide.
17,229. BROOKS and HOLT. Polishing or finishing of electro-plated and other articles.
17,257. ADAMS. Apparatus for generating electrical pressure.
17,815. ATKINSON. Direct-acting electric generators and directly-driven electric compressors for air or other gases.
17,877. BESTWICK. Composition of or from which may be manufactured tubes for various purposes, tyres, and other articles requiring more or less flexibility, or for use as a non-conductor of electricity.
17,878. BESTWICK. Composition of or from which may be manufactured billiard-balls, handles for umbrellas or sticks, electric buttons, and other articles of a like nature and general utility, and as a substitute for mica.
17,953. RATHBONE. Means and appliances connected with air-tight electric arc lamps.
19,020. WILBY. Electric arc lamps.

1900.

516. VESELY. Points and switches of electric tramways and railways.
1,680. SAYER. Picking up electric current sent from a generating station by a railway car and returning it.
2,702. RIETER. Electromagnetic brake dynamometer.
5,257. HEYS (Scott, Varley and Anderson). Apparatus for winding or producing coils, bobbins, helices, or the like for electrical and other purposes.
5,727. TRUDEAU. Electric heating and apparatus therefor.
6,703. BERGMANN. Magneto-electric machines for igniting purposes.
7,314. SAYER. Boiling and vapourising fluids by electricity.
7,781. ROBINSON. Apparatus for wireless telegraphy. (Secret document under sec. 44 of the Patents, &c., Act, 1883.)
7,782. ROBINSON. Transmitting and receiving switch for wireless telegraphy. (Secret document under sec. 44 of the Patents, &c., 1883.)
8,344. MINN and SUN ELECTRICAL CO. (LTD.). Double pin plug and socket for electrical connections.
8,671. SCHULZ. Construction of electric switch.
8,704. CARTER. Apparatus for facilitating the photometry of arc lamps and the like sources of light.

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Ltd.).

The thirteenth half-yearly report of the directors of this company (for the half-year to June 30) states that after writing off as depreciation £5,630. 19s. 4d., and paying interest on debenture stock, the balance to credit of profit and loss at the end of the half-year (including £5,212. 1s. 1d. brought forward) was £31,399. 8s. 11d. Out of this the directors propose dividends at the rate of 6 per cent. per annum on the preference and 10 per cent. per annum upon the ordinary shares (taking £14,923. 17s. 10d.). The amount payable to the original directors being £4,218. 8s. 2d., the balance available is £12,257. 2s. 11d. £2,000 of this is carried to debenture redemption, and £3,500 to reserve, leaving £6,757. 2s. 11d. to be carried forward. The balance of capital remaining unissued (10,000 preference and 10,000 ordinary shares) was allotted to the shareholders in June last, and 8,788 preference and 9,425 ordinary shares were taken up, and the balance was so greatly over-applied for by the shareholders that it could only be allotted in about the proportion of one preference share for every 10, and one ordinary share for every 50 applied for.

Of the balance of £29,656. 2s. on share premiums account, £5,000 has been applied to writing down the company's property at Thames Ditton and £20,000 has been transferred to reserve. The balance (£4,656. 2s.) has been brought up to £21,493. 2s. by payments under the first instalment of the premiums upon the 1900 issue of shares.

The large engine, capable of working up to 3,000 I.H.P., exhibited by the company at Paris, in conjunction with a dynamo by Messrs. Siemens Bros. & Co., has been awarded a Grand Prix, another similar award being made for the dynamo.

Owing partly to difficulty in obtaining dynamos from the makers, and partly to other causes for which the company is not responsible, an unusually large value of completed or nearly completed engines (all on order) remained in the accounts at the end of the half-year under the head of "unfinished work." Had it been possible to deliver and invoice these engines in the half-year, a larger amount of profit would have been brought into the accounts.

DIRECT WEST INDIA CABLE CO. (LTD.)—The third annual general meeting was held at the offices yesterday (Thursday), under the presidency of Mr. Thomas Skinner. The chairman proposed the adoption of the report and accounts to June 30, in which the directors stated that the net result was a profit of £5,455. 18s. 3d., which was satisfactory considering the circumstances under which the company had to work, but compared unfavourably with a profit of £19,186. 1s. 1d. made in the previous year, when revenue was greatly aided by the Spanish-American war and other unusual occurrences. An interim dividend of 2½ per cent. had already been paid, and it was now proposed to make a further distribution of 3½ per cent. which would leave £3,655. 18s. 3d. to be carried forward, increasing the amount to credit of revenue to £25,146. 15s. 1d. The revenue account for the year ended June 30 showed that the revenue from messages, subsidies, and other receipts had been £19,186. 4s., from interest on investments £1,891. 13s. 7d., and from transfer fees £6. 2s. 6d. The company's cables continued to work with complete efficiency. Under the deed the redemption of the company's debentures commenced in June last, and £9,000 of debentures had been acquired and cancelled. The retiring directors, Mr. Geo. G. Ward and Mr. Fred. Ward offered themselves for re-election. The report was unanimously adopted.

HALIFAX AND BERMUDAS CABLE CO. (LTD.)—The eleventh annual general meeting of this company was held at the offices yesterday (Thursday), Mr. Thomas Skinner presiding. The directors' report for the year ended June 30 last stated that the net result of the year's working was a profit of £3,795. 7s. 9d., compared with £10,141. 19s. 10d. for the previous year. This important reduction was mainly due to normal times as compared with a period which was benefited largely by traffic arising from the Spanish-American war. An interim dividend of 2½ per cent. had already been paid, and it was now proposed to make a further equal payment, which would together absorb £2,500, and leave £1,295. 7s. 9d. to be carried forward. This would increase the amount to credit of revenue to £13,092. 8s. 3d. The revenue account for the year ended June 30, 1900, showed that £16,379. 17s. was derived in that period from messages, subsidies, and other receipts, £1,007. 17s. 9d. from interest on investments and deposits, and £3 from transfer fees. The company's cable continued to work with complete efficiency. Offers for the sale of debentures to the trustees were invited in December and June last, and £5,197. 2s. 5d. was paid for £5,200 of debentures. The retiring directors, Mr. Geo. G. Ward and Mr. Fred. Ward, offered themselves for re-election. The chairman proposed and Mr. T. G. H. Glynn seconded the adoption of the report and accounts, which were unanimously passed.

MERSEY RAILWAY CO.—At the half-yearly meeting on Tuesday, the chairman (Mr. J. Falconer) said the most important work the directors had had to deal with since the last general meeting had been the promotion of the act passed last session to enable the company to work the railway by electricity, and to extend the time for paying off the redeemable first debenture stock. The bill also embraced a scheme for re-arranging the finances of the company, and for the appointment of a joint committee, by agreement with the Wirral Railway Co., for enabling the two companies to have a joint system of electric traction. According to the best advice, the result of adopting electric traction would be not only to free the tunnel from the fumes which were so objectionable to passengers, but also to cheapen the cost of working while greatly increasing the service. The difficulties against which they had had to contend with steam traction, and their want of success, would not be experienced with electric traction. This view has been strikingly confirmed by the result of the opening of the Central London Railway—an electric line working under conditions not nearly so favourable as in the case of their line. The Mersey Company had a full-sized railway tunnel of the ordinary type, and they had complete liberty as regarded the construction of their carriages and the electrical plant with which to haul them. If a joint scheme were arranged with the Wirral Company for working the two concerns by electric traction the cost involved was estimated, roughly, at £500,000: that was the amount of the borrowing powers provided for. If they did not come to terms with the Wirral Company, and had to raise the money on their own account, the cost was estimated at about £300,000.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28 1/16d. per oz. (Sept. 27). Consols (2¾ per cent.) 98¼–98⅜ for money, 98 5/16–98 7/16 for account; 2½ per cent. 96¾–97¼ (Sept. 27). Stocks and Shares Continuation Days, Oct. 10 and 24; Ticket Day, Oct. 11; Pay Days, Sept. 28 and Oct. 12; Mining Share Carry-over Days, Oct. 9 and 23.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—Dividends at the rate of 6 per cent. per annum on the ordinary and preference shares for the half-year ended 30th inst., and payable Nov. 1, are announced.

COMPAGNIE INTERNATIONALE D'ELECTRICITE.—A dividend of 10 per cent. was paid for the year 1899-1900 against 11 per cent. in the previous year.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—An interim dividend for the quarter ended June 30 of 2s. 6d. per share (tax free), payable on Oct. 15 next, has been declared. The share register will be closed from 6th to 13th prox. inclusive.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment on Oct. 15 of a dividend at the rate of 3½ per cent. per annum, less tax, on the preference stock for the quarter ending Sept. 30, and the usual interim dividend of 1¼ per cent. on the ordinary stock, free of tax, in respect of profits for the quarter ended June 30 last. The transfer register will be closed from Oct. 8 to 15 inclusive.

EVERED AND CO. (LTD.)—An interim dividend at the rate of 7½ per cent. per annum for the half-year ended June 30 has been declared.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The financial papers announce the declaration of a quarterly dividend of 1s. 9d. per share on the ordinary shares in this company.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE CO. (LTD.)—Dividends at the rate of 7 per cent. per annum on the ordinary and 9 per cent. on the preference shares have been declared. The company has owned for several years a small electricity station on which there was a loss of £143 last year, but no attempt has yet been made by the company to popularise its electric lighting department.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to the further issue of 5,000 £5 fully-paid shares of the *Telegraph Manufacturing Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc or Dec.
	1900	£	£		£	£
*Birmingham Tramways	Sept. 22	4,631	+ 316	11	50,245	+ 2,072
Blackpool Corporation...	„ 20	1,358	+ 552	25	23,438	+ 5,789
Blackpool and Fleetwood	„ 22	1,044	+ 211	12	16,895	+ 127
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 23	590	+ 246	25	12,918	+ 2,642
Brisbane Trams	Aug. 8	2,286	+ 511	5	8,854	+ 1,586
*Bristol Trams & Carriage	Sept. 21	3,555	+ 134	12	42,868	- 247
*Buenos Ayres & Belgrano	Aug. 26	2,022	- 111	8	17,061	- 553
Central London Railway	Sept. 22	4,891	...	8	37,199	...
City & South London Ry.	„ 23	1,519	+ 605	12	18,047	+ 6,826
Cork Elec. Trams	„ 20	477	+ 40	38	15,723	+ 1,270
Dover Corporation	„ 22	285	+ 6	25	6,109	+ 292
Dublin & Lucan Rly. ...	„ 22	103	+ 10	12	1,401	+ 261
Dublin United	„ 21	3,667	+ 515	12	46,757	+ 5672
Dublin Southern Dist....	„ 21	1,000	+ 151	12	13,845	
*Glasgow Corporation ...	„ 22	9,814	+ 842	...	...	...
Hull Corporation	„ 22	1,306	+ 700	12	15,957	+ 8,818
*Liverpool Corporation...	„ 15	9,053	+ 1,554	37	286,263	+ 32,996
Liverpool Overhead Rly.	„ 23	1,789	+ 406	12	20,995	+ 859
*Sheffield Tramways	„ 23	2,630	+ 1,052	38	83,689	+ 29,883

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 19.	Price Wednesday, Sept. 26.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 26. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£96,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	... ...	... ...	...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£822,720	Stock	15/0	Anglo-American	59 62	59 62	5 19 3	Feb., May, Aug., Nov.	60⅛	...
£3,088,640	Stock	30/0	Do. Preferred	110⅛ 111⅛	110 111	5 9 1	„ „	111	110⅛
£3,088,640	Stock	27/0	Do. Deferred	11⅜ 12⅛	11½ 12	10 16 0	„ „	12	11⅜
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	101 103	101 103	3 17 0	„ „	102⅜	102
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	„ „	15⅞	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100⅞ 104⅞	100⅞ 104⅞	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	10⅞ 11¼	10⅞ 11¼	6 4 5	Jan., Apr., July, Oct.	...	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	149 154	149 154	4 11 6	Jan., Apr., July, Oct.	151½	149¼
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	99 102	99 102	3 9 0	„ „	99⅜	99
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	114 119	114 119	3 8 1	May and November ...	115	...
250,000	10	2/6	Eastern Extension.....	15 15½	15 15½	4 10 4	Jan., Apr., July, Oct.	15½	15
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 118	113 118	3 8 6	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	99 102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	100⅞ 103⅞	100⅞ 103⅞	3 17 8	May and November ...	...	...
180,227	10	4/6	Globe Telegraph and Trust	11 11½	10⅞ 11½	4 13 4	Jan., Apr., July, Oct.	11⅜	10⅞
180,042	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	14¾ 15¼	3 19 0	„ „	14¾	14⅝
150,000	10	5/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July.....	...	...
£34,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	93 101	93 101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	50 54	49 53	4 14 4	May and November ...	49	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	103 106	103 106	5 13 2	March and September	103½	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	123 131	126 131	4 13 5	„ „	...	126½
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	93 101	98 101	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America	⅛ 1	⅛ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	100 103	3 18 4	January and July.....	101	...
88,321	10	1/0	West India and Panama	¾ 1	¾ 1	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	„ „	7⅛	7⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 6	„ „	6⅞	6½
£80,000	100	5%	* Do. 5 per Cent. Debentures	105 108	105 108	4 13 6	January and July.....	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜ 15½	14⅜ 15½	4 11 10	Mar., June, Oct., Dec.	15 3/16	15 1/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1905)	103 106	103 106	4 14 4	June and December ...	...	...
			TELEPHONES.						
44,000	£5	4/0	Chill Telephone (fully paid)	2½ 3½	2½ 3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	... ...	... ...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ⅜	⅛ ⅜	6 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
590,000	5	3/0	National	4½ 4¾	4½ 4¾	6 6 4	February and August	4⅝	4 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13 15	13 15	4 0 0	„ „	14½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	13 15	13 15	4 0 0	„ „	14½	14
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5 5½	5 5½	4 15 3	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 101	98 101	3 9 8	June and December ...	98½	...
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October.....	1 1/16	...
58,000	5	4/6	United River Plate	4¾ 5¼	4¾ 5¼	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December ...	5⅛	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104 107	104 107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 19.	Price Wednesday, Sept. 26.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 21. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ekh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅜ ⅝	⅜ ⅝	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red.)	100 103	100 103	4 7 5	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	7⅞	7½
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 6¾	6½ 6¾	...	...	...	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp.	9 10	9 10	4 12 6	February and August	9½	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6¾ 7¼	6¼ 7¼	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109 112	110 113	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	9 10	8½ 9½	4 4 3	February and August	9⅜	8⅞
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½ 13½	12½ 13½	4 9 0	January and July	13½	12½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124 129	124 129	3 18 2	June and December	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½ 9½	8½ 9½	6 6 4	...	8⅝	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11 12	11 12	5 0 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½ 5⅛	4½ 5⅛	5 9 1	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	101¼	100⅞
85,000	10	6/0	Metropolitan Elec. Supply Ord.	13 14	12½ 13½	4 1 6	April and October	13⅝	13⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December	113	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	97 100	3 10 7	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	14½ 15½	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5⅝ 6⅛	5⅝ 6⅝	3 16 11	,,	...	...
300,000	1	1/6	Rand Electric	⅞ 1	1/16 1⅛	10 18 2	...	...	...
£135,000	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 107	104 107	4 4 1	,, ,,	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 3	...	...	...
65,000	5	...	South London Electric Supply Ordinary	3 4	3 4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12 13	11½ 12½	5 4 0	March and September	12⅞	12½
29,437	5	...	Do. £2 10s. paid	8½ 9½	8½ 9½	...	...	8¾	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	⅞ 1⅛	⅞ 1⅛	4 8 11	...	...	...
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅝ ¾	⅝ ¾	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅜ ½	⅜ ½	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅜ ½	⅜ ½	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅞ 6⅛	5⅞ 6⅛	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅝ 5⅛	4⅝ 5⅛	...	...	...	...
90,060	2	1/2½	Brush Electrical Engineering	1¾ 2	1¾ 2	6 0 0	September	1 1/16	1⅞
15,731	2	...	Do. £1 paid	... ...	... ...	...	...	...	...
90,000	2	1/2½	Do. 5 per Cent. Pref. Non-Cum.	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2⅛	...
15,731	2	...	Do. £1 paid	... ...	... ...	...	...	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	106 111	106 111	4 0 11	February and August	...	...
£125,000	Stock	4½%	* Do. 2nd Debenture Stock	101 103	101 103	4 7 5	June and December	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	12½ 13½	12½ 13⅝	5 11 1	,, ,,	12⅞	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 5½	5 5½	4 10 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	6 8 0	...	1⅜	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/9⅜	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	7 0 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	5 6 8	...	...	...
54,000	3	2/-	Crompton and Co. (Nos. 1 to 32,098)	3½ 4½	3½ 4½	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	1¾ 2⅛	1¾ 2⅛	8 0 0	February and August	1⅞	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅞ 4⅛	3⅞ 4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	90 92	90 92	4 7 5	June and December	...	...
£100,000	Stock	...	Do. 5% 2nd Deb. Standing Prov. Certs (70% pd)	63 73	68 72	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4½ 5	4½ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	94 102	100 103	4 8 0	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	1⅞ 2⅛	2 2⅛	5 6 8	January and July	2⅛	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2¾ 3¼	2⅞ 3¼	4 6 2	July	3⅛	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	102 105	3 16 2	January and July	...	...
30,000	5	4/0	Henley's Telegraph Works Ordinary	11½ 12½	12½ 13½	5 11 1	February and August	12⅝	...
30,000	5	2/3	Do. 4½ per Cent. Preference	5 5½	5 5½	4 1 10	,, ,,	5⅝	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	108 112	108 112	4 0 4	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	3 9 9	,, ,,	21½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 104	99 102	3 18 5	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	35 39	34 38	4 14 8	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 5¾	5½ 5¾	4 6 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10⅝ 11⅛	10⅝ 11⅛	5 4 4	April and October	11	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6⅝ 7	6⅝ 7⅛	4 2 9	,, ,,	7⅛	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	4/0	Blackpool and Fleetwood Tramways	14 16	14 16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	103 105	103 105	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	21½ 22½	21½ 22½	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10⅝ 10⅞	10⅝ 10⅞	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
12,000	10	5/0	British Columbia Electric Railway 5% Pref.	10 10½	10 10½	4 15 3	May and November	10½	...
45,000	10	11/0	British Elec. Trac. Ord.	14½ 15½	14 15	6 13 4	...	15⅛	14⅜
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12⅝	12⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	123 125	123 124	4 0 4	...	123⅝	...
£150,000	Stock	...	Do. Do. (issued Feb. 5, 1900)	122 125	122 125	...	...	123⅛	122⅝
40,000	5	2/8 1/10	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	5⅛	...
27,500	5	...	Do. "B"	3⅞ 4⅛	3⅞ 4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	104 107	4 14 8	...	10 1/8	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	96 99	96 99	5 1 0	...	96	95
206,297	10	3/0	Central London Ordinary	10 10½	10 10½	2 17 2	June and December	10⅝	10⅛
£855,000	Stock	1¼%	City and South London Railway Con. Ordinary	58 61	58 61	2 5 2	February and August	59	...
37,500	10	1/5 1/8	Do. (Nos. 22,501 to 60,000)	5 6	5 6	2 9 4	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	138 143	138 143	3 9 11	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	130 135	130 135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	21 22	20½ 21½	3 12 9	March and September	21½	20⅜
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15	14½ 15	3 18 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9¾ 10½	9¾ 10½	4 17 7	May and November	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary	8⅛ 8½	8 11/16 8 13/16	4 9 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13½	3 15 6	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	104 106	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3¾	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	0/0	Do. 5 per Cent. Preference	10½ 10⅞	10⅝ 10⅞	4 14 1	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	104 107	104 107	...	...	...	...
240,000	Stock	5%	Waterloo and City Ordinary	92 95	92 95	3 3 7	June and December	93	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,168. [Me. 24. Vol. XLV.] FRIDAY, OCTOBER 5, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 15 cents, or 80c., or 70pf.

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NOTES.

THE International Electricity Congress, the summarised report of whose proceedings we conclude in this issue, has been the opportunity for the publication of a number of Papers, but it must be confessed that, although some have been of considerable interest, they have been as a whole disappointing. Among the exceptions we may mention three excellent Papers of the "report" or summary order by M. VIOLLE, M. BLONDEL, and M. BLONDEL in conjunction with Capt. FERRIÉ, setting forth respectively the present status of photometry, of the theory and construction of arc and incandescent lamps, and of wireless telegraphy; while Mrs. AYRTON'S contribution to our knowledge of the electric arc was undoubtedly the most important of the actual Papers, and is likely to lead to useful practical results besides advancing a step further towards a complete theory of the physics of this intricate phenomenon.

IN the direction of general resolutions the most noticeable result of the labours of the Congress has been to propose names for the C.G.S. units of magnetic field and magnetic flux. The names "gauss" and "maxwell" will be received with satisfaction, as would be anything tending to perpetuate the memory of these two pioneers. It may be questioned, on the other hand, whether names for units of magnetic field and magnetic flux are necessary at all, for we have been able to do without them for so long; and even if such names are necessary, would it not have been preferable to have adopted the practice followed hitherto, and have given names to more convenient units of greater magnitude, leaving the electrical C.G.S. units without specific titles? In any case it is a matter for regret that in no country will the correct pronunciation of *both* gauss and maxwell be found easy.

IN another column we reprint a letter from Dr. J. A. FLEMING, which appeared in yesterday's *Times*, on recent advances in Marconi telegraphy. Although lacking in technical particulars, the letter is of special interest as giving the authoritative statement of a thoroughly qualified witness, that the isolation of simultaneous messages can be effectively carried out. The technical particulars are promised later, and we hope to furnish them to our readers so soon as they can be disclosed. Meanwhile, we may direct attention to the chief points in Dr. FLEMING'S letter. Evidently the process of syntonising the receivers each to a special wave-tone has been chosen, and is relied on, as the method of producing the satisfactory degree of isolation which Dr. FLEMING describes. It is admitted that this process does not originate with Mr. MARCONI, but the claim is advanced that "no one has given practical proof of possessing a solution of this problem which for a moment can compare with that Mr. MARCONI is now in a position to furnish." We may also call attention to the replacement of the vertical wire by a hollow metal cylinder, a change which removes finally the necessity for high masts in signalling over long distances. We congratulate Mr. MARCONI on the great advance which his lengthy and patient researches have thus rendered possible.

A BRIEF communication by M. GEORGES RHEINS to the Académie des Sciences, abstracted by Mr. FOURNIER in another column of this issue, will be read with interest by both cable makers and users, and will, perhaps, give rise to some interesting "life" experiments on cables. It appears that with both gutta percha and paper insulation the copper, presumably by some sort of electrolytic action, can actually penetrate outwards in such a way as to interfere with the electrical properties of the dielectric. Thus M. RHEINS observed that, in 20 years, copper had soaked through to the surface of a gutta percha cable, and that four years had sufficed for the metal to penetrate into the first layer of paper on a cable insulated with this latter substance. Unfortunately

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M. Rheins omits from his Paper all reference to the details of the experiments. We are not informed where the cables were laid during their time of probation, nor how the insulation was protected externally. However, it is of value to know that, in certain circumstances, a gutta-percha cable can perish in 20 years through an action hitherto unnoticed, and that even paper insulation is not everlasting. On the other hand, it might be possible to obtain an approximation to Oliver Heaviside's ideal dielectric combining "leakance" and inductance if gutta-percha could be permeated with iron instead of copper, although we fear that in such a case the increased "permittance" or capacity might spoil the effect. But before any definite conclusions can be drawn one way or the other, we must know more of Mr. Rheins' experimental conditions, and, if they have been such as to preclude the possibility of a "mare's nest," the true cause of the effect must be discovered, and an endeavour made to accelerate it on selected test lengths of cable.

Further correspondence appears in our issue this week on the effect of lightning flashes on carbon filaments, a subject which has aroused widespread interest. The coherer theory appears to be largely favoured, though there are not wanting critics who regard this as being too fanciful. A crucial test might be arranged by subjecting a glowing lamp to strong Hertzian radiation, rapidly intermittent. Incidentally, our correspondent, Mr. F. Alex. Taylor, raises the old cry against the name "coherer" and the phrase "decoherence." They are a misnomer and completely misleading phrase; but where can we find better? There is the same trouble about "wireless telegraphy," palpably not wireless. Terms so phonetically convenient stick hard, and are not easily sledge-hammered off by logic.

Prof. Bose has suggested "molecular receiver" as a substitute for "coherer"; but, not unconscious of the comparative inconvenience of a double-barrelled name, he has proposed its contraction to "mol." The latter condemns the former, and both fall irretrievably. Besides, there are other forms of "molecular receiver" affected by radiation—a photographic plate, for example. How are we to discriminate, and what in the name clinches the apparatus as distinctly Hertzian? Arbitrary names usually seem uncouth at the first; usage tones them down. Response to radiation is the most universal characteristic of coherers of all classes. Might they not be termed "responders"? Distinctly, when we remember the entire action that goes on, we see that the apparatus does more than *receive* radiation—it *responds* to it.

The "Twopenny Tube," we know, is buried underground; but it is not yet dead. A writer in *The Times* appears to think it is, and has written its epitaph: "It failed through its success." The world has been told until now that "nothing succeeds like success," a motto more appropriate to the railway in question, wherein success has grown at compound interest. Critics of the new railway are numerous. Some object to the "chopper" system of ticket collection, previously matured by years of experience on the New York "Elevated"; others are sensitive to draughts, more Boreal than Æolian it must be admitted; while others, again, like the writer of epitaphs, want seats guaranteed even in the most crowded of trains. Our own criticism we shall come to presently. In the matter of overcrowding, the obvious remedy is to increase the number of trains during the busiest hours. This change the Central London Railway Co. is fully prepared to adopt so soon as a 2½ minutes' headway can safely replace the existing headway of 5 minutes. Discretion in this respect is the better part of valour, for a disastrous rear collision would do more than anything else to call promptly for an epitaph, of different phraseology.

As an underground railway complete in itself, the "Twopenny Tube" really calls for but little improvement. Where it is most conspicuously defective is in its linkage with other and similar railways, swelling in numbers to form a widespread network beneath the metropolis. A ready opportunity has been narrowly missed to make this a really united network, but there is time yet for the remedy. At present, transference between any one and any other of the three electric railways converging on the vicinity of the Bank can only be made by a double journey to the surface (or nearly so) and down again. To transfer from the "Twopenny Tube" to the City and South London Railway involves two lift journeys and a tedious march through lengthy passages. In the ideal arrangement it would be possible to pass from one line to the other through a passage-way at the low level of the railways. We hope that all future interconnections will be arranged in this manner.

"Twopenny Tube" Appetiser.—An American contemporary states that travel on the "Twopenny Tube" is reputed to develop an appetite in the traveller, the tonic effect being "ascribed to the ozone generated by the electricity." A little ozone evidently goes a very long way.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Tangier—Tarifa	Jan. 5, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Pará—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Pernambuco—Para	Sept. 19, 1900 ...	Sept. 28, 1900
Zanzibar—Mombasa	Sept. 20, 1900 ...	—

Carbon Filaments and Lightning Flashes.—Mr. L. S. Levy, has contributed the following letter to the *Electrical World* of Sept. 22:—

In the London *Electrician*, Aug. 31, 1900, some leading remarks are made regarding a phenomenon that was noted in incandescent lamps during an electric display accompanying a storm. I have noted the very same thing, viz., a momentary increase in brightness with each lightning flash, but would look for the explanation not in a coherer effect in the carbon filament, but in the increased voltage of the line, due to resonance. Conditions are not favourable to the ordinary manifestation of the latter condition, but the varying periodicity of the discharge will make them so, though only for an instant.

If we are to accept the statement made by Prof. Elihu Thomson, to the effect that not all lightning discharges are oscillating in character, I am strengthened in my belief, as in several instances the momentary brightening in the lamps was absent.

Paris Exhibition Literature.—The third number of "L'Electricité à L'Exposition de 1900" has been published. It contains complete descriptions of the alternators installed at the Paris Exhibition for the supply of current there, and also of the two German continuous-current machines which are driven by the same engines as the German alternators, and were not included in the previous number describing the continuous-current machines. The present number, which is

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written by MM. J. A. Montpellier, M. Aliamet and F. Loppé, maintains the excellence shown in its predecessors, and MM. Hospitalier and Montpellier, the editors, as well as Messrs. Dunod, the publishers, are to be congratulated on the manner in which they are attacking the task of describing the electrical features of the Paris Exhibition.

Institution of Civil Engineers.—The Council have, in addition to the medals and prizes given for communications discussed at the meetings of the Institution in the past session, made the following awards in respect of other Papers dealt with in 1899-1900: A "George Stephenson" medal and a Telford premium to L. F. Vernon-Harcourt, M.A. (London); Telford premiums to H. J. S. Heather, B.A. (South Africa); Walter Rosenhain (Cambridge), James Glover, M.A. (Lowton, Lancs.), A. B. Brady (Brisbane), R. C. Farrell (Dunoon), C. F. V. Jackson, B.E. (Sydney); and G. B. Walker (Barnsley). For students' papers: The "James Forrest" medal and a "Miller" prize to C. B. Fox, B.A. (Wimbledon), the "James Prescott Joule" medal and a "Miller" Prize to J. W. Smith (Burton-on-Trent); and "Miller" prizes to B. Humphrey (New Swindon), H. E. O'Brien, B.Sc. (Horwich), H. E. Wimperis, B.A. (Cambridge), and A. H. Morton (Glasgow). The Council have nominated Mr. R. F. Whitehead to the "Palmer" scholarship at the University of Cambridge in succession to Mr. A. H. Kirby, who graduated last June.

Absorption of Hertzian Rays.—Signor Emile Guarini and Lieut. Poncelet have sent us a joint communication on experiments they have made with screens placed between a Wimshurst machine and a coherer. The Wimshurst machine, provided with its usual condensers, emitted Hertz waves which affected the coherer, and the experimenters satisfied themselves that only direct waves need be taken account of, as when a screen was placed between the coherer and the machine, the former was protected. The distance between coherer and machine was a few metres. It was found that the human body, interposed between the machine and the coherer, effectively absorbed the rays whether the body was insulated or not. This might have been expected. On the other hand a thin sheet of iron, which would not screen the coherer under normal conditions, screened it when connected to earth. The writers try to explain the different action of the insulated and earthed iron plate, by the hypothesis that this metal screw "constituted a new radiator acting by induction from the transmitter. The electric waves," they continue, "do not pass a metallic screen, but produce in it induced oscillating currents, which in their turn produce a radiation in space." Earthing the screen prevents this inductive effect, they suggest. We think that the authors should have examined carefully their experimental conditions, and have endeavoured also to reproduce the effect with a different arrangement of apparatus, before putting forward this theory. It is a pity that so much energy is wasted in methodless experiment in a field in which patient and methodical investigation is urgently needed.

Wireless Telegraphy and Earth Connection.—"It is wonderful," says the *Electrical World* of New York, "how much seems to depend upon the earth in Hertzian-wave telegraphy. It is common belief that the earth has little or nothing to do with the matter, and that the air or upper world of ether is all important. On the other hand, however, it is now recognised that transmission can be carried considerably further over the ocean than over the land, and it is believed that the difference is due to the higher conductivity of sea-water. It is even stated that on land the dryness or dampness of the soil noticeably influences the transmission, and apparently from the same cause. It is further stated that Hertzian-wave telegraphy has been a failure in South Africa during the recent war, owing to the general prevalence of bad earth. Not only is good earth in the telegraphic sense difficult to secure, but the long desert plains are most unfavourable to the transmission of electric waves. What is ideally needed for their transmission is a highly conducting level surface over which the waves may run without absorption, being continually reflected. In the absence of such an electric mirror the waves tumble into the earth and become absorbed as well as dispersed. All these conditions seem to point to the ocean as the future scene of utilisation of Hertzian-wave telegraphy. On land we can ordinarily hang or bury our wires and be content. At sea we are unable to maintain metallic communication, and where the ocean begins the opportunity of the wireless telegraph begins also. It is to be hoped that the day may not be far distant when the light-houses along our coasts will also be Hertzian-wave houses and issue signals day and night to the shipping within 50 miles radius. The steamer's mast will then have two functions left—one to hold up flags and the other to hold the antenna."

Recent Advances in Wireless Telegraphy.—The following letter, which we comment on in our editorial notes this week, was contributed by Prof. J. A. Fleming to *The Times* of yesterday's date:—

As the subject of wireless telegraphy has not yet apparently lost interest for the general reader, I venture to ask a little space to make known for the first time some recent achievements by Mr. Marconi which have astonished those who have been allowed to examine them. Every one is aware that in his system of electric wave telegraphy an important feature is the employment of an elevated conductor, which generally takes the form of a wire suspended from a mast. When Mr. Marconi attracted attention by his feat of establishing communication across the Channel without wires, critics raised a not altogether valid argument against its commercial utility, that a wave or signal sent out from one transmitter would affect equally all receivers within its sphere of influence, and hence the privacy of the communication would be destroyed. No one felt the force of this objection more strongly than the distinguished inventor himself, whose original work has caused so many others to attempt to follow in his steps. For the last two years he has not ceased to grapple with the problem of isolating the lines of communication, and success has now rewarded his skill and industry. Technical details must be left to be described by him later on, but meanwhile I may say that he has modified his receiving and transmitting appliances so that they will only respond to each other when properly tuned to sympathy. I am well aware that other inventors have claimed to be able to do the same thing, but I do not fear refutation in saying that no one has given practical proof of possessing a solution of this problem which for a moment can compare with that Mr. Marconi is now in a position to furnish.

These experiments have been conducted between two stations 30 miles apart, one near Poole in Dorset and the other near St. Catherine's in the Isle of Wight. At the present moment there are established at these places Mr. Marconi's latest appliances, so adjusted that each receiver at one station responds only to its corresponding transmitter at the other. During a three days' visit to Poole, Mr. Marconi invited me to apply any test I pleased to satisfy myself of the complete independence of the circuits, and the following are two out of many such tests: Two operators at St. Catherine's were instructed to send simultaneously two different wireless messages to Poole, and without delay or mistake the two were correctly recorded and printed down at the same time in Morse signals on the tapes of the two corresponding receivers at Poole.

In this first demonstration each receiver was connected to its own independent ærial wire hung from the same mast. But greater wonders followed. Mr. Marconi placed the receivers at Poole one on the top of the other, and connected them both to one and the same wire, about 40ft. in length, attached to a mast. I then asked to have two messages sent at the same moment by the operators at St. Catherine's, one in English and the other in French. Without failure each receiver at Poole rolled out its paper tape, the message in English perfect on one and that in French on the other. When it is realised that these visible dots and dashes are the results of trains of intermingled electric waves rushing with the speed of light across the intervening 30 miles, caught on one and the same short ærial wire, and disentangled and sorted out automatically by the two machines into intelligible messages in different languages, the wonder of it all cannot but strike the mind.

Your space is too valuable to be encroached upon by further details, or else I might mention some marvellous results, exhibited by Mr. Marconi during the same demonstrations, of messages received from a transmitter 30 miles away and recorded by an instrument in a closed room merely by the aid of a zinc cylinder, 4ft. high, placed on a chair. More surprising is it to learn that, whilst these experiments have been proceeding between Poole and St. Catherine's others have been taking place for the Admiralty between Portsmouth and Portland, these lines of communication intersecting each other; yet so perfect is the independence that nothing done on one circuit now affects the other, unless desired. A corollary of these latest improvements is that the necessity for very high masts is abolished. Mr. Marconi now has established perfect independent wireless telegraphic communication between Poole and St. Catherine's, a distance of 30 miles, by means of a pair of metal cylinders elevated 25ft. or 30ft. above the ground at each place.

I need not enlarge on the possibilities thus opened out for naval and military purposes. The importance of this practical solution of the problem of independent electric wave telegraphy, in which each wireless circuit is as private as one with a wire, is obvious without comment. My desire is solely to mention the above facts for the benefit of general readers, whose minds will thus perhaps be eased of any doubts lest this brilliant application of electrical discoveries should, like some others, fall short in satisfying the requirements of practical use and be relegated to the region of imperfect inventions or unfulfilled hopes.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Deterioration of Cables.—When a cable is used for transmitting a variable current, characterised by equal fluxes of opposite electricity, it preserves all its electric and organic properties intact. When, however, the current traverses it always in the same direction, the cable, according to G. Rheins, passes through four stages marked by the complete loss of some electric property, and the change of the properties remaining. The order of disappearance is the following: Inductance, capacity, insulation, conductivity. This process of deterioration is due to the slow penetration of the metal of the core into the dielectric, and this penetration appears to be independent of the kind of dielectric, since it is observed both in the case of paper and of gutta-percha. In one case of the latter, used for 20 years, the copper of the core was found to have soaked through to the surface of the insulator. In another case, that of a paper cable in use for four years, the copper was found to have penetrated into the first layer of paper, but not into the second.

[G. Rheins, *Comptes Rendus*, Sept. 10, 1900.]

Resistance of Bismuth.—W. Eichhorn has carried out some interesting investigations of the speed with which bismuth assumes a certain resistance under the influence of a magnetic field. He mounted a bismuth coil on a revolving disc so that at a certain point it passed through a magnetic field. Its instantaneous resistance was measured by means of contact pieces attached to the disc, and the resistances shown at various points when entering or leaving the field were compared with the resistances shown at the same points in a state of rest. Any lag or hysteresis of the resistance would then show itself as a difference of resistance for corresponding points, according to the state of rest or motion. The rate of revolution was 1,000 per minute. A well-marked difference was observed both on entering and leaving the field. On leaving the field the resistance remained too high. This result is specially conclusive. For in the state of rest the resistance was influenced by the heat of the magnetising current, which tended to exaggerate the normal resistance. That the resistance when in motion is still greater shows that the bismuth does not instantaneously lose the high resistance acquired in the maximum field. The difference is constant for any speed of revolution exceeding 500 per minute, but below that rate it increases with the speed. The author calls the phenomenon a viscous hysteresis of resistance.

[W. Eichhorn, *Ann. der Physik*, No. 9, 1900.]

Atmospheric Potential during a Solar Eclipse.—The modern theory of ionisation, or rather of "electronisation," has been applied with considerable success to the explanation of atmospheric electricity. Elster and Geitel suppose that the impact of the ultra-violet rays of the sun upon the upper strata of the atmosphere produces the separation of positive and negative electrons, and that the different velocities of the latter produce an unequal distribution of positive and negative charges in the atmosphere. If that is true, then a temporary cessation of the sun's activity in this respect might produce a well-marked change in atmospheric potential. Such a change was searched for at Pavia by E. Oddone during the total eclipse of the sun on May 28. Unfortunately, the geophysical observatory at Pavia was not in the path of totality, but 8·10*n*ths of the disc were obscured, and a measurable effect could therefore be hoped for. The measurements, taken with a water-dropping collector and Exner electroscope showed a slight increase of positive potential, but it was difficult to dissociate this effect from the effect of moisture. Perhaps some observations hitherto unpublished were taken within the area of totality. In any case, the chances are that the effect of a change in the upper atmosphere would not be felt for some time at the earth's surface.

[E. Oddone, *Rendic. Ist. Lombardo*, 33, 1900.]

Reflection of Cathode Rays.—Two years ago, H. Starke described a study of the diffused reflection of cathode rays, and showed that the reflected rays take their charges with them. He has since repeated the experiments with greater precautions, and has studied more especially the reflective powers of copper and aluminium for cathode rays. Mirrors made of the two metals were placed inside a metallic cylinder through an opening in which the cathode rays entered. A galvanometer connected with the mirror measured the amount of cathode radiation absorbed. The amount reflected and diffused was measured by nearly surrounding the mirror with a second cylinder fitting in the first, and connected with another electrometer. The two metallic cylinders were enclosed in a vacuum together with the cathode furnishing the rays. The mirror was put into two different positions in the cylinder, so as to determine the amount of cathode radiation diffused by the gas itself. The reflective power of aluminium was found to be 28·2, and that of copper 45·5, whatever the velocity of the cathode rays. This ratio is, by the way, very nearly the same as that of the square roots of the atomic weights of the two metals. It would be well to find out whether such a rule would hold good throughout.

[H. Starke, *Ann. der Physik*, No. 9, 1900.]

Ratio of Conductivities.—In view of recent attempts to bring thermal and electrical conduction under the common theory of electrons, the ratio between the two conductivities in question acquires additional interest. E. Grüneisen has therefore examined the influence upon this ratio exerted by certain impurities in copper and iron. He determined the thermal conductivities of four iron bars and three copper bars by projecting a current of steam against their end surfaces, as in Schulze's method, and following the propagation of the heat through the bar by means of a thermo couple, one element of which was the bar itself. In copper, it was found that a very small proportion of arsenic suffices to reduce the thermal conductivity to one-tenth of its value in pure copper. The electrical conductivity is depressed at the same time to one-twelfth of its original value. In iron, the difference is even greater, the electrical conductivity being a great deal more sensitive than the thermal conductivity. Thus the ratio of the former to the latter, which is 1,730 in nearly pure iron, becomes 2,160 (C.G.S.) in an iron bar containing 1·5 per cent. of carbon, 0·19 of manganese, and 0·05 of silicon. The electrons conveying electric charges are evidently more disturbed by foreign bodies than those which convey heat only.

[E. Grüneisen, *Ann. der Physik*, No. 9, 1900.]

Helical Vacuum Discharge.—The new vacuum phenomenon discovered by E. Ruhmer is of considerable interest and is a striking sight. It is best produced in a glass tube 1mm. long and 4cm. wide, exhausted so that a discharge from a 30cm. induction coil just forms a spark of 15cm. through air in preference to the tube itself. When an industrial current at 110 volts pressure is sent through the tube and a Wehnelt interrupter, a thick red stripe traverses the tube from end to end. On reducing the current by suitable resistances, the stripe breaks up into a series of glowing patches. On placing the tube vertical and grasping it round the middle, so that the anode is uppermost, the patches arrange themselves in a spiral, which slowly turns about its axis, making one revolution in about 7sec. The diameter of the screw is about 2·5cm., and the screw is left-handed. Sometimes the diameter is smaller, and then the screw is right-handed, but in both cases the rotation is such that the wave line appears to descend. The point of attachment at the electrodes remains the same. The pitch of the screw varies with the strength of the current and the rate of interruption. The phenomenon has not been hitherto explained, but it has probably some connection with the warm air current rising spirally in the tube.

[E. Ruhmer, *Physikal. Zeitschrift*, June 23, 1900.]

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ELECTROMAGNETIC THEORY.—CXVIII.*

BY OLIVER HEAVISIDE.

(*Continued from page 638.*)

§ 473. Another way of getting Fresnel's wave-speed was described to me by Prof. G. F. FitzGerald. Write the second, or Faraday's circuital law in the form

$$-\operatorname{curl}\mathbf{F}=\mu p\mathbf{H}, \tag{38}$$

and the first, or Maxwell's, in the form

$$\operatorname{curl}(\mathbf{H}-\mathrm{V}c_1\mathbf{Fw})=p\mathbf{D}=p\mathbf{D}_0+p\mathbf{D}_1, \tag{39}$$

where $\mathbf{D}_0$ belongs to the ether, and $\mathbf{D}_1$ is the electrisation or electric polarisation added on by the matter. Then let

$$\mathbf{D}_0=c_0\mathbf{F}, \qquad \mathbf{D}_1=c_1(\mathbf{F}+\mathbf{e})=c_1\mathbf{E}, \tag{40}$$

where $\mathbf{e}=\mathrm{V}\mathbf{w}\mathbf{B}$. These equations give Fresnel's wave speed when w is small, that is, $\mathrm{U}=v+(c_1/c)w$.

It occurred to me that the term $\mathrm{V}c_1\mathbf{Fw}$ should be $\mathrm{V}c_1\mathbf{Ew}$, because in the additional part thus introduced, or $\mathrm{V}c_1\mathbf{ew}$, all the factors are related to the matter. This change makes no difference in the approximate result, and was not objected to. But Prof. FitzGerald believed the above way was equivalent to Lorentz's.

To find Lorentz. After profound research I succeeded in discovering Prof. H. A. Lorentz's "Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern," Leiden, 1895. This important application of Maxwell's theory to optical phenomena ought to have been done into English at once to save repetitional labour. Though sad, it is a fact that few Britons have any linguistic talent. This is not due to laziness, but mainly to a real mental incapacity, combined with the feeling that one language is quite enough. Foreigners, on the other hand, seem to be gifted linguists quite naturally, so much so that they have invented a large number of lingos, and are commonly skilled in several at once. Very well; I would say let them give us poor islanders the benefit of their skill, by doing all their best work into English. And why not make English the international scientific language? It would be all the same to the foreigners, and a great boon to Great-Britain-and-Irelanders, and the other English-speaking people.

On examination, I find that Lorentz's equations do lead to the Fresnel wave-speed, and in the above way. As his work is not so well known in England as it deserves to be, I will give a short sketch of Lorentz's way of treating the circuital equations, with reference to the matter in hand, but without any particular confinement in details. I observe with some personal gratification that Lorentz employs Vector Analysis (not Quaternions), and that he works entirely upon the circuital equations and their accessories, without the vector-potential or the Principle of Least Action, which last, in spite of its name, has the remarkable property of increasing the amount of the work to be done.

Let H and F be the magnetic and electric forces in ether away from matter and electrification, then

$$\operatorname{curl}\mathbf{H}=p\mathbf{D}_0=c_0p\mathbf{F}, \tag{41}$$

$$-\operatorname{curl}\mathbf{F}=p\mathbf{B}_0=\mu_0p\mathbf{H}, \tag{42}$$

are the fundamental circuital equations. I think it proper to have two ethereal constants. I do not consider the velocity of propagation to be a fundamental constant. It is a compound idea. Propagation is caused by some properties of the ether, I believe, and all known cases of propagation arise from the interaction of two properties. Lorentz has $\mu_0=1$, or ignores μ altogether, and $c_0=\mathrm{V}^{-2}$. Of course I also rationalise his units.

If there is electrification, measured by its volume density $\rho=\operatorname{div}\mathbf{D}_0$, the above equations suffer no change unless the electrification moves. Let the velocity of ρ be $\mathbf{u}+\mathbf{w}$, where the part w is constant, the same for all the electrification, and u is variable. As is well-known, $\rho(\mathbf{u}+\mathbf{w})$ is a part of the Maxwellian true current, the missing link in the chain of the displacement current $p\mathbf{D}_0$. So

$$\operatorname{curl}\mathbf{H}=p\mathbf{D}_0+\rho(\mathbf{u}+\mathbf{w}) \tag{43}$$

takes the place of (41). The reference space in these equations is the ether itself, supposed fixed. But let the reference space have the same common motion w as the matter carrying the electrification. Let p' be the time differentiator for the moving matter, then

$$p'=p+\mathbf{w}\nabla \tag{44}$$

shows its connection with p. The circuital equations become

$$\operatorname{curl}\mathbf{H}=(p'-\mathbf{w}\nabla)\mathbf{D}_0+\rho(\mathbf{u}+\mathbf{w}), \tag{45}$$

$$-\operatorname{curl}\mathbf{F}=(p'-\mathbf{w}\nabla)\mathbf{B}_0. \tag{46}$$

Now, in general,

$$\operatorname{curl}\mathrm{V}\mathbf{w}\mathbf{B}=\mathrm{V}\nabla\mathrm{V}\mathbf{w}\mathbf{B}=\mathbf{w}.\nabla\mathbf{B}+\mathbf{B}\nabla.\mathbf{w}-\mathbf{B}.\nabla\mathbf{w}-\mathbf{w}\nabla.\mathbf{B}, \tag{46A}$$

(Vol. I., p. 200, equation 181).

Applying to (46), we have

$$-\mathbf{w}\nabla.\mathbf{B}_0=\mathrm{V}\nabla\mathrm{V}\mathbf{w}\mathbf{B}_0,$$

and applying to (45),

$$\mathbf{w}.\nabla\mathbf{D}_0-\mathbf{w}\nabla.\mathbf{D}_0=\mathrm{V}\nabla\mathrm{V}\mathbf{w}\mathbf{D}_0,$$

so (45), (46) become

$$\operatorname{curl}(\mathbf{H}-\mathrm{V}\mathbf{w}\mathbf{D}_0)=p'\mathbf{D}_0+\rho\mathbf{u}, \tag{47}$$

$$-\operatorname{curl}(\mathbf{F}+\mathrm{V}\mathbf{w}\mathbf{B}_0)=p'\mathbf{B}_0, \tag{48}$$

when we travel with the matter. The velocity w may be imagined to be the translational velocity of the earth through the ether at the place in question, it being assumed that the ether is stagnant. Lorentz makes a further transformation for the consideration of aberrational questions, but that is not wanted here. What is wanted is the introduction of the electric moment or the electrisation in a non-conducting material. There is no volume electrification, owing to molecules being equally endowed with positive and negative ions. These ions are displaced under the action of electric force, producing a sort of polarisation; and the first approximation is to assume an equilibrium theory between the moving force on an ion and the displacement. This takes no count of inertia, and the resultant effect is to make the electrisation simply proportional to the moving force. That is

$$\mathbf{D}_1=c_1\mathbf{E}=c_1(\mathbf{F}+\mathbf{e}), \tag{49}$$

where $\mathbf{e}=\mathrm{V}\mathbf{w}\mathbf{B}_0$, is the result. Perhaps the averaging is the obscurest part of the process. The moving force on ρ at a point is $\rho\mathbf{E}$, not $\rho\mathbf{F}$, the additional part $\rho\mathbf{e}$ being Maxwell's electromagnetic force on the current element $\rho\mathbf{w}$.

The circuital equations (47), (48) therefore become

$$\begin{aligned}\operatorname{curl}(\mathbf{H}-\mathrm{V}\mathbf{w}\mathbf{D}_0)&=p'(\mathbf{D}_0+\mathbf{D}_1),\\ &=p'(c\mathbf{F}+c_1\mathbf{e}),\\ &=p'(c\mathbf{E}-c_0\mathbf{e}),\end{aligned} \tag{50}$$

$$-\operatorname{curl}(\mathbf{F}+\mathrm{V}\mathbf{w}\mathbf{B}_0)=p'\mathbf{B}_0. \tag{51}$$

These are the equations employed by Lorentz for a moving dielectric. But I think it is somewhat plainer to let the reference space be the fixed ether. To transform, put $p'=p+\mathbf{w}\nabla$, and use (46A), or rather the special simpler forms following it. We get

$$\begin{aligned}\operatorname{curl}(\mathbf{H}-\mathrm{V}\mathbf{D}_1\mathbf{w})&=p\mathbf{D}=p(\mathbf{D}_0+\mathbf{D}_1),\\ &=p(c\mathbf{F}+c_1\mathbf{e}),\end{aligned} \tag{52}$$

$$-\operatorname{curl}\mathbf{F}=p\mathbf{B}_0=\mu_0p\mathbf{H}, \tag{53}$$

Or, in terms of E and H,

$$\operatorname{curl}(\mathbf{H}-\mathrm{V}\mathbf{D}_1\mathbf{w})=p(c\mathbf{E}-c_0\mathbf{e}), \tag{54}$$

$$-\operatorname{curl}(\mathbf{E}-\mathbf{e})=p\mu\mathbf{H}. \tag{55}$$

Perhaps the most significant form is got by taking out the $\mathrm{V}\mathbf{D}_1\mathbf{w}$ in (52). Then

$$\operatorname{curl}\mathbf{H}=p\mathbf{D}_0+p'\mathbf{D}_1, \tag{56}$$

$$-\operatorname{curl}\mathbf{F}=p\mathbf{B}_0, \tag{57}$$

express the relations. As the ether is supposed to be stationary the time differentiator is simply p for $\mathbf{D}_0$. But the matter moves at speed w, so the time differentiator is p' instead. The distinction is most important, and the functions of p and p' must not be confounded. In the other equation (57), $\mathbf{B}_0$ belongs to the ether, the matter being regarded as unmagnetisable, so the time differentiator is p simply. In this way of regarding (56), (57) we can eliminate the ionic hypothesis, if we can trust that $\mathbf{D}_0$ and $\mathbf{D}_1$ can be separated in the manner assumed.

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Lorentz deduces the wave speed from equations equivalent to (50), (51) only after a transformation of variables, including a changed time variable, making the zero of time different for different parts of space. But there is no need for this complication. The mathematics of plane waves is quite simple. Thus, using (52), (53), let w||z, F||x, H||y. They reduce to

$$-\Delta\{H + c_1 w(F - w\mu_0 H)\} = p(cF - c_1 w\mu_0 H), \quad (58)$$

$$-\Delta F = \mu_0 pH, \quad (59)$$

where Δ is d/dz, and the quantities are now all scalars.

Also $p = -U\Delta$, U being the wave speed; so

$$H + c_1 w(F - w\mu_0 H) = U(cF - c_1 w\mu_0 H), \quad (60)$$

$$F = \mu_0 UH, \quad (61)$$

giving the quadratic

$$U^2 - 2U\frac{c_1}{c}w = v^2 - \frac{c_1}{c}w^2, \quad (62)$$

where $\mu_0 c v^2 = 1$, and, therefore, approximately

$$U - v = \frac{c_1}{c}w, \quad (63)$$

the required result.

That the moving force on ρw due to its motion in the field B_0 is ρe may be most simply seen thus. The magnetic force due to ρw is the ordinary magnetic force of a current element. The moving force on a magnetic pole in its field is therefore known. Conversely, the force on ρw due to the pole is known. It is the ρe in question. That the pole gives a special kind of magnetic field is immaterial, because it is only the value of B_0 at ρ that is concerned.

But I think the above theory is possibly too simple to be true. In the first place, can the optical result be considered to be so well established as to make it be necessary to get the Fresnel wave-speed? And, if so, is it proper that the result should come out direct from elementary equations which take no count of dispersion? There is a very wide difference between light vibrations, billions per second, and those concerned in long waves. The above is really a propagational theory, without any reflex actions. On the other hand, U should strictly be the speed of a simply periodic wave-train, itself the resultant of the forward and backward actions. Now it is true that when U does not vary much within a given range of frequency, any wave which is compounded of simply periodic waves within that range is propagated with little distortion, so that a simple pulse theory is approximately true. But when U varies very widely with the frequency, and the arbitrary wave when analysed involves widely discrepant values of U, for example, an impulsive wave itself, an impulsive theory cannot be even approximately true. For this reason I conceive that a more proper theory should be of a secondary character, involving the differential connection between the ethereal disturbance and the internal motions.

And yet it is suggested that the relations (56), (57) may be proper for long waves. But then the effect of magnetisation is not exhibited. If the above reasoning about the meaning of the time differentiators is correct, independently of the ionic hypothesis, it will be equally correct to extend them to

$$\text{curl } H = pD_0 + p'D_1, \quad (64)$$

$$-\text{curl } F = pB_0 + p'B_1, \quad (65)$$

where the new B_1 is the magnetisation, existent when μ differs from μ_0, and of course assumed to be of elastic character. The question then arises as to the relation of D_1 to F, and B_1 to H. If we write

$$D_1 = c_1(F + e), \quad (66)$$

$$B_1 = \mu_1(H + h), \quad (67)$$

it is still matter for argument whether e should be the former VwB_0, or should become VwB, using the complete induction. And as regards h, whether it should be VD_0w, or VDw, or existent at all. In the theory of a movable ether of variable c and μ, the variable parts representing matter, everything can be done symmetrically. But with matter moving through ether, and special hypotheses in connection therewith, there would appear to be no longer a necessity for symmetry.

Prof. FitzGerald says there are electrons, but there are no magnetons, therefore there will be a want of symmetry, other than that arising from putting zero for quantities which might exist. But I think some salt is required here. For, first, it is known not that there are no magnetons, but rather that if there be any, they are in pairs like the ions, and do not dissociate as far as can be concluded from $\nabla B = o$. Next, granting that there are no real magnetons, the theory of the magnetic shell remains. It shows that a closed electric current, which may consist of moving electrons, may be replaced by a double sheet of magnetons so far as external magnetic force is concerned. Thirdly, there are considerations concerning space and time variation of vectors which are quite independent of the physical nature of the vectors. So, altogether, I think it will be wise not to be overhasty in rejecting terms in the circuital equations because magnetons do not exist. Let us try to keep to symmetry to aid understanding any want of symmetry that may be forced upon us by special hypotheses. Say, however,

$$e = nVwB_0, \qquad h = mVD_0w, \quad (68)$$

where m and n are numerics. This will give considerable latitude. What is now the wave-speed?

First, considering a plane wave travelling the same way as w, (64), (65) make

$$-\Delta(H + D_1 w) = pD, \quad (69)$$

$$-\Delta(F + B_1 w) = pB, \quad (70)$$

and therefore

$$H + D_1 w = UD, \quad (71)$$

$$F + B_1 w = UB. \quad (72)$$

Now introduce (66), (67), with the meanings given by (68), we get

$$H + c_1 w(F - wn\mu_0 H) = U(cF - c_1 wn\mu_0 H), \quad (73)$$

$$F + \mu_1 w(H - wmc_0 F) = U(\mu H - \mu_1 wmc_0 F), \quad (74)$$

which give U for any value of w. Neglecting squares, the quadratic is

$$U^2 - Uw\left[\frac{c_1}{c}\left(1 + n\frac{\mu_0}{\mu}\right) + \frac{\mu_1}{\mu}\left(1 + m\frac{c_0}{c}\right)\right] = v^2; \quad (75)$$

where $c = c_0 + c_1$, $\mu = \mu_0 + \mu_1$, and $\mu c v^2 = 1$. That is

$$\frac{U - v}{w} = \frac{c_1}{2c}\left(1 + n\frac{\mu_0}{\mu}\right) + \frac{\mu_1}{2\mu}\left(1 + m\frac{c_0}{c}\right). \quad (76)$$

To revert to the former case, $\mu_1 = 0$, and $n = 1$. But if both m and n are unity, then

$$\frac{U - v}{w} = \frac{c_1}{2c}\left(1 + \frac{\mu_0}{\mu}\right) + \frac{\mu_1}{2\mu}\left(1 + \frac{c_0}{c}\right); \quad (77)$$

and if we employ e = VwB, h = VDw as another extreme case, then $n = \mu/\mu_0$ and $m = c/c_0$, producing

$$U - v = \left(\frac{c_1}{c} + \frac{\mu_1}{\mu}\right)w. \quad (78)$$

Here magnetisation acts similarly to electrisation. Notice that this way of introducing μ_1 allows the coefficient of w to be greater than unity. Then the speed of the wave is increased from v to more than $v + w$ by moving the matter at speed w. This is not impossible, however improbable it may appear.

If we ask how still to obtain Fresnel's wave-speed when μ_1 is finite, examination of (76) shows that $m = -1$ will do it, along with the former $n = +1$. But if $n = \mu/\mu_0$, so as to use the full e, then we require $m = -c/c_0$. But it seems very unlikely that μ_1 should have no influence on the wave-speed.

There are many other ways of modifying the circuital equations so as to always lead to Fresnel's wave-speed when $\mu_1 = 0$, but it is of no use discussing them without some particular reason.

In § 471 above I referred to Dr. Larmor's investigation of the wave-speed. He has kindly asked me to delete the § 87 of his stimulating work "Ether and Matter," being convinced of its erroneousness, and has referred me to his § 73 later on. There is no investigation of the wave-speed there, but on making the necessary reductions I find (subject to an indeterminateness) that the general equations there given do lead to

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Fresnel's speed, and in the same way as Lorentz's. But there is some indefiniteness about the meaning of the vector (α, β, γ), which he identifies with Maxwell's magnetic force, so I give the equations here in vectorial form and rationalised, that the matter may be made more distinct.

Let $(P, Q, R) = \mathbf{E}$; $(a, b, c) = \mathbf{B}$; $(p, q, r) = \mathbf{w}$. Then Larmor's second circuital law is

$$-\operatorname{curl}(\mathbf{E} - \mathbf{e}) = \dot{\mathbf{B}}, \qquad \mathbf{e} = \mathbf{V}\mathbf{w}\mathbf{B}. \tag{79}$$

This requires no remark.

Let $(A, B, C) = \mathbf{I}$; $(A_1, B_1, C_1) = \mathbf{I}_1$; $(A_0, B_0, C_0) = \mathbf{I}_0$; $(u, v, w) = \mathbf{J}$; $(f, g, h) = \mathbf{D}_0$; $(f', g', h') = \mathbf{D}'$; $(f'', g'', h'') = \mathbf{D}''$; $(f'_0, g'_0, h'_0) = \mathbf{d}_0$; $(\alpha, \beta, \gamma) = \mathbf{H}$. Then Larmor's first circuital law is

$$\operatorname{curl}\mathbf{H} = \mathbf{J}, \tag{80}$$

where J is what he terms Maxwell's total current

$$\mathbf{J} = \sigma\mathbf{E} + \mathbf{w}\rho + p c_0(\mathbf{E} - \mathbf{e}) + p(c_1\mathbf{E} + \mathbf{d}_0) \tag{81}$$

i.e., the sum of the conduction current, convection current, rate of time increase of the ethereal electric displacement, and ditto of the material electric displacement. For it is given that

$$\mathbf{J} = \sigma\mathbf{E} + \mathbf{w}\rho + \dot{\mathbf{D}}'', \qquad \mathbf{D}'' = \mathbf{D}_0 + \mathbf{D}' \tag{82}$$

$$\mathbf{D}_0 = c_0(\mathbf{E} - \mathbf{e}) = c_0\mathbf{F}, \qquad \mathbf{D}' = \mathbf{d}_0 + c_1\mathbf{E}. \tag{83}$$

Here w is the speed of the matter and of ρ the electrification, and $\mathbf{d}_0$ is intrinsic electrisation, analogous to $\mathbf{I}_0$, which is intrinsic magnetisation.

Now as regards H, it is given that

$$\mathbf{H} = \mathbf{B} - \mathbf{I}_1, \qquad \mathbf{I}_1 = \mathbf{I} + \mathbf{V}\mathbf{D}'\mathbf{w}, \qquad \mathbf{I} = \mathbf{I}_0 + \kappa\mathbf{H}, \tag{84}$$

which lead to

$$\mathbf{H} = \mathbf{B} - \mathbf{I}_0 - \kappa\mathbf{H} - \mathbf{V}\mathbf{D}'\mathbf{w}. \tag{85}$$

There are no μ's; that is, the units are "electromagnetic," only rationalised. Remembering this, we have in Maxwell's theory

$$\mathbf{H} = \mathbf{B} - \mathbf{I}_0 - \kappa\mathbf{H}, \tag{86}$$

because $1 + \kappa = \mu$ ("electromagnetic," numerics). This makes $\mathbf{V}\mathbf{D}'\mathbf{w} = 0$, which is obviously not meant. On the other hand, if we ignore (86), and use only (85), we express H in terms of B and $\mathbf{V}\mathbf{D}'\mathbf{w}$; viz.,

$$(1 + \kappa)\mathbf{H} = \mathbf{B} - \mathbf{V}\mathbf{D}'\mathbf{w}. \tag{87}$$

Perhaps this is not meant either. It occurs to me to suggest that the H in equation (80) is not meant for Maxwell's H; call it H′ instead, and then in (85) we shall have H′ on the left side and H, subject to (86), on the right side. This will give

$$\operatorname{curl}(\mathbf{H} - \mathbf{V}\mathbf{D}'\mathbf{w}) = \mathbf{J}, \tag{88}$$

which I think it probable is what Dr. Larmor really means. Because, transferring $\mathbf{V}\mathbf{D}'\mathbf{w}$ to the other side, this equation is the same as

$$\operatorname{curl}\mathbf{H} = \sigma\mathbf{E} + \rho\mathbf{w} + p\mathbf{D}_0 + p'\mathbf{D}', \tag{89}$$

which is equivalent to Lorentz's equation, with the addition of conduction current and intrinsic displacement; because D′ reduces to $\mathbf{D}_1$ when $\mathbf{d}_0 = 0$.

It took some trouble to effect this reconciliation, and I could wish that Dr. Larmor had himself brought his work into line with that of other people; but as he has not done so, he may perhaps be grateful to me for trying to do it. If, however, I have not correctly interpreted his (α, β, γ) or H or H′, in the above way, I do not see how to harmonise matters. I should call curl H the total current, as in (89); not the J in (80).

(To be continued.)

Charing Cross, Euston, and Hampstead Railway.—At a meeting held at the Charing Cross Hotel, last Friday, the undertaking of the Charing Cross, Euston, and Hampstead Railway Co. was formally transferred to Mr. Charles T. Yerkes, of New York, and the gentlemen associated with him in this London electric railway scheme.

A UNIVERSAL CAREY-FOSTER BRIDGE.

BY CHARLES V. DRYSDALE, B.SC.

The Carey-Foster method of comparing resistances has long been known, and has been almost universally adopted for the standardisation of coils of values from a tenth of an ohm upwards. Of recent years, however, resistances of much lower values—down to one ten-thousandth of an ohm—have been used, principally in connection with the measurement of large currents by potentiometer methods. As the Carey-Foster method is undoubtedly by far the most accurate method of standardising coils, the author was led some five years ago to extend this method for use with low resistances. This was accomplished by using the principle of the Kelvin

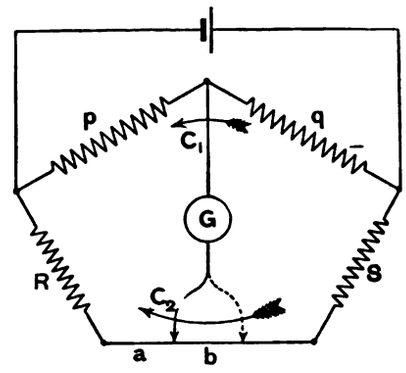

FIG. 1.

double bridge—*i.e.*, of employing a second pair of ratio coils connected across the junction between the resistances. The slide-wire was then removed from its ordinary position between the coils and introduced between the ordinary ratio coils. It will be well, first, to say a few words as to the theory of the method.

Fig. 1 shows the connections of the ordinary Carey-Foster bridge, where R and S are the resistance to be tested and the standard coil respectively, and p and q the approximately equal ratio coils. As is well known, balance is obtained by moving the slide-wire contact when R and S are in the positions shown, and again when they are interchanged. The difference between the resistances R and S in then equal

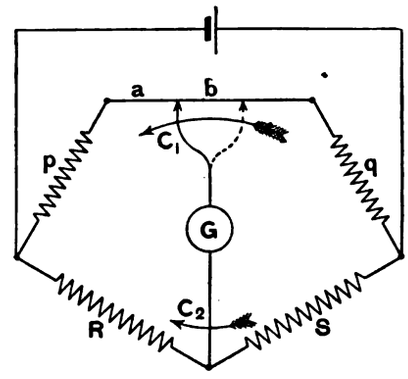

FIG. 2.

to the resistance of the slide-wire between the points of contact, independently of the values of the ratios. For if C_1 is the current passing through p and q, and C_2 that through R and S, we have at first

$$C_1 p = C_2(R + a), \text{ or } R + a = (C_1/C_2)p,$$

where a is the resistance of the slide-wire, including any contact resistance, up to the point of balance.

On interchanging R and S we have in the same way $S + a + b = (C_1/C_2)p$, the ratio of C_1 to C_2 remaining the same, as the total value of the resistance is not altered. Hence $R + a = S + a + b$, and $R - S = b$, as stated.

Let us now suppose that the slide-wire is introduced between p and q instead of between R and S, as in Fig. 2.

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Then we have $R = C_1/C_2(p+a)$, and on interchanging R and S, $S = C_1/C_2(p+a+b)$.

Hence, $R - S = \left(\frac{C_1}{C_2}\right)b = \frac{R+S}{p+q+r}b$, where r is the total resistance of the slide-wire.

It will thus be seen that the difference of the resistances is now expressed as the resistance of the wire between the points of contact, multiplied by a factor depending on the resistances of the coils and wire. This apparently introduces more complexity into the method, but in practice it makes very little difference. The value of the slide-wire resistance is always found practically by determining the length of the wire corresponding to a known alteration in the difference between R and S, so that it is equally easily determined in either case. Moreover, if the slide-wire resistance r is small in comparison with $p+q$, as it usually is in practice, it will be seen that the bridge will give directly the *percentage* difference in the resistances of the coils instead of the *absolute* difference, thus saving a small amount of calculation. Further, since only two contacts have now to be interchanged instead of four, a much simpler commutator can be used and the number of mercury contacts may be reduced.

Fig. 3 shows the only modification necessary to make the bridge suitable for the comparison of low resistances. As is well known standards of low resistance are provided with four terminals, two for connection to the current-carrying circuit, and two "potentiometer terminals," between which the P.D.

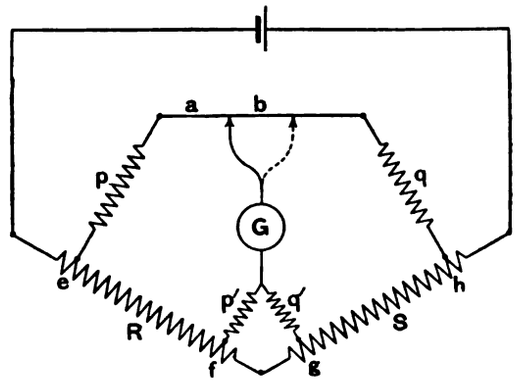

Fig. 3.

can be measured. The resistance of the arrangement is then defined as the ratio of the P.D. between the potentiometer terminals to the current flowing through the arrangement.

For comparing these standards they are connected in series by their current terminals exactly as with ordinary resistances. The ratio coils p and q with their slide-wire, however, span across the two extreme potentiometer terminals e and h as shown in Fig. 3, instead of between the current terminals, while a second pair of approximately equal ratio coils p' and q' are connected across the inner potentiometer terminals f and g as shown. The galvanometer is connected between the junction of the coils $p'q'$ and the slide-wire contact, or virtually between the "electrical centre" of the contact resistance and the slide-wire. In this case if the connections between R and S and the ratio coils are interchanged the same formula applies as in the last case. For if x is the resistance between the terminals f and g including the contact resistance we have:—

$$R + \frac{p'}{p'+q'}\frac{x(p'+q')}{p'+q'+x} = R + \frac{p'x}{p'+q'+x} = \frac{C_1}{C_2}(p+a),$$

and on interchanging

$$S + \frac{p'x}{p'+q'+x} = \frac{C_1}{C_2}(p+a+b),$$

hence $R - S = (C_1/C_2)b$, as before.

In practice it is not usually necessary to interchange the connections with the inner ratio coils p' and q' since the contact resistance x is usually very small, and the ratio coils used with a Carey-Foster bridge are pretty closely equal as a rule. It can be easily seen whether reversal of these coils is necessary, by obtaining balance on the slide-wire and observing whether it is disturbed on interchanging the ratios, but in the author's experience the interchanging of these ratios has been found unnecessary.

A word should be said as to the resistance of the connections. These connections may be divided into two classes, those which are interchanged with the coils, *i.e.*, are between the coils and the commutating device, and those which are not interchanged. The latter have obviously no effect, as their resistance is added to each of the coils in turn. The former do affect the result, and consequently their resistance should be made as low and as nearly identical as possible on the two sides of the bridge.

Construction of the Universal Bridge.—Before describing the bridge which the author has used, it may be well to show that the existing forms of Carey-Foster bridge can be easily

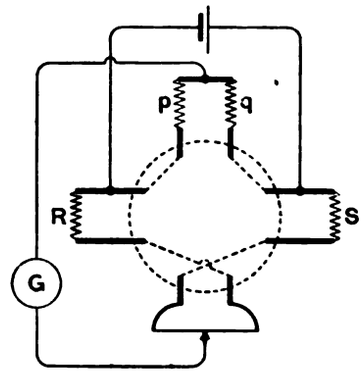

Fig. 4.—Ordinary Carey-Foster Bridge.

modified to admit of low resistance comparison. Fig. 4 shows a diagram of the Nalder form of bridge which has been extensively adopted, the dotted circle representing the commutator, and the dotted straight lines the commutator connections. On turning this commutator half round the resistances R and S are interchanged. In order to convert such a bridge all that is necessary is to introduce a second pair of ratio coils, p and q, between the commutator and slide wire as shown. If the resistances are connected as in the diagram the battery being directly connected to the resistances, it will be seen that the arrangement is electrically equivalent to Fig. 3 and that the interchanging of the connections is

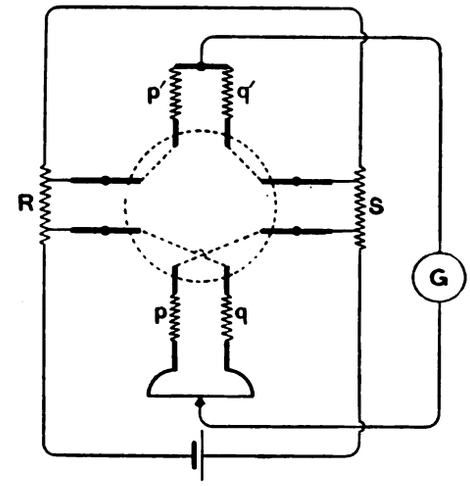

Fig. 5.—Ordinary Carey-Foster Bridge converted for Low Resistance Measurement.

exactly that required. In order to use the bridge for ordinary resistance measurements, the gaps shown bridged by p and q can be simply short circuited by copper connectors dipping into the same cups. It will be seen also that if two extra battery terminals are fixed as shown, the bridge can always be used either with the slide-wire between the coils in the ordinary way, or with it between the ratios, which is more convenient when percentage differences are required.

The design of the bridge which the author has employed is due to Mr. A. D. Hughson, who has had a long experience of

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accurate resistance work, and who independently suggested the connection of the slide-wire between the ratio coils, with the object of simplifying the commutator.

In Fig. 5 is shown a diagram of this bridge, while the photographs illustrate its construction. The main features in which it differs from existing types of bridge may be enumerated as follows :—

(*a*) The copper connecting bars are all mounted *beneath* the ebonite base, and have mercury cups projecting through so as to be level with the surface of the ebonite. This makes it perfectly easy to keep the ebonite clean and free from mercury, which usually lodges between the bars. It also most effectively prevents any creeping of the mercury over the bars.

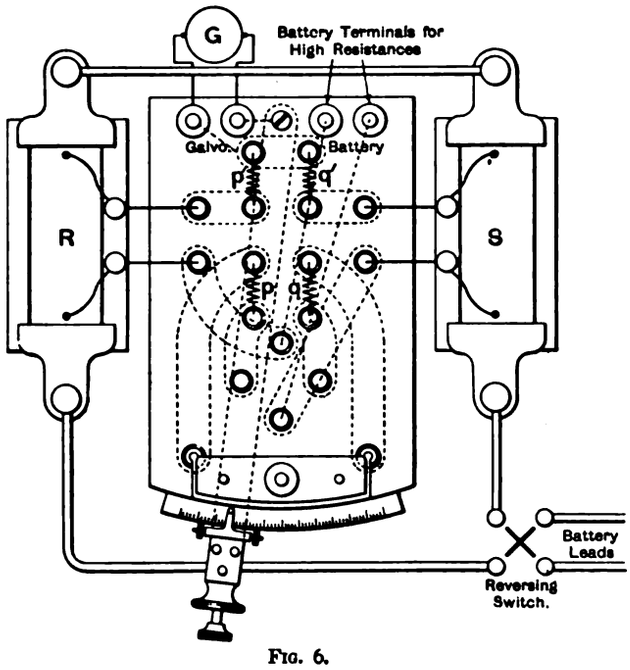

FIG. 6.

(*b*) The slide-wire is connected between the ratio coils in all cases, as in Fig. 2, thus enabling the commutator to be made with four instead of eight contacts.

(*c*) Arrangements are made for the second pair of ratio coils required for low-resistance work to stand in mercury cups just behind the main ratio coils. When these ratios are not required their place is taken by an ebonite disc having two short-circuiting copper connectors, which drop into the same cups. To convert from an ordinary to a low-resistance bridge all that is necessary is to withdraw the disc and stand the ratio bobbin in its place.

(*d*) To gain greater accuracy of reading the sliding contact is mounted on a radial arm so as to move very freely, even when the observer is sitting

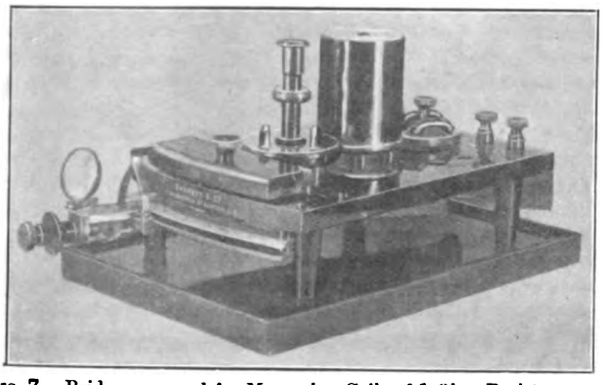

FIG. 7.—Bridge arranged for Measuring Coils of 1 Ohm Resistance and upwards.

at arm's-length from it. This avoids heating of the coils by radiation from the observer's body, and is of considerable importance in practice. The slide-wires are therefore mounted on curved ebonite blocks, and drop on pins on the bridge so as to be easily interchanged. A vernier is provided by which it is possible to read as accurately on short wires as it is usually possible to do with long wires. Short wires are to be preferred in practice as being generally more uniform, less likely to slacken or get damaged, and less liable to temperature differences between the ends. The vernier is read by a universally mounted lens. Considerable care has been devoted to securing a perfectly even pressure between the contact and slide-wire, and to make both the contact and wire of the same material, to avoid thermo forces as much as possible. The importance of these latter points can only be appreciated by those who have had experience in accurate resistance measurement, and it may be at once said that these improvements have rendered it possible to work conveniently to an accuracy of one part in a million when comparing ordinary 1 ohm coils. The sensitiveness indeed is such with a good Kelvin galvanometer that even with a platinoid slide wire $\frac{1}{4}$in. thick hand adjustment is not sufficient to get perfect balance, and it is proposed to fit a clamp and tangent screw to the sliding contact.

Care has of course been taken to eliminate contact errors by making the bars of as nearly as possible identical section and length on both sides of the bridge. Any residual error can be easily determined by taking readings with short-circuited contacts.

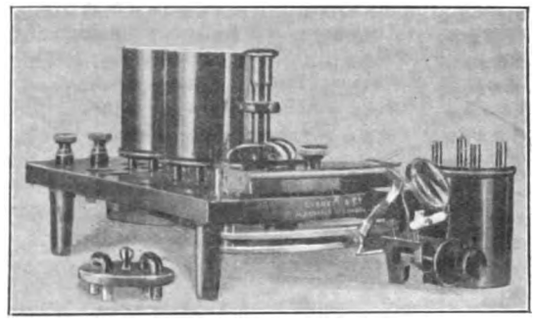

FIG. 8.—Bridge arranged for Low Resistance Measurement.

In a further article the author proposes to give an account of some tests which he has been recently conducting with some specially designed resistance coils, in which he has combined greater possibility of permanence and high-radiating power with an almost negligible temperature coefficient and an electrical means of determining the temperature. It will be seen from these tests that the accuracy claimed for the bridge is justified, and although this may seem almost useless

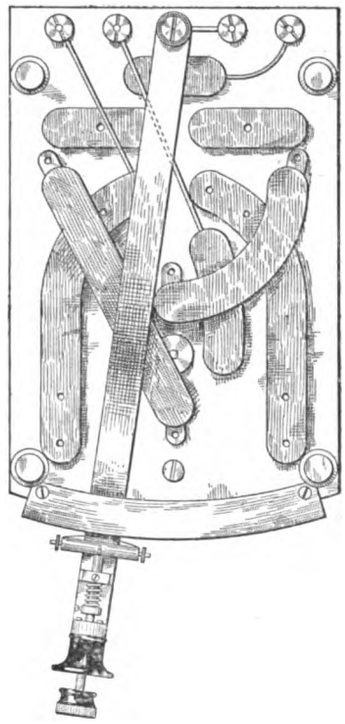

FIG. 9.—General View of Connections from below.

refinement, there are many cases in which it is of great value to determine small differences of resistance with accuracy. It is further proposed to say a few words as to the methods employed in building up and subdividing resistances from a single standard coil.

In conclusion, the author would like to point out that this bridge is preferable for standardising low resistances to any existing form of bridge or potentiometer. In all existing Kelvin bridges, or low resistance measurers, the standard

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consists of a platinoid or other wire, the uniformity of which is rarely satisfactory. Moreover, in testing low resistances it is of great importance to use the full working current both for sensitiveness and to get the normal conditions of temperature. This is generally impossible with a standard wire, as it will rarely carry more than a small fraction of the current taken by a properly designed low resistance standard without overheating. In the new bridge of course the full working current can be used without any difficulty. It is only necessary to be careful that the ratio coils have a resistance of about a thousand times that of the resistance tested, so as to avoid sensible distortion of the stream lines and equi-potential surfaces in the resistance. The advantage over the potentiometer is apparent in the fact that with the bridge method the current can be reversed at each reading, thus eliminating any thermo-electric effects. This cannot obviously be done with the potentiometer.

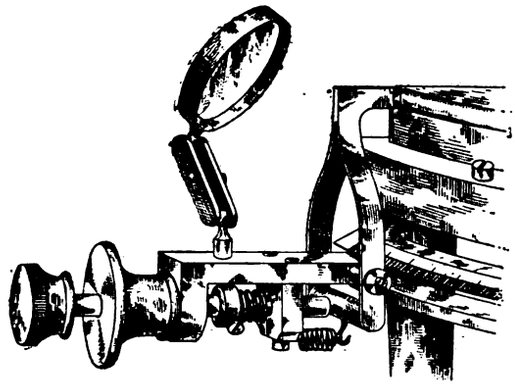

FIG. 10.--Details of Slide-wire Contact.

The bridge illustrated in the photographs was made for the author, for the laboratories of the Northampton Institute, by Messrs. Everett & Co., London, and has been found in every way satisfactory.

THE PARIS EXHIBITION.—VIII.*

(BY OUR SPECIAL CORRESPONDENT.)

Another compounded alternator is one exhibited by the firm of Bréguet. It is a three-phase machine, designed for 2,200 volts at 220 amperes for each phase on a circuit with a power factor of 0·8, and it runs at 250 revs. per min. and 50∿ per sec. frequency. The compounding, which is intended to maintain the pressure at the alternator terminals constant, whatever the current and whether it be useful or wattless, is effected by a special exciter as in the last machine described, in combination with a transformer. The alternator has a rotating field magnet with 24 poles, and its fixed armature resembles that of any other 24-pole, three-phase alternator.

The exciter has to generate continuous current when excited with alternating current, but M. Boucherot, the designer of the machine, has solved the problem in a different way to that employed by M. Leblanc in the Grammont exciter described in my last article. Fig. 47 shows the principle adopted in the design of the exciter. Suppose R in this figure to be an iron ring provided with two windings, the sections of which, instead of each having the same number of turns, are given each a number of turns varying round the circumference in accordance with a sine law, and connected to the commutator by one of the methods shown in Fig. 48 or Fig. 49. Returning to Fig. 47, we shall, for instance, have at B a group of $n \cos k\phi$ turns in series with a group at C of only $n \sin k\phi$ turns. Suppose this ring placed as rotor within a double rotatory field arranged as dotted in Fig. 47, this field rotating in the direction of the arrowhead with a speed ω. Finally, let the armature be turned in the same direction with a speed Ω. It can be shown that if the relation between these speeds be $\omega = -k\Omega$, a continuous current can be taken from brushes placed at A and A′ in the figure. The angle between these brushes is $\psi = \frac{\pi}{k+1}$, and the E.M.F. of the current so obtained

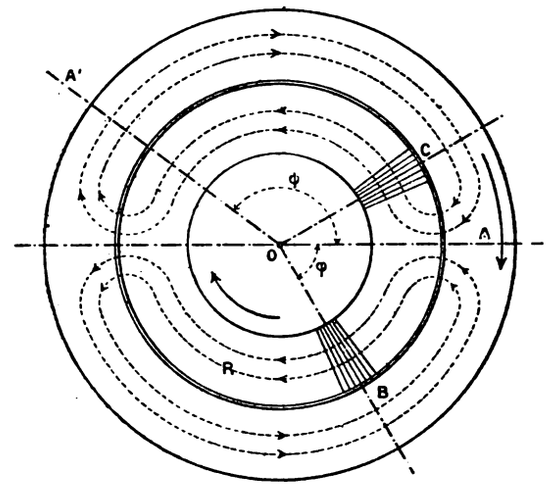

FIG. 47.—PRINCIPLE OF THE BOUCHEROT EXCITER.

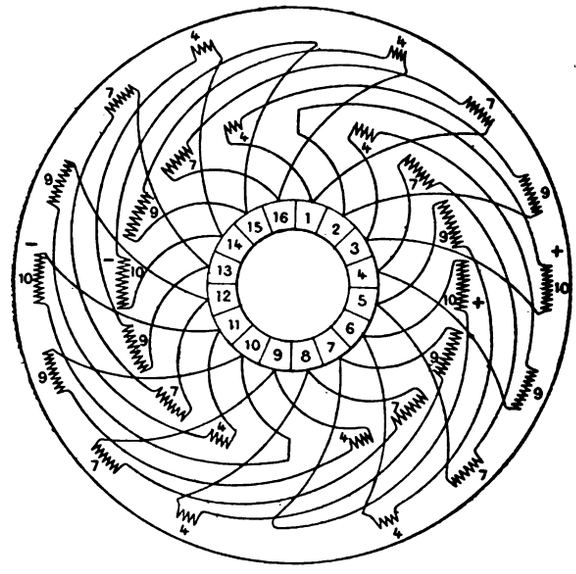

FIG. 48.—WINDING OF ARMATURE OF BOUCHEROT EXCITER FOR $k=1$.

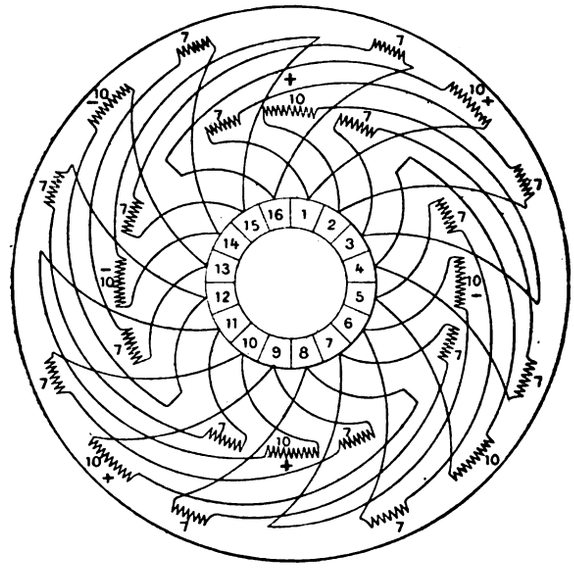

FIG. 49.—WINDING OF ARMATURE OF BOUCHEROT EXCITER FOR $k=-2$.

is $E = 2ne\Omega$, where e is a constant depending on the flux. The rotatory magnetic field is obtained by two two-phase currents through two windings on the stator of the exciter, or three windings and three three-phase currents may be employed.

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, and September 14 and 28.

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Fig. 50 show the general arrangement of the machine. The co-efficient k may be given a number of values, whole numbers or fractions; $k=1$ and $k=-2$ are the most useful. When $k=1$ (Fig. 48) the machine can be excited with single-phase alternating current. The alternating magnetic field is then to be considered as the superposition of two rotatory fields rotating in opposite directions at a speed ω. One of these, rotating as it does at the same speed as the armature, generates no current in it, and the system works as if it had one field rotating at the speed $-\omega$.

When k is given the value -2, the exciter can have half as many poles as the alternator, and yet only two brushes per pair of poles. Fig. 49 shows the connections for the armature of this arrangement, and it is the system adopted in the machine at the exhibition. The exciter is directly coupled to the shaft of the alternator, turning at 250 revs. per min., and has therefore been given 12 poles.

Another extraordinary feature of this set is that the field magnets of the alternator are provided with two windings which can be excited with two-phase current by slightly modifying the exciter. The design is intended to give the remarkable result that the machine shall be asynchronous—that is to say, that the frequency of the alternator is not necessarily exactly proportional to the speed of the field-magnets. It would seem, however, that this *tour de force* has a disadvantage which counterbalances any advantages that it might have for parallel running. Although the machine may be asynchronous, when the slip is only very slight an enormous difference in the output ensues; for instance, it appears that the load can vary from zero to a maximum for a slip of less than 1 per cent. As all true inventors, M. Boucherot has invented a further device to overcome the defects of the first invention. This device is for the purpose of counteracting the above effect and

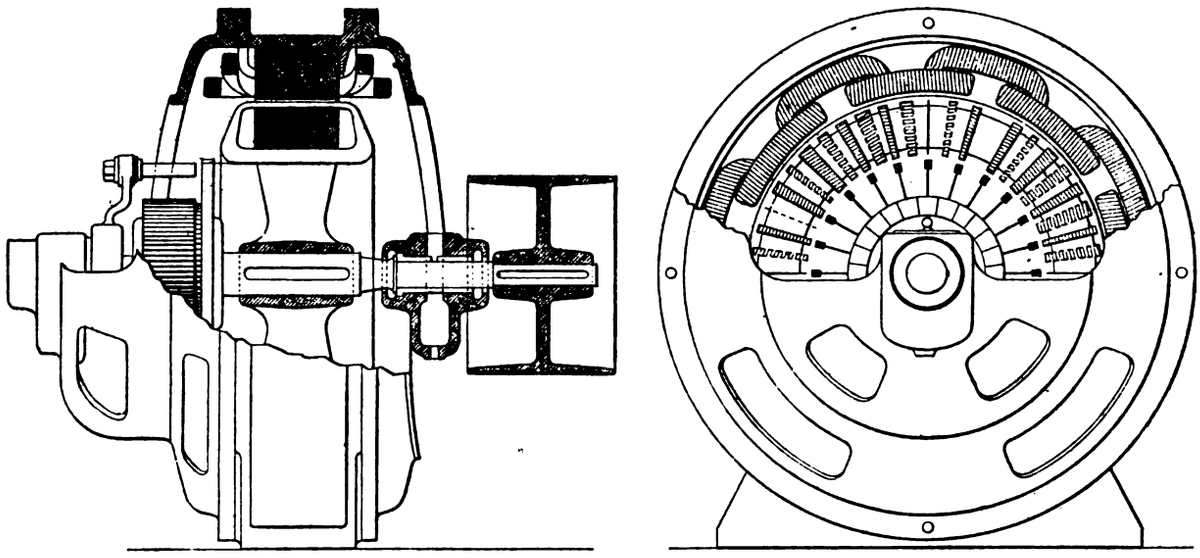

Fig. 50.—General Arrangement of Boucherot Exciter.

Thus the exciter, when it is itself excited with a three-phase current, delivers continuous current from its terminals; but the connections to produce compounding of the alternator, so that its terminal potential difference is constant whatever the current, have still to be explained. These connections are very simply made by means of the three-phase transformer already alluded to, and are shown in Fig. 51. The primaries of

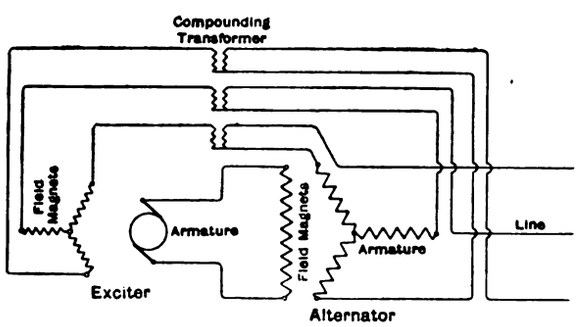

Fig. 51.—Connections of Boucherot Exciter and Alternator.

this transformer are in the main circuit of the alternator, and thus the E.M.F. of the secondaries will increase as the current supplied to the main circuit increases. The secondaries are consequently connected in the circuit between the armature of the alternator and the field coils of the exciter, so that the greater the current supplied by the alternator the greater is the excitation of the exciter. This increases the E.M.F. generated by the armature of the exciter as the load increases, which in its turn increases the current through the field winding of the alternator and reinforces the alternator E.M.F.

rendering the machine "panchrone," as M. Boucherot terms it, a word intended neither to suggest perpetual motion nor finality of design for all time, but merely to indicate that the power supplied is practically independent of the speed. However, as the machine is excited with continuous current at the exhibition, I will not enter into the "asynchronous-panchrone" theory here. Those readers who desire to study it may refer to an article by M. Boucherot himself in the *Industrie Electrique* of July 25. It should be added that by the end of June the compounding exciter had not yet put in an appearance at the exhibition, and the alternator was being excited by an ordinary continuous-current dynamo. The alternator is driven by an enclosed Delaunay-Belleville vertical triple-expansion engine. This engine has two low-pressure cylinders, placed below the H.P. and I.P. cylinders respectively, and the two cranks are set at 90deg. Its main dimensions are:—

Diameter of H.P. cylinder	510mm.
Ditto I.P. do.	820mm.
Ditto each L.P. do.	850mm.
Stroke	460mm.
Length of engine overall	2·850 metres.
Width ditto	2·400 do.
Height ditto	5·250 do.

An alternator exhibited by the Compagnie Générale Electrique of Nancy resembles very much the Schuckert machine described in a former article. In Fig. 52 it is seen that it follows the same lines in several respects, including the radial stays for stiffening the armature. In the background on the left is seen a large but ugly three-phase alternator made at the French works of the Electricité et Hydraulique Co. It develops 210 amperes at 2,200 volts per phase, with a frequency of 50 $\sim$ per sec. and 94 revs. per min., and its ungainly appearance seems due to the small proportion

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between the width and diameter of the armature. In the background on the right of Fig. 52 a glimpse is caught of the Décauville machine described in *The Electrician* of August 24 (p. 666).

The Nancy alternator has an output of 450 kilovolt-amperes at 3,000 volts and 50 ∽ per sec., when making 93·5 revs. per min. Its armature is built up of core discs ½mm. thick, insulated from one another by paper. These are held in place by four semi-circular castings with ventilation holes, this frame being stiffened, as already mentioned, by radial wrought iron rods. The winding is placed in micanite tubes. The internal diameter of the armature is 4½ metres, and its external diameter 5·050 metres. Its width is 580mm. and it has 96 coils wound in 384 holes, 32 coils in series constituting the winding of each phase. The total weight of the armature is 14 tons. Cast-steel is employed for the flywheel field magnet, which has 64 poles of elliptical section and weighs 9·6 tons. The cables connecting the field coils to the slip rings are led through one of the arms of the flywheel. A series-wound exciter is employed, generating 75 amperes at 120 volts. The alternator is driven by a single-cylinder Weyher and Richemond engine.

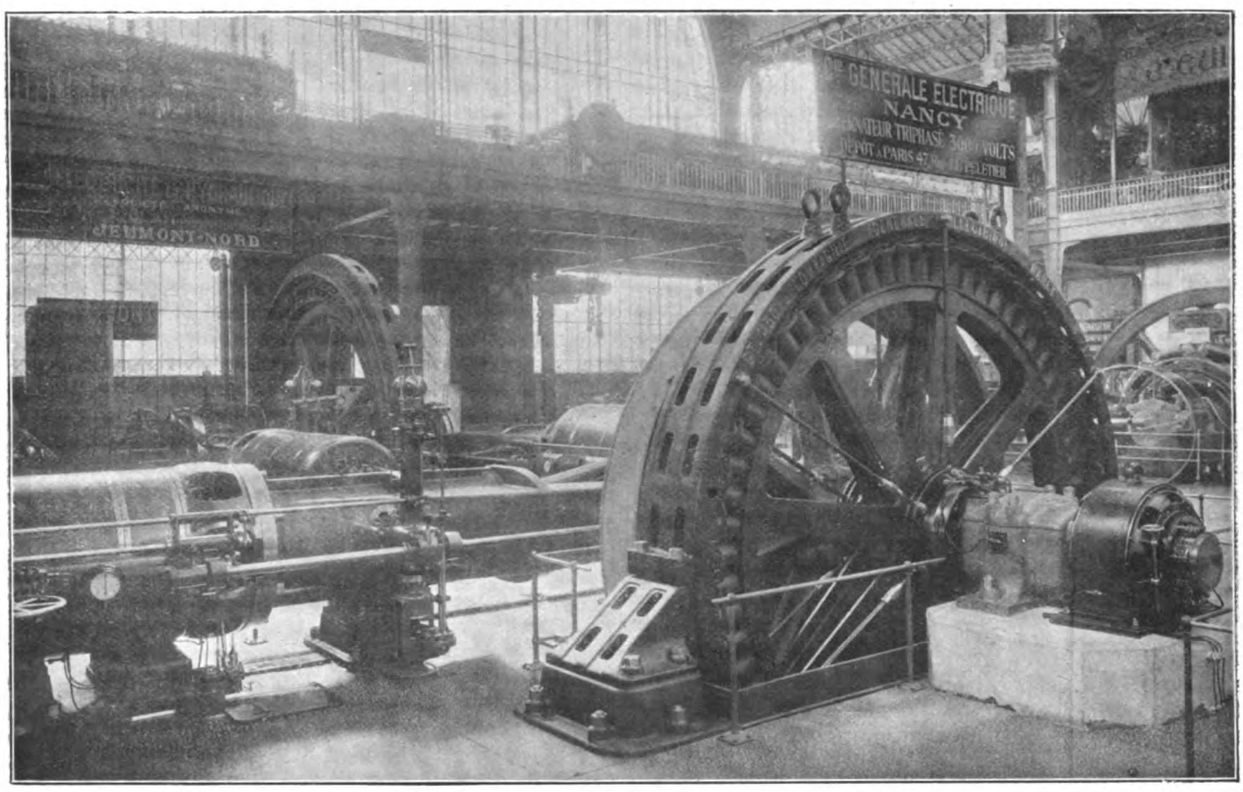

FIG. 52.—ALTERNATOR BY THE COMPAGNIE GÉNÉRALE ELECTRIQUE OF NANCY. 450 kilovolt-amperes at 3,000 volts.

Another French alternator of good, normal design without startling peculiarities is the Labour machine, driven by a tandem compound Dujardin engine, with Corliss valve gear. Messrs. Dujardin & Co., it may be mentioned in passing, exhibit a number of engines of various types, typical of the best French practice of to-day. The alternator is three phase, and intended for an output of 1,200 apparent kilowatts on a load factor of 0·5 at 3,000 volts and 50 ∿ per sec. The flywheel field magnet has a diameter of 5·6 metres, and revolves at 80 revs. per min., requiring about 100 amperes exciting current at 220 volts, when the alternator is fully loaded. A feature of the machine is the bronze ⌊⌋-shaped connectors between the coils of the armature.

The Société de l'Eclairage Electrique, who are the makers of the Labour dynamo, have in their general exhibit a 30,000-volt single-phase alternator, which is, however, not shown in operation. A ring-shaped casting is bolted to the bed-plate, and the annular core of the armature is concentric with this, being held at about 3in. distance by brackets. The armature is fixed, and a 14-pole field magnet revolves within it. The windings are laid four together in micanite tubes in tunnels in the armature, but there are twice as many holes as necessary for the winding, so that every alternate hole only contains windings. The field magnets turn at 428 revs. per min., and the frequency is 50 ∼ per sec.

A fine 800 apparent kilowatt three-phase set, exhibited by the Fives-Lille Company is of the usual flywheel type, and is driven by a cross-compound horizontal Corliss engine, the dynamo being placed between the two cylinders, Another large set is a 1,000kw. three-phase Thomson-Houston alternator built in France for the French Thomson-Houston Co., and driven by a vertical cross-compound Allis engine, likewise constructed in France by the Société Française de Constructions Mécaniques (Anciens Etablissements Cail). The alternator follows the usual Thomson-Houston design. It is 40-polar, and generates current at 5,500 volts and 25∽ per sec. The dynamo is placed next to a flywheel between the cylinders of the engine.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"The A B C of Electricity." By W. H. Meadowcroft. Sixth Edition. (London and Manchester: John Heywood.) 2s.

"Injectors: their Theory, Construction and Working." By W. W. F. Pullen. Second Edition. (Manchester: The Technical Publishing Co.)

Shifting the Blame.—There seems no end to the mischief wrought by stray electric currents in the ground. The asphalt pavements in Brooklyn, it is said, are being ruined by leaking gas mains beneath them. The hydro-carbons used in enriching the gas are excellent solvents of asphalt, and so soften it in spots that it breaks up and crumbles. The gas companies, when brought to task for the injury done by their mains, however, shift the blame to the electric railway companies, whose wandering return currents they assert cause corrosion of the gas mains and consequently give rise to the gas leakage which, in turn, develops the trouble with the pavement.

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THE INTERNATIONAL ELECTRICITY CONGRESS.

(*Concluded from page 844.*)

Section III.—*Electrochemistry.*

M. Keller's Paper, an abstract of which appeared in our last issue, was read on Tuesday, August 21st. In the discussion on it Mr. Petavel asked what would be the best disposition for the alternators in the furnaces. M. Keller replied that the alternators might be about 2m. from the furnaces with a separation wall between them. Thus the cables would be from 18m. to 20m. long and the power factor as high as 0·9. Some existing installations had a power factor as low as 0·7. M. Keller estimated an expenditure of from 50f. to 60f. of electrodes per ton of carbide, based on the price of 60f. per 100kg. of electrodes. With perfected furnaces, 25f. worth of electrodes per ton of carbide could be arrived at.

M. Hollard then read a Paper on "The Principles of Electrolytic Analysis." In electrolytic analysis, he said, the separation of metals based on the polarisation E.M.F.s of their salts had been insisted upon too much. This principle was not true in analysis where the polarisation E.M.F. depended on the concentration of the metal and where the concentration diminished at every instant as metal was gradually being deposited. The principle could, however, be applied when the E.M.F.s of polarisation were large enough not to be neutralised by the diminution of the concentration of the bath. Hence a first classification of the metals into groups. These groups could again be sub-divided according as the ions of the metals in them were incapable of electrolytic deposition or if the complex ion was partly dissociated. M. Hollard then spoke of the influence of the current and current density on analysis and described a new system of electrodes.

On Wednesday M. Zenger described a battery which would utilise sea water for the production of electrical energy. One electrode was a porous carbon tube filled with bromine and the other an iron tube pierced with holes and filled with pieces of iron. The whole was immersed in a solution of bromides and alkaline chlorides which were residues from the manufacture of marine salt. These salts would be so hygrometric that it would never be necessary to replace the water. The bromine tube was hermetically sealed and did not give off gases. This battery had given very good results for telephony, telegraphy, with or without wires, and optical telegraphy. The weight of the cells was about one-third that of the corresponding Bunsen cells or accumulators. The author proposed to utilise these batteries for the production of electrical energy, and thought that bromine might sink to a very low price; iron had little value, and the alkaline salts were residues of manufacture. General Sébert, the chairman, said that the principle of this cell had been indicated by Col. Renard. M. Vignon remarked that bromine was worth 2fr. 50c. per kg., and its production was so limited that its commercial utilisation in M. Zenger's battery seemed difficult.

Section IV.—*Telegraphy and Telephony.*

The first Paper read in this section was by M. André, on a central battery telephone system. This was followed by a communication from Dr. Rudolph Blochmann on the question of the directibility of apparatus for telegraphy with electric waves. The author's hypothesis was that the terrestrial globe was surrounded by equipotential surfaces which are not troubled by an object raised in the atmosphere provided that it has no great sectional area as, for instance, a high vertical metallic wire. But if electrical oscillations were produced along this wire the equilibrium of the equipotential surfaces would be disturbed in the same way as the surface of water is disturbed when a stone is dropped into it. Just in the same way waves were produced which extended from place to place, and which could be received by the vertical wire attached to the receiving apparatus. If this hypothesis were a true one, Dr. Blochmann pointed out that the directibility of the apparatus now employed for the new telegraphy must be regarded as impossible. Capt. Ferrié asked how Dr. Blochmann explained that transmission was better between two stations separated by water than between two inland stations, and Dr. Blockmann replied that the equipotential surfaces were much more regularly distributed on the water.

On Tuesday Prof. Châtelain read a Paper by M. Popoff on telephonic receivers for wireless telegraphy. M. Popoff suggested that the diminution of resistance in the radio-conductor or coherer could be directly observed by a telephone. In July, 1899, he had utilised this phenomenon in an apparatus constructed for him by M. Ducretet. The receiver included a cell in circuit with a telephone and a "radio-conductor" of steel filings whose surface was oxidised. Experiments made in the winter in the Gulf of Finland with stations 47km. apart were quite successful. The masts were 48 metres high, and one of them was in a forest 5km. from the sea.

M. Willot followed with a note on wireless telegraphy, in which, contrary to the results obtained by Mr. Marconi at the naval manœuvres last year, he expressed the opinion that it was necessary for the transmitting and receiving stations in a wireless telegraph system to be in sight of one another, as the curvature of the earth's surface presented an insurmountable obstacle. He then suggested a new system of wireless telegraphy by employing different strata indicated in the geological maps, and connecting the two stations by means of this strata. We referred to this suggestion in an editorial note in our issue of Sept. 21. M. Tissot favoured the equipotential surface theory of Dr. Blochmann. He had transmitted messages successfully between French warships in the Channel, 89 nautical miles apart, and with masthead wires 26 metres long. Contrary to M. Popoff he was particularly careful to exclude any oxidised filings in the construction of his coherers.

Mr. Gavey then described what had recently been done in this country in connection with wireless telegraphy. In February, 1894, he was engaged in experiments with the electromagnetic system of wireless telegraphy across Loch Ness, the object in view being the discovery of the law which governed this method of transmission. It occurred to him to endeavour to establish communication by means of telephones, and this was done with thoroughly satisfactory results, conversation being readily exchanged between two parallel wires separated by a distance of 1¼ miles, the wires themselves being 4 miles in length. The question had been allowed to rest for some time, but recently it had become necessary to establish communication between the rocky islets known as the Skerries and the Coast Guard station at Cemlyn, in the Island of Anglesey. Accordingly a wire 750 yards in length was erected along the island, and a corresponding wire, roughly parallel with it, was erected from a point opposite the Skerries to Cemlyn Station, a distance of 8½ miles. The average distance between the two wires was 2·8 miles. Telephonic communication had been thoroughly practicable, and is now in daily use. Further experiments, between the north coast of Ireland and Rathlin Island had recently been made, and it was found in this case that a similar system could be worked at an approximate distance of 6½ miles between the transmitting wires.

M. Chaye-Pacha then spoke of an application of the microphone for the security of fishermen in Newfoundland to enable them to hear the approach of a steamer. The apparatus consists of a microphone enclosed in a box and immersed in the water. It is connected to a battery and a telephone on the boat. The noise of a steamer can thus be heard 4km. or 5km. away. By covering the microphone box almost entirely by means of a sound proof cover, such as a double wall of lead enclosing lampblack, and by providing the uncovered part with an acoustical trumpet, the direction the sounds come from can be determined. M. Roosen read a Paper reviewing the different systems for underground telephone cables, and expressed himself in favour of the system of stoneware pipes employed at Brussels. A discussion on the various systems followed, in which MM. Wunschendorff, Gavey, West and de la Touanne took part.

On Wednesday the proceedings were opened with a Paper by M. Blondel and Capt. Ferrié on "The Present Condition, and Progress Made in Wireless Telegraphy by Hertzian

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Waves." We shall publish an abstract of this Paper. This was followed by a communication by M. Pinter on the Pollak-Virág system of fast speed telegraphy, a sysrem which has been fully described and discussed in our columns. The third Paper was by M. O. Rochefort on "Unipolar Transformers." It gave data of the construction of induction coils made by the author and employed by M. Tissot in wireless telegraphy. The primary is not essentially different from that of the classical Rhumkorff coil, but the secondary is formed of a single flat coil covering the central half of the primary, or two such coils in series. Dr. Blochmann announced that he had asked M. Branly's permission to propose that the Congress should pass a resolution to call the filings tube the Branly tube, but this gentleman had declined the honour in a letter which Dr. Blochmann read to the meeting.

On Thursday the first Paper was communicated by Capt. Squier and Mr. E. Crehore and presented by Dr. Kennelly on "A Practical Telegraph Transmitter Using the Sine-Wave for Operating the Wheatstone Receiver." An abstract of this Paper has already appeared in our columns. Dr. Kennelly referred to the experiments which had been made in England between London and Edinburgh, and said that the system had recently been employed in America on a line belonging to the Commercial Cable Co. between New York and Canso, a length of about 2,000km. Mr. Gavey spoke of the great improvements that had recently been made in the Wheatstone system, enabling up to 400 words per minute to be transmitted with batteries, and said that Capt. Squier's experiments had been made on a Sunday on a quiet line which was not subject to inductive disturbance from neighbouring circuits. The subject of sine-wave transmission on submarine cables is referred to in our leading article this week.

Capt. Ferrié described numerous experiments he had made with carbon-carbon, carbon-metal, and metal-liquid coherers. He had found that a carbon-metal contact was more sensitive than a carbon-carbon contact, and a metal-liquid contact was less sensitive. He also put forward a theory of the action of the coherer.

M. Semenov followed with an account of some experiments which he had made with an adjustable coherer to determine whether it was a coherer or a "radio-conductor," and expressed himself in favour of the cohesion theory.

M. Bodde described an apparatus designed to utilise wireless telegraphy for the avoidance of collisions at sea. The transmitter is put in the focus of a parabolic cylindrical mirror, which is turned round its focus so as to send Hertzian waves successively in all directions. These waves are received by the receiving masts of neighbouring vessels in the ordinary manner. Each vessel is provided with a similar transmitting and receiving apparatus, and to prevent the two from affecting one another the author suggests a commutator tuned in synchronism with the transmitter mirror. He had not been able to make experiments on a large scale, but had verified the fact that when using the commutator the desired effect of screening the receiver from the transmitter on the same vessel had been attained.

Section V.—*Electro-Physiology.*

M. Bergouie, who occupied the chair on Monday in the absence of the President of the Section (M. D'Arsonval), observed that as the Congress had been preceded by congresses on radiology, radiography and medicine, the number of interesting communications and reports was limited.

M. Stanoiĕvitch read an interesting Paper on the analogy between the lines of magnetic and electromagnetic force in machines with the disposition of cells in plants. He described a series of investigations which had extended over four years, and which had led him to conclude that the organic cells obeyed the laws of Maxwell, and that they acted proportionately to the product of their mass and in inverse propertion to the square of their distance apart. Other Papers were read, but they were of medical rather than electrical interest.

At the meeting of the official delegates of the various governments, the recommendation of Section I. that the names "gauss" and "maxwell" be given to the C.G.S. units of magnetic field and magnetic flux respectively, was adopted by a majority of the delegates, as also was a resolution proposed by M. Stanoiĕvitch that electrical energy should be protected by law in the same way as any other property.

At a general meeting of the delegates on Saturday, August 25th, besides a number of speeches of congratulation and thanks from the French and foreign members, a resolution, put forward by sub-section B of Section II., was passed, requesting the governments to facilitate as much as possible the establishment of overhead and underground circuits intended for transport and for the distribution of electrical energy.

ELECTRICITY WORKS ACCOUNTS.

Blackpool Municipal Electric Supply Works and Tramways.

The figures we give this week in our analysis of the accounts of the Blackpool undertaking indicate most satisfactory working during the year 1899-1900. In consequence of the reduction of the initial price in the tariff from 8d. to 7d., the average revenue from all sources has dropped from 4·29d. to 3·86d. per unit sold. Thanks to the lower costs of working, however, this reduced revenue has not had such an influence as might have been expected on the working profit, which was £7,963, or 7·22 per cent. of the mean capital, as compared with £7,450, representing 8 per cent. on the capital, in the preceding year.

Comparing the business done in the two years, it will be found that while the lamp connections increased 29·6 per cent. the output advanced by 32 per cent. In 1898-9, of the total output of 870,184 units sold the tramways took 181,850 units, or 20·9 per cent., and the public lamps 164,922 units, or nearly 19 per cent. Last year, of the total output of 1,148,564 units sold 228,651 units, or 19·9 per cent., represented the supply to the tramways, and 193,053 units, or 16·8 per cent., the amount used in public lighting. It is somewhat surprising to find that, with the above proportions of arc lighting and traction loads, the load-factor should be barely up to the average of municipal stations in 1898-9. The value of this factor in Blackpool in 1898-9 was 10·46 per cent. Last year it was 10·1 per cent.

Among the generating costs the items of fuel and repairs and maintenance have risen—the former very considerably—viz., from 0·55d. to 0·70d. per unit. Even at the present figure, however, this charge is well within the average. The items of oil waste, water, &c., and repairs and maintenance, are above the average. Although the collective generating and works costs have increased, they still, together with the total costs, present excellent figures.

In our second table is given a summary of the tramway accounts for the two years ended at March 31, 1900. It will be seen that while the working expenses both at the station and on the route had increased slightly, the management, property, and general charges were diminished sufficiently to do more than neutralise the increase in the working costs.

During the year ended at March 31 last there was special expenditure on account of doubling the line from Church-street to Springfield-road and from Hounds Hill to Church-street. This expenditure was £4,210, and of it a third, or £1,403, was charged to revenue, the remaining two-thirds being carried forward in suspense. In our analysis this charge of £1,403 has been deducted out of the working profit merely, and therefore does not enter into the revenue account to vitiate a fair comparison of the two years' results. A loss of £809 on realisation of the centre-channel stock plant has not been charged to the repairs and maintenance out of revenue, but to the net revenue account with the reserve fund contribution. Last year the traffic on the tramways was 3,421,736 passengers as compared with 2,881,027 in 1898-9—an increase of 22·7 per cent. The figures for the car mileage were respectively 318,885 and 259,754—an advance of 18·75 per cent.

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BLACKPOOL.

Undertaking Worked by — Blackpool Corporation.
Date of Commencement of Supply — Oct., 1893.
System of Supply — [con.-curr. for tramway supply. Alt.-curr. trans. sub-stations for lighting and
Chief Engineer — Robert C. Quin.

YEAR ENDED	MAR. 31, 1899.	MAR. 31, 1900.
QUANTITIES—		
Units generated	1,098,603	1,427,607
„ SOLD (TOTAL)	870,184[a]	1,148,564[k]
„ sold to consumers	705,262[a]	955,511[k]
„ sold for public lighting, &c.	164,922	193,053
„ used on works	25,044	24,906
UNITS SOLD per 8 c.p. LAMP CAPACITY	20·6	15·3
Maximum supply demanded	950 kilowatts	1,300 kilowatts
Number of public lamps	146 arc	200 arc, 264 glow
Number of consumers	694	900
Connections to mains in 8-c.p. lamps	60,200	78,000
CAPACITY OF PLANT IN 8-c.p. LAMPS	42,200	75,000
CAPACITY OF PLANT IN KILOWATTS	1,350	2,400

CAPITAL—	Total.	Per kw. capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£120,000	£88·9	£161,334	£67·2
Share	—	—	—	—
Loan (including Debenture charges)	120,000	88·9	161,334	67·2
RECEIVED (TOTAL)	—	—	—	—
Share	—	—	—	—
Loan (including Debenture charges)	—	—	—	—
AUTHORISED, NOT RECEIVED (TOTAL)	—	—	—	—
Share (unissued)	—	—	—	—
Share (uncalled)	—	—	—	—
Loan (including Debentures)	—	—	—	—
REPAID (TOTAL)	—	—	—	—
RESERVE OR SINKING FUND	7,155	5·30	9,460	3·94
DEPRECIATION FUND	657	0·486	678	0·282
EXPENDED (TOTAL)	102,003	75·6	118,535	49·4
Lands and buildings	11,913	8·81	12,041	5·02
Plant	58,531[b]	43·3	72,663[m]	30·3
Mains	29,381	21·8	31,613	13·2
Miscellaneous	2,178	1·61	2,218	0·924
BALANCE OF CAPITAL ACCOUNT	—	—	—	—

REVENUE—	Total.	Per unit sold	Total.	Per unit sold.
TOTAL	£15,557	4·293d.	£18,485	3·858d.
Revenue from supply	12,053[c]	3·323d.	14,612[n]	3·053d.
„ meters, &c.	—	—	—	—
„ public lighting	3,385[d]	0·934d.	3,792[o]	0·793d.
„ sale of lamps, &c.	63	0·017d.	24	0·005d.
„ miscellaneous sources	56	0·015d.	37	0·008d.
EXPENDITURE—				
TOTAL COSTS	£8,108	2·237d.	£10,501	2·194d.
WORKS COSTS	6,302	1·738d.	8,501	1·776d.
Generation of Electricity	*5,101[e]*	*1·407d.*	*7,141*	*1·492d.*
Fuel (including cartage, &c.)	2,011	0·555d.	3,354	0·701d.
Oil, waste, water, stores	788	0·217d.	845	0·177d.
Wages at station	1,614	0·445d.	1,775	0·371d.
Repairs & maintenance at Station	611	0·169d.	1,124	0·235d.
Distribution of Electricity	*406*	*0·112d.*	*572*	*0·120d.*
Wages, &c. / Repairs, renewals of mains, &c.	406	0·112d.	572	0·120d.
Public Lighting	*795*	*0·219d.*	*788*	*0·165d.*
Attendance	299	0·083d.	310	0·065d.
Renewals	495[f]	0·137d.	478	0·100d.
MANAGEMENT CHARGES, &c.	1,806	0·498d.	2,000	0·418d.
Royalties	—	—	—	—
Rent, rates, taxes	*439[g]*	*0·121d.*	*576*	*0·120d.*
Management	*1,367*	*0·377d.*	*1,424*	*0·298d.*
Salaries	928	0·256d.	974	0·204d.
Stationery, &c.	102	0·028d.	169	0·035d.
Establishment charges	169	0·047d.	156	0·033d.
Law charges, &c.	168[h]	0·046d.	125	0·026d.

FINANCIAL RESULTS—	Total.	% to mean cap. exp'd.	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£7,450	8·00%	£7,963	7·22%
Carried to Depreciation Fund	—	—	—	—
Carried to Res. or Sinking Fund / Net int. on loans (incl. Deb. charges)	5,324	5·72%	6,787	6·15%
BALANCE FROM LAST ACCOUNT	—	—	—	—
Do. AVAILABLE for DISTRIBUTION, &c	2,125[i]	2·28%	1,176	1·07%
Deficit	—	—	—	—
ORDINARY DIVIDEND PAID	—	—	—	—
% of TOTAL COSTS to GROSS REVENUE	52·1%		56·9%	
Expenditure per kilowatt capacity	£6. 0s. 2d.		£4. 7s. 6d.	
REVENUE PER KILOWATT CAPACITY	£11. 10s. 5d.		£7. 13s. 10d.	
Expenditure per 8-c.p. lamp capacity	3s. 10d.		2s. 9½d.	
REVENUE PER 8-C.P. CAPACITY	7s. 4½d.		4s. 11d.	
REVENUE PER 8-C.P. CONNECTED	5s. 2d.		4s. 8½d.	
Price charged for lighting, per unit	8d. to 2d.[j]		7d. to 2d.[j]	
„ for power, per unit	2d.		2½d. and 2d.[l]	
„ for public lighting	8d. to 2d.[j]		7d. to 2d.[j]	

£100 mortgage fee and stamp duty, and £17 towards transformer patent action. *i* Carried to credit of general district rate. *j* On maximum demand system, one-hour scale. In 1899-1900 churches charged at 5d. per unit. *k* Includes 228,651 to tramways. *l* 2½d. per unit for private motors and 2d. per unit for supply to tramways for traction. *m* Inclusive of £10,906 on public arc lamps, posts, switches and their erecting. *n* Includes £1,906 from tramways for 228,651 units at 2d. *o* Includes £2,443 for current at 8d. 7d. and 2d. per unit, £788 for attendance, repairs, maintenance and carbons, and £560 interest and sinking fund charges on capital outlay on public lamps.

BLACKPOOL CORPN. TRAMWAYS

Worked by — Blackpool Corporation.
Date of Commencement of Working — Conduit system, 1885. Trolley system, July, 1899.
System — Overhead trolley at 500 volts.
Tramways Manager — J. Lancaster.
Engineer — Robert C. Quin.

Year ended	March 31, 1899.	March 31, 1900.
QUANTITIES.		
Car mileage	*259,754*	*318,885*
Passengers Carried	2,881,027	3,421,736
Total Length of Single Track	1·325 miles.	1·325 miles.
„ „ Double „	1·788 „	1·788 „
Total equivalent Length of Single Track Worked	4·901 „	4·901 „
Rolling stock, No. of motor cars	16	16
„ No. of trailers	nil	nil
Total Capital Expenditure	£90,832	£100,744
On Promenade line	37,875[a]	37,878[a]
On Lytham-road line	17,662[b]	17,662[b]
On Station-road (South Shore) line	5,362[c]	5,362[c]
On Promenade extension line	151	151
On Dickson-road line	9,873	9,873
On Springfield-road to Gynn line	nil	1,030
On cars	4,437	6,864
On plant at electricity works	3,879[d]	3,894[d]
On Extens'n of tram shed (Blundel-st.)	4,292	5,302
On conversion from conduit to overhead trolley system	7,303	12,724

REVENUE.	Total.	Per car mile.	Total.	Per car mile.
Total	£18,235	16·84d.	£22,611	17·02d.
Passenger traffic	17,883	16·52d.	22,285	16·78d.
Advertising	326	0·301d.	326	0·245d.
EXPENDITURE.				
Total	11,547	10·68d.	13,742	10·34d.
Total Working Expenses	9,409	8·700d.	11,642	8·765d.
At station	*271*	*0·250d.*	*402*	*0·303d.*
Wages	59	0·055d.	78	0·059d.
Cleaning and repairs	36	0·033d.	120	0·090d.
Electric lighting	122	0·113d.	130	0·098d.
Coal, coke, water and gas	55	0·051d.	60	0·045d.
On road	*9,138*	*8·440d.*	*11,240*	*8·465d.*
Wages	3,228	2·984d.	4,113	3·096d.
Electric power for tract'n and lighting	1,515	1·400d.	1,905	1·434d.
Cleaning centre channel and rails	345	0·318d.	165	0·124d.
Repairs & mainten'ce, roadway & rails	496	0·458d.	1,884[e]	1·419d.
„ „ centre channel	666	0·616d.	200[e]	0·151d.
„ „ mot'rs & gearing	1,516	1·401d.	666[e]	0·501d.
„ „ cars and wheels	1,093	1·010d.	1,370	1·031d.
Oil waste, &c., for cars	19	0·018d.	10	0·008d.
„ „ motors and gearing	76	0·070d.	59	0·044d.
Lamps for car lighting	43	0·040d.	54	0·041d.
Uniforms and badges, &c.	140	0·130d.	170	0·128d.
Management and General Charges	2,138	1·976d.	2,100	1·580d.
Rents, rates and taxes	*1,108*	*1·024d.*	*991*	*0·746d.*
Management	*834*	*0·771d.*	*958*	*0·721d.*
Salaries	708	0·654d.	796	0·599d.
Printing and stationery	126	0·116d.	160	0·120d.
General charges	*196*	*0·181d.*	*151*	*0·114d.*

FINANCIAL RESULTS.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
Working Profit	£6,687	8·04%	£7,466[i]	7·80%
Carried to tramway reserve fund	750	0·902%	2,000[f]	2·09%
Interest and sinking fund	3,180	3·82%	3,819	3·99%
Balance from last account	nil	—	1,758	1·84%
Balance	2,758[g]	3·32%	3,405[h]	3·55%
Per cent. of total expenditure to revenue	63·3%	—	60·8%	—
Revenue per Mile of Track	£3,715	—	£4,613	—
Expenditure per mile of track	£2,355	—	£2,805	—
Revenue per Passenger from Fares	1·49d.	—	1·56d.	—
Total Revenue per Passenger	1·52d.	—	1·59d.	—

BLACKPOOL CORPORATION TRAMWAYS.—REMARKS—*a* Includes £15,587 total cost of purchase of works, plant, &c., from Blackpool Electric Tramway Co. (Ltd.) and expenses of purchase and £9,125 repairing and reconstructing centre channel, plant, machinery, &c., in 1894. *b* Includes cost of constructing centre channel from South Shore railway station to Manchester Hotel £5,264. *c* Includes £2,660 on centre channel work, including centre channel, chairs, insulators and labour. *d* Includes £753 on two dynamos and exciters installed at tram shed less amount received for them on removal. *e* After crediting £809 loss on realisation of centre channel stock, see *f*. *f* After *adding* loss on realisation of centre channel stock £809, see *e*. *g* Of which £1,000 was transferred in aid of borough rate account. *h* Transferred in aid of borough rate account. *i* After deducting £1,403 part of special expenditure in doubling the line at certain places. Two-thirds of the total expenditure on this account is carried forward in suspense.

BLACKPOOL.—REMARKS—*a* Inclusive of 181,850 units sold for tramway traction. *b* Inclusive of £2,783 on lamp-posts, including erection, &c., and £3,203 for public lamps and switches, &c., and fixing. *c* Inclusive of £1,515 received from tramways at 2d. per unit. *d* Inclusive of £2,113 for current, £795 for attendance, carbons and maintenance, and £478 interest and sinking fund charges on capital cost of public lamps. *e* Includes £76 part cost of temporary plant. *f* Of which £170 is for carbons and their carriage. *g* Includes £100 provision for liability under Workmen's Compensation Act, 1897. *h* Includes £50 contribution to Victoria Hospital,

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SINE-WAVE TRANSMISSION ON SUBMARINE CABLES.

Messrs. Crehore and Squier's system of sine-wave transmission of signals through submarine telegraph cables has been before the telegraphic world for some time past. A Paper on the subject was presented by these inventors to the American Institute of Electrical Engineers, at Philadelphia, last May, when it met with considerable discussion. The subject was again brought forward at Paris during the International Congress of Telegraphy. An abstract of the Paper, which was then read for the authors by Dr. A. E. Kennelly, appeared in our issue of September 7th. The authors have advanced this important subject in two directions. In the first place they have drawn attention to the circumstance that the sine-wave form of transmission of currents is one (though possibly not the only one) which can be utilised to convey the necessary energy through cables without undue waste of time or power, and in the second place they have devised a simple apparatus whereby as close an approximation to the sine-wave form as the shape or composition of the cable signals will admit of is given to the impulses required for their production. Their formulæ for calculating the impedance of the various parts of the circuit may also prove of service, and should result in improvements being made in the proper proportioning of the apparatus to the cables they are meant to work. There is undoubtedly room for progress in this direction, particularly in connection with the arrangements at the receiving end of the line. By this is meant that it is highly probable the best definition of signals will be obtained, other things being equal, when the receiving condensers, resistances, and instruments in circuit are correctly tuned to the frequency of the arriving waves, and the formulæ may assist towards this by enabling us to calculate what the impedance at the receiving end should be to satisfy the conditions under which the waves are being propagated. It has been recognised for some time past that the only true method of comparing the relative speeds of cables differing either in design or length, lies in the comparison of the frequencies at which impressed sine-waves produce records of standard amplitudes at the distant ends of the cables; but for these comparisons to be just, it is necessary to employ a recording instrument having no appreciable electro-magnetic or mechanical inertia,

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so that of itself it does not influence the results. An oscillograph of sufficient sensibility would, in other words, be required for such tests, and were one available, many interesting and really pressing questions connected with the design and working of submarine cables might at once be answered.

The alternate-current measurements made by Messrs. Crehore and Squier take the form indicated, in every respect, with the exception of the receiving instrument, which appears to have been an ordinary siphon recorder, similar to those usually employed for signalling on submarine cables, aud the adjustment of which remained unaltered throughout the experiments. There is a disposition, therefore, to regard the results they obtained rather as measurements of the sensibility of the instrument to the amplitude and frequency of the impressed waves than of the speed capacities of the cables in question. In other words, the dying-away of discernible signals at the frequency of about seven complete waves per second, whatever the voltage employed, is attributed more to the want of synchronism between the coil of the receiving apparatus and the frequencies than to the reduction of the amplitudes occasioned by loss of energy along the cable. Judging from the remarks made by several of the speakers at the discussion in Philadelphia there seems to be an impression, in America at all events, that little or nothing has been done for many years to improve the carrying capacity of cables. This impression, however, is not correct. The problem of employing the materials of which cables are constructed to the best advantage has been forced upon cable engineers, not only by the enhanced cost of these materials, but also by the enormous increase generally of the traffic which cables nowadays have to carry. A large amount of patient experiment has been undertaken from time to time in every direction promising an advancement upon old practice, and, as a consequence, a good deal has been quietly accomplished by modifications, not only in the construction of the cores of the cables themselves, but notably in the methods and apparatus by which they are worked. Amongst other things, nearly every conclusion come to by Messrs. Crehore and Squier, as the result of their investigations and experiments, has been anticipated on this side of the water. The improvement in the received signals as the result of modifying the impressed wave-form and increasing the E.M.F.—the difference between the virtual voltage and that impressed upon the near end of the line—the possibility, in consequence, of being able to raise the virtual voltage to the highest useful limit without endangering the cable, and the influence of the composition of the signals upon the speed at which they can be transmitted, are all facts which have been ascertained, recognised, and acted upon.

But the methods of experimenting which have led to the discovery of these facts, and the means by which the impressed wave-form is modified to produce the best results at the further end of the cable, are entirely different to those employed by the designers of the sine-wave transmitter. It has been ascertained that, by adding a certain resistance to the battery circuit (a condenser at the sending end being used), and at the same time raising the voltage—to compensate for the reduction of effective pressure which the addition of the resistance would otherwise cause—a remarkable increase in the amplitude of the received signals is produced. This result seems capable of explanation in the following manner: The effect of the inserted resistance is to retard the rise of potential in the condenser, and to cause the current flow to extend over a longer portion of the total period of the battery contact, and, since the maximum height of the pressure curve is at the same time maintained by proportionately increasing the E.M.F., the total energy imparted to the cable is appreciably increased, and the amplitude of the signals at the further end is consequently enlarged.

The combined effect of the condenser and resistance is, in fact, to cause the front at least of the impressed wave to assume an approximately sine-wave form. Between the signals the condenser is not earthed through the resistance, but directly. It might be anticipated that this would destroy all further semblance to the sine-wave, but there is a certain amount of evidence that this is not the case, although unfortunately it is not yet conclusive. There is an inclination to believe, however, that, for some reason, harmonics do not exist during the discharge, in spite of the sudden earthing; or that if they do they are in some way beneficial, since the definition of the signals does not appear to suffer, but is, on the contrary, rather improved, and in any case is markedly better, allowing for differences of K.R, than that produced at Canso by the alternator transmitter on the Coney Islahd cable. As, however, the rather disappointing character of the latter signals may be due to a number of complicated causes foreign to the transmitter, the question of the relative superiority of the two systems must be left to be decided by the results of further and more exact investigation. It is to be noted, however, as a significant fact, that Messrs. Crehore and Squier do not specifically claim to have obtained higher speeds, or better signals, on either of the cables experimented upon with their transmitter; and, further, it would appear that their signals were identical in shape and size with others produced by the ordinary methods at the same speeds. It is just possible, therefore, considering the complexity of the phenomena attending the transmission of electric waves through submarine cables, and that two important factors at least—the inductance and the dielectric conductivity—have not been accorded whatever weight may be due to them, that the sine-wave theory may eventually be found not to fit the problem so completely as has been supposed, and that the tuned condenser method, if so it can be designated, may prove by its flexibility to admit of a closer adjustment of the conditions at the sending end to the requirements of the cables and receiving apparatus. It would not be advisable, therefore, for these and other reasons—among which is the question of expense—to advocate the immediate abandonment of present methods for one which, though it certainly has theory to commend it, has not as yet given incontestible proof of its superiority in practice. Two of the chief recommendations of the alternator transmitter are, it would seem, freedom from delicate mechanism and from sparking; and it also undoubtedly brings us one step nearer to the possession of signalling apparatus designed upon engineering rather than on watchmaking lines. This last is a matter for congratulation.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

The Law and Practice relating to Letters Patent for Inventions. By Roger William Wallace, Q.C., and John Bruce Williamson. (William Clowes & Sons, London.) 40s.

Two colossal works on patent law having been reviewed in our columns within the last three years, it may seem surprising that there has been found room for another one. The newcomer is even more colossal, though not unreasonably so, having regard to the ever-increasing pile of judicial decisions which must needs be noticed. In printing and general

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appearance it will compare favourably with any of its predecessors, or, indeed, with most legal volumes with which we are acquainted; and it is decorated on the cover, by official leave, with an impression of the Patent Office seal bearing the Royal Arms. In arrangement of the subject, the authors have not departed materially from that of previous writers, which is one necessarily involving a vast amount of repetition, though this is not, we think, quite so apparent in the present work as in some others. In the usual table of cases at the beginning a small but welcome addition is made by giving the subject of the patent dealt with. Many people who would not recollect the purport of the decision, say, in the case of Savory *v.* Price, would recognise it at once under the title of the "Seidlitz Powder case." The first chapter gives an interesting summary of the events leading up to the Statute of Monopolies passed in 1624. It is pointed out that this act, although the Magna Charta against oppressive monopolies, did not introduce any new principle, since such monopolies, had always been illegal according to common law. So early as the reign of Edward III., a licence under the great seal purporting to grant a monopoly for the sale of a well-known commodity had been declared void, and the holder of it severely punished by Parliament. The Tudor sovereigns and James I. had granted monopolies more or less in defiance of the law, but even under Elizabeth, the Court of King's Bench had the courage to declare one of these to be utterly void and contrary to law. The statute of James's reign was therefore a declaratory and regulating act rather than a new departure in legislation.

The chief novelty since the last general treatise on patent law appeared, is the practice relating to compulsory licences. Mr. Gordon has so recently and exhaustively dealt with this as a separate subject, that the authors have contented themselves with a comparatively short chapter upon it. We are glad to notice, however, that they endorse the opinion expressed in Mr. Gordon's book, as to the inconvenience of the practice under which the Board of Trade gives judgment based upon the report of a legal referee before whom the case is tried, while the report itself is withheld from publication, so that the reasons for the decision never appear. Since one of the authors has himself, on more than one occasion, acted as referee, this opinion should carry all the more weight, and, we hope, may lead to the conviction that some alteration in this respect is expedient. The appendices, which contain forms and circulars issued by the Patent Office as well as numerous precedents, seem very complete, including a specimen form of specification with drawings.

THE MAGNETIC PROPERTIES OF IRON FILINGS AS AFFECTED BY FERRO-MANGANESE.

BY PROF. ERNEST WILSON.

It has long been known that manganese steel containing a sufficient quantity of manganese is practically a non-magnetic substance. The author thought it would be of interest to examine the magnetic properties of a mechanical mixture of iron filings and ferro-manganese; to compare these with the magnetic properties of simple iron filings; and to examine the effect produced upon the magnetic properties of the two mixtures by raising their temperatures to 800°C. or 900°C.

The method of experiment was to place the filings in an asbestos box having the shape of a hollow cylinder. On this cylinder were wound primary and secondary coils consisting of asbestos-covered copper wires, the secondary next the cylinder. The cylinder was then enclosed in an iron box and the whole placed in a Fletcher furnace ready for heating. The magnetic properties of the mixtures could be then examined by aid of a ballistic galvanometer, before and after heating, without disturbing the specimen. The temperature was calculated from the increase in electrical resistance of the secondary coil. Finally, in order to eliminate the correction due to the asbestos of the box and wire covering (which was taken to be non-magnetic) the filings, which had become solid after heating, were stripped of the asbestos and re-wound with new primary and secondary coils of cotton-covered copper wire. Experiments were again made with the ballistic galvanometer at atmospheric temperature. In the first case the area of asbestos between secondary and filings was 50 per cent. of the actual area of the filings. In the second case the area of cotton between secondary and filings was 5 per cent. of the area of the filings.

The iron filings were made with a new 12in. rough file from a bar of Turton's Bessemer steel, containing approxi-

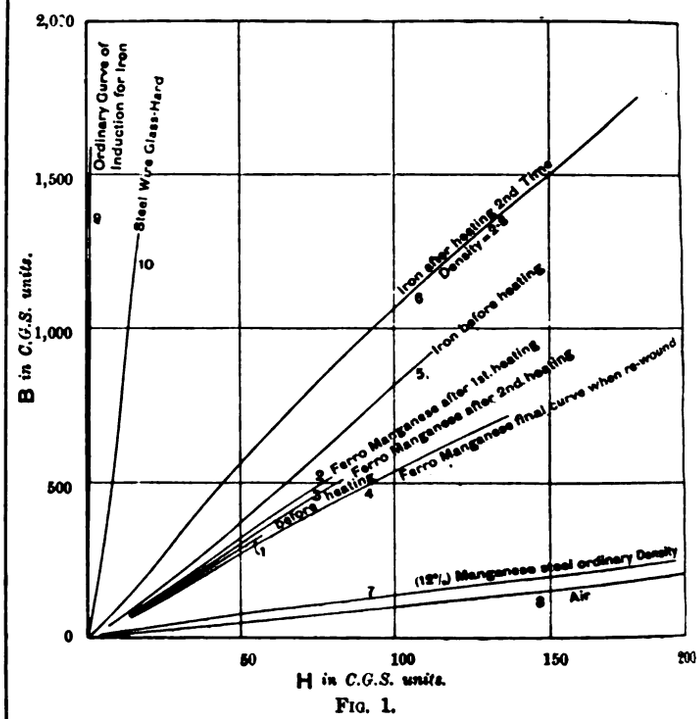

FIG. 1.

mately 98·5 per cent. iron, 0·8 per cent. manganese, 0·45 per cent. carbon, 0·12 per cent. silicon, with traces of sulphur and phosphorous. The ferro-manganese was in form of powder, containing about 85 per cent. manganese, 8 per cent. iron, 6 per cent. carbon, 1 per cent. silicon. The mixture of iron filings and ferro-manganese used contained 17·8 per cent. by weight of ferro-manganese. The dimensions of the asbestos boxes used were: Internal diameter 2·5cm., external diameter 4·8cm., length 2·8cm.

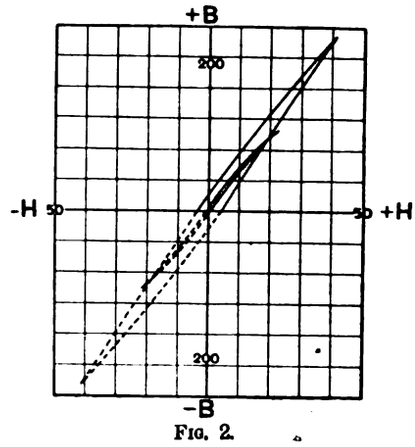

FIG. 2.

The density in grammes per cubic centimetre of the iron filings and ferro-manganese after heating was 2·81, being an increase of about 7 per cent. on its original value. The density of the iron filings only after heating was 2·8, being an increase of about 3 per cent. on the original density.

Fig. 1 gives the relation between B, the induction per square centimetre of the cross-section of the specimen, and H the magnetising force per centimetre linear: both in C.G.S. units. Curve 1 was obtained from the mixture of ferro-

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manganese and iron filings before heating. Curve 2 was obtained from the same specimen after being heated to 667°C., when again at atmospheric temperature. Curve 3 was obtained after a second heating to 860°C., when again at atmospheric temperature. At this stage the cylinder was stripped of abestos and re-wound. The curve 4 was then obtained and should agree with curve 3 if the asbestos were non-magnetic, which was assumed in making the correction,

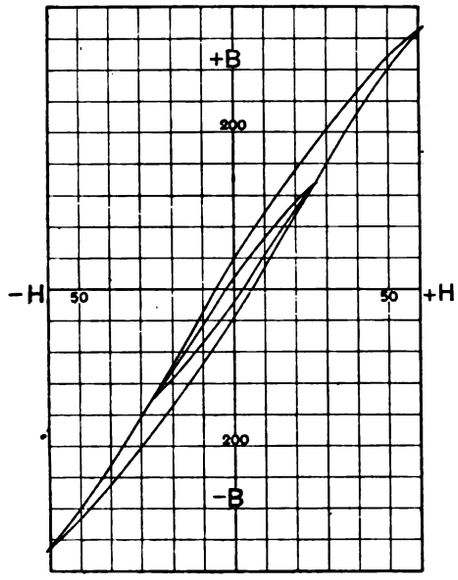

FIG. 3.—Fe and Mn after second heating.

and the true cross-sectional area of the asbestos were known. The first heating increased and the second heating diminished the permeability; the final permeability is slightly in excess of the initial permeability. Curve 5 was obtained from simple iron filings before heating. Curve 6 was obtained after the iron filings had been heated twice to about 900°C., when

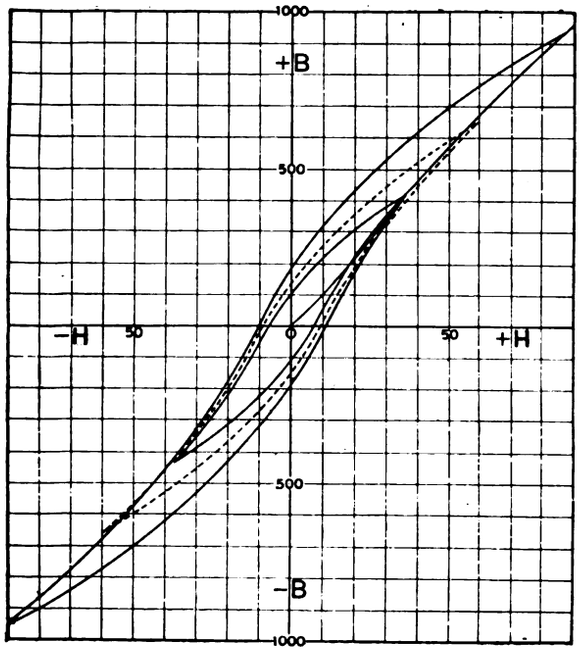

FIG. 4.

again at atmospheric temperature. The simple iron filings have a higher permeability than the mixture of iron filings and ferro-manganese. Moreover, after a second heating the increase in permeability is considerable in the iron filings. It appears that the presence of the ferro-manganese has counteracted the increase in permeability which would have been experienced had the ferro-manganese been absent. These effects may be connected with the formation of iron oxide as a matrix, which is well known to be magnetic, and possible variation in the hardness of the iron filings. In Fig. 1 curve 7 was obtained from a specimen of manganese steel with 12 per cent. manganese.* Curve 8 is the straight line for unit permeability. Curve 9 is an induction curve for ordinary wrought iron, and curve 10 an induction curve for glass hard steel.

We have now to deal with the dissipation of energy by magnetic hysteresis. Fig. 2 shows two curves obtained from the ferro-manganese specimen before being heated. Fig. 3

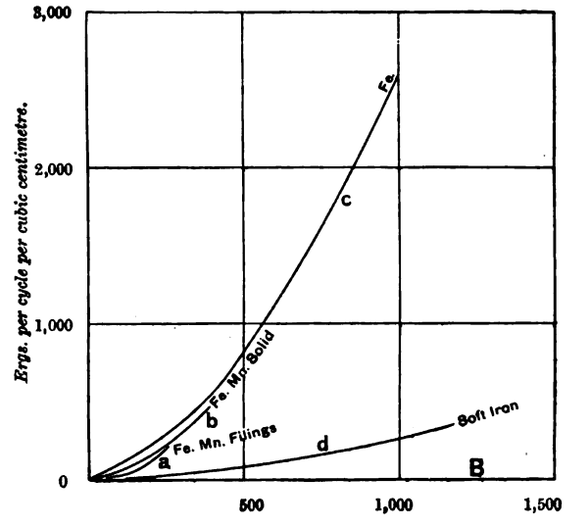

FIG. 5.

shows two curves obtained from the ferro-manganese specimen after the second heating when at atmosphere temperature. Fig. 4 shows three curves obtained from the simple iron filings after the second heating when at atmospheric temperature. In Fig. 5 the dissipation of energy due to magnetic hysteresis obtained from Figs. 2, 3, 4 is plotted in terms of maximum B. In Fig. 6 this dissipation is plotted in terms of maximum H. In Fig. 7 is plotted the coercive force in terms of intensity of magnetisation $\frac{B-H}{4\pi}=I$. In each of the Figs. 5, 6, 7 the curve *a* refers to the ferro-manganese specimen before heating; curve *b* refers to the ferro-

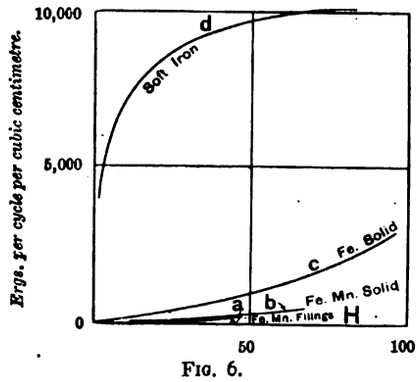

FIG. 6.

manganese specimen after being heated twice; curve *c* refers to the iron-filing ring after the second heating; curve *d* refers to a specimen of good wrought iron. Fig. 5 shows that heating the ferro-manganese specimen has had the effect of increasing the dissipation of energy due to magnetic hysteresis for a given value of B, although in Fig. 1, curve No. 1 indicates smaller permeability than curve No. 3. The simple iron filings after heating dissipate more energy than the ferro-manganese specimen after heating. Each of the specimens

* This specimen had previously been cooled by placing it in liquid air. It is still non-magnetic at atmospheric temperature, but the author cannot say if it was magnetic at the low temperature. It was still non-magnetic at about −80°C. when cooled in carbonic acid snow. The author is indebted to Prof. W. Ramsay, F.R.S., for having cooled the specimen in liquid air.

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dissipates considerably more energy than a piece of good wrought iron. Turning to Fig. 6, we see that the curves *a*, *b*, *c* have the same relative positions as in Fig. 5, but the soft-iron curve *d* is now much higher than the curves *a*, *b*, *c*. The curves *a*, *b* in Fig. 7 show that the coercive force for these specimens is not nearly constant, as is almost the case with the curve *d* for soft iron,* thereby indicating a much greater possible increase in the dissipation of energy due to magnetic hystersis than has been already observed. The curve *c* more nearly approximates to a constant value of the coercive force, which would probably be several fold that indicated by the curve *d* for soft iron.

Conclusion.—The presence of 17 per cent. by weight of ferro-manganese in a mechanical mixture with iron filings reduces the dissipation of energy due to magnetic hysteresis for given limits in the values of either B or H, after being raised to a temperature of 800°C. to 900°C. The increase in permeability after heating simple iron filings to about 900°C.

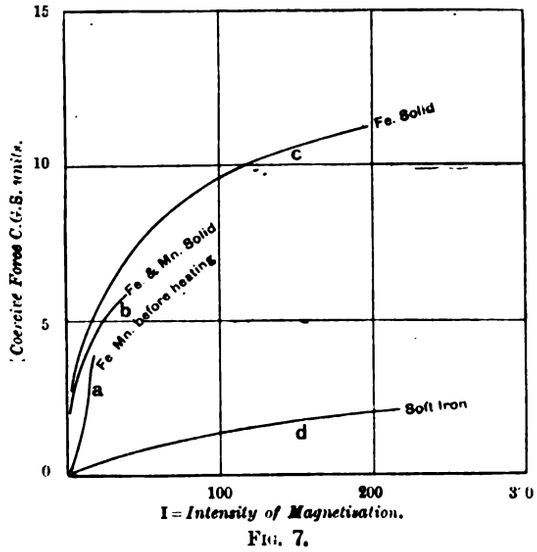

Fig. 7.

is greatly reduced by the presence of the ferro-manganese. Mr. S .L. Walkden has given me assistance in the experimental part of this Paper, and in the working out of the results. I wish to acknowledge this, and to return him my thanks.

THE OSMOTIC PRESSURE THEORY OF PRIMARY CELLS.†

BY W. R. COOPER, B.SC.

(*Concluded from page 854.*)

Measurement of Single E.M.F.s.—The existence of electrolytic solution pressure is purely hypothetical, for unfortunately we have no means of directly measuring it, or of proving that it does exist. Taking it for granted, however, that we have a statement of facts in the equation

$$E = 0{\cdot}0002T \log_{10} \frac{P}{p},$$

it should be possible to deduce the value of the solution pressure in many cases if we could measure single E.M.F.s—*i.e.*, the E.M.F. due to a metal in contact with a liquid.

This E.M.F. must not be confused with the contact force between metals and liquids, which is a purely electrostatic effect, and therefore unable to help us here. The determination of the Peltier effect at such a junction would give a measure of the E.M.F., but the value of such measurements is sometimes disputed. Fortunately, the work of Ostwald, Lippmann, Helmholtz, and others has rendered this possible in another way. One method of arriving at the required result is by means of a dropping mercury electrode. Suppose we have a mass of mercury which is allowed to run into an electrolyte in a fine stream. This stream is continuous near the jet, and may therefore be arranged to form a connection between the electrolyte and the mercury in the reservoir. As the stream falls it breaks into globules. Now, when such a stream starts, the mercury is positively electrified owing to the low value of its solution pressure. But as the flow continues the difference in potential diminishes. In the words of Helmholtz * ". . . . when a quantity of mercury, otherwise insulated, makes contact with an electrolyte by flowing rapidly through an orifice, the mercury and the electrolyte cannot be at different potentials. For if the potentials were different—*e.g.*, if the mercury were positive—each falling drop would present an electrical double layer at its surface, thus removing positive electricity from the mercury, and would gradually reduce the positive potential until it became equal to that of the liquid." Thus the measurement of the single E.M.F. between mercury and a solution becomes comparatively easy. Usually the E.M.F. between two stationary mercury electrodes in the same electrolyte is zero, because the two potential differences involved are equal and opposite. But if one of the potential differences is removed by using a dropping mercury electrode, then the E.M.F. between the moving and the stationary mercury will be simply that between mercury and the solution.

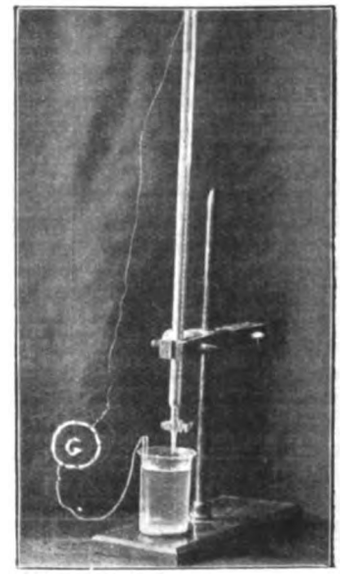

Fig. 3.—Dropping Mercury Electrode.

The mode of action of a dropping mercury electrode may be shown by the simple arrangement given in Fig. 3. A burette serves as the mercury reservoir, and is supported about a centimetre above the surface of dilute sulphuric acid contained in a beaker, which also holds some mercury. Connection is made between the latter and a galvanometer, G, by a wire passing down a piece of glass tubing which is attached to the side of the beaker and dips into the mercury, thus protecting the wire from the acid. A second wire passes from the galvanometer down the bore of the burette, making contact with the mercury which it contains. Upon opening the tap, so that the mercury flows in a rapid stream, a deflection of the galvanometer will be observed.

Another method of measuring single E.M.F.s depends upon surface tension.

As the result of such measurements, it has been found that the E.M.F. between mercury and mercurous chloride in normal potassium chloride solution is 0·56 volt. Knowing this, it is a simple matter to deduce other values on the assumption that the E.M.F. of a cell is the algebraic sum of two such potential differences. For example, if both plates tend to send cathions into solution, they oppose each other, and we have

$$E = E_1 - E_2$$

* This curve is taken from *Phil. Trans.* Roy. Soc., Vol. 184 (1893), A, p. 997.

† From a book on "Primary Batteries," shortly to be published by *The Electrician* Printing and Publishing Co. All rights reserved.

* *Zeitschrift für Physikalische Chemie*, Vol. I., p. 584, 1887.

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as the resultant E.M.F. Supposing the E.M.F. of the cell, zinc/normal zinc sulphate solution/mercurous chloride in normal potassium chloride solution/mercury, to be 1·08 volts, then, since ions tend to pass *out* of solution in the case of mercury, we have

$$1{\cdot}08 = E_1 + 0{\cdot}56,$$
$$E_1 = 0{\cdot}52,$$

and therefore the value of the E.M.F. between zinc and normal zinc sulphate solution is 0·52 volt.

It should be noted that this value is larger than that resulting from the measurements of the Peltier effect by Bouty.*

Calculation of Electrolytic Solution Pressure.—We now have the means of calculating the values of the various electrolytic solution pressures. We have at a temperature of 15°C. the relation

$$E = \frac{0{\cdot}0575}{n} \log_{10} \frac{P}{p},$$

or

$$\log_{10} P = \frac{nE}{0{\cdot}0575} + \log_{10} p.$$

In the case of zinc, $n = 2$; and if the solution is normal zinc sulphate, $E = 0{\cdot}52$. Also, if we suppose the sulphate to be completely ionised, then the osmotic pressure p due to a gramme molecule in a litre of solution will be 22·38 atmospheres.

Substituting these values, we find $P = 2{\cdot}7 \times 10^{19}$ atmospheres.

The solution pressures of other metals may be calculated in the same way after deducing the values of corresponding single E.M.F.s.

The following examples, mostly due to Neumann, will give an idea of the results obtained, which vary somewhat according to the data on which they are based :—

Magnesium	$1{\cdot}15 \times 10^{43}$	atmospheres.	Lead	$1{\cdot}1 \times 10^{-3}$	atmospheres.
Zinc.....	$2{\cdot}7 \times 10^{19}$	,,	Copper ...	$4{\cdot}8 \times 10^{-20}$	,,
Iron.....	$1{\cdot}2 \times 10^{4}$	,,	Palladium .	$1{\cdot}5 \times 10^{-36}$	,,

These figures will at once strike the reader as somewhat strange, most of them being enormously large or extremely small. It must, however, be remembered that such figures really only represent the striving of the molecules to pass into the ionic state, and the pressures here given are the osmotic pressures which it is necessary that the metallic ions already in solution should exert in order that no ionisation, and consequently no electrification, should take place. It should also be borne in mind that no such pressure has been directly or indirectly observed. All we can say is that if electrolytic solution pressure exists, and if it acts in the way here described, then the magnitude of the pressure must be of the order given above.

From our preliminary discussion of solution pressure, it will be inferred that those metals with the high pressures are negatively electrified, and those with low pressures are positive to solutions of their salts. Between these two extremes metals may be found which are not electrified at all if the concentration of the solution is suitable.

Having found the values of solution pressures, we are now in a position to calculate the E.M.F. of any reversible cell. But such calculations can in no way confirm the values we have already found for the solution pressures, because the latter are based upon the experimental determination of such E.M.F.s. It is simply a case of reasoning round in a circle, and therefore such calculations become of no further interest.

Effect of Varying the Negative Ion.—It will be noticed that the formula arrived at for the value of a single E.M.F. is quite independent of the negative ion: it depends only upon the osmotic pressure of those positive ions which are of the same metal as that which is immersed in the solution, and upon the electrolytic solution pressure of the metal. Thus we should expect the E.M.F. of zinc in zinc sulphate solution to be the same as that of zinc in zinc chloride, provided the degree of ionisation is the same in both cases. This deduction has been verified by Neumann, who carried out measurements upon a large number of salts. Unfortunately, these were mostly salts of organic acids, which are well known to produce no effect upon the E.M.F. Very decided changes, however, are often observed in passing from one halogen salt to another, and this fact led Bancroft* to the conclusion that, although a single E.M.F. is independent of the concentration when ions of the metal are not in solution, and also generally independent of the positive ion in such a case, yet it depends upon the negative ion and upon the solvent. He concluded further that in aqueous solutions the E.M.F. is the sum of two terms, one due to the electrode and the other to the negative ion. For most metals and most electrolytes the term due to the negative ion has the same arithmetical value and the same sign; but in the case of mercury the sign is opposite, although the value is the same. A. E. Taylor† arrived at the conclusion that a single E.M.F. is not a function of the negative ion; he looks upon mercury and copper as exceptions, the effect in these two cases being probably due to the formation of complex salts.

* *Journal de Physique*, 1st Series, Vol. VIII., p. 229, 1879; and Vol. IX. p. 306, 1880.

* *Physical Review*, Vol. III., p. 250, 1896.

† *Journal of Physical Chemistry*, Vol. 1, p. 1, 1896.

ON THE SIMILARITY OF EFFECT OF ELECTRICAL STIMULUS ON INORGANIC AND LIVING SUBSTANCES.‡

BY PROF. J. CHUNDER BOSE, D.SC.

(*Concluded from page 865*).

ON THE STRAIN AND ELECTRIC THEORY OF VISION.

Two theories may be advanced to explain the phenomenon of visual impulse.

1. *Chemical Theory.*—It is supposed that vision originates from the metabolic changes produced in the "visual substances" in the retina, the metabolic changes consisting of two phases, the constructive or anabolic phase and the destructive or katabolic phase. The theory, as will be seen, is very complex, and there are certain difficulties in the way of its acceptance. It is difficult to see how the quick visual process could be due to the comparatively slow chemical action, consisting as it does of the breaking down of the tissue followed by its regeneration. The bleaching action of light on the visual purple gave some support to the chemical theory; but it has been found that the presence or absence of visual purple is not of essential importance to vision. For it is well known that in the most sensitive portion of the human retina, the *fovea centralis*, the visual purple is wanting. The visual purple is also completely absent in the retina of many animals possessing keen sight.

2. *Electric Theory.*—According to this theory, the visual impulse is an electric impulse (an electric impulse in the optic nerve is known to produce visual sensation). The nerve is a conductor of electric current, and the brain an extremely delicate detector of current. I now come to the consideration of the most difficult part of the subject as to the production and regulation of visual current in response to the fluctuating stimuli of the incident light on the sensitive substance in the retina. The visual current may be produced in two different ways.

I have said that the effect of radiation stress is to produce a molecular strain which may give rise to either an electromotive variation or to a variation of conductivity. Imagine an elementary voltaic cell in the retina, composed of two similar elements immersed in an electrolyte, and imagine one of these elements to be more exposed, and therefore more strained by radiation. The difference in the strain of the two elements will give rise to an E.M.F. In this case the varying current impulse is directly due to the strain effect of radiation.

Or we may have an independent E.M.F. already existing in the retina, and the visual current may be supposed to be regulated by the conductivity change (also due to molecular strain) of an interposed sensitive substance under the action of radiation. In connection with this is Prof. Lodge's very important coherer theory of vision, which explains in a simple manner the production of visual impulse by the sudden change of conductivity due to coherence. This very suggestive theory labours, however, from the insufficiency of the coherer theory itself. The automatic visual recovery, the formation of positive and negative images, and the various phenomena connected with after-effects cannot be explained from the simple coherence theory. It will presently be shown that all these phenomena may be explained from the theory of molecular strain.

The choice of either the electromotive or the conductivity variation hypothesis is to be determined by the consideration as to the presence or absence of an independent E.M F. in the retina. The

‡ Abstract of a Paper read before Section A of the British Association at Bradford.

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experimental verification of this question is very difficult, owing to the disturbing effect of the current of "injury." The experiments of Dewar and McKendrick show that an eye current exists when two electrodes are connected, one with the coronea, and the other with the cut end of the optic nerve. Here the effect of injury is present; (the most important result established by the above investigations is the *variation* of retinal current by light). In order to reduce the effect of injury, I carried out experiments with the two electrodes fixed on the retina itself, so that the two injury effects might neutralise each other to a more or less extent. Under these conditions, I obtained a retinal current; it cannot, however, be assumed that the two effects of injury at the two electrodes were exactly similar. The feeble visual sensation, even in the dark, known as the "intrinsic light of the retina" seems, however, to point to the existence of an accidental or real E.M.F. in the retina.

In any case, the visual current is due, directly or indirectly, to the strain effect produced by radiation. If the visual circuit does not contain an E.M.F., then the electromotive variation due to strain, suffices to explain the visual effect; if there is an E.M.F. in the circuit, then the conductivity variation regulates the visual impulse.

On an Artificial Retina.

I have been able to construct several curious receivers which are sensitive to radiation, and also exhibit an automatic recovery. One of these responds not only to visible, but also to invisible lights. It is very strongly affected by electric radiation; the same receiver responds not only to heat radiations, but also to different coloured lights. The action of this receiver is probably somewhat complex, and for the present I will deal with the simple receiver made of magnetic oxide of iron, which was shown to be sensitive to electric radiations and to exhibit, when slightly warm, an automatic recovery.

Parallel Experiments with the Artificial and the Real Retina.—I will presently describe the effects produced on the artificial retina by radiation of varying intensity and duration, and will also give some typical curves based on quantitative measurements. For the purpose of comparison it became necessary to carry out a corresponding set of experiments with the eye. In this I at first met with great difficulties. For example, from the analogy of the somewhat permanent distortion (attended with increased conductivity) produced in the sensitive substance by the action of intense electric radiation, I imagined that the particular portion of the retina, on which an image was formed of a strongly luminous external object, would remain sub-permanently conducting even after the removal of the source of light. In that case I thought it would be possible to revive the perception of the image by applying an E.M.F. to the eye. The difficulty was in the application of an external E.M.F. to the retina. I attempted applying the electrodes of a voltaic cell to the eye thinking that the retina acting as a shunt might allow a portion of the current to pass through it. I was, however, obliged to desist from further experiments in this direction, owing to the extremely irritating effect of an external E.M.F. on the eye.

It then occurred to me that if the visual circuit is an electric circuit, then it is not at all necessary to apply an external E.M.F., that the strain effect in particular portions of the retina on which the image was formed could be demonstrated by the current effect which might persist, since the recovery of sensitive substances is not instantaneous; in that case all one need do is to shut one's eye immediately after exposure to light to perceive the after-effect; closure of the eye makes it certain that the observed effect is due to the light stimulus immediately preceding, and not to other disturbing causes. In adopting this method, it did not strike me at the time that I was straying into obscure region of after-images. This has been of advantage to me, for not knowing exactly what to expect and free from any preconceived bias, I was better able to observe the various after-effects and notice several phenomena which are perhaps novel. I will in each of the following sections first describe experiments with the artificial retina under (a); the corresponding experiments with the eye will then be described under the section (b).

It is to be borne in mind that the visual sensation in the dark is not, as previously mentioned, one of intense darkness; there is even then a very feeble sensation of light, known as the intrinsic light of the retina; this shows the existence of a natural feeble current in the visual circuit. Suppose, now, the visual current is by any means increased there would then be produced a corresponding increase in the sensation of light; similarly, if the retinal current corresponding to the intrinsic light is in any way diminished, there would be produced a sensation of darkness more intense than the mere passive sensation of darkness in the absence of light.

Effect of Radiation of Short Duration.

I give two curves (α) and (β) for the magnetic oxide receiver; in (α) the electric radiation was near the receiver, and a single flash of intense radiation was allowed to act. In (β) the intensity of the incident flash of radiation was reduced by removing the radiator further away. It will be seen—

(1) That there is a very short latent period;

(2) That even after the radiation is cut off the curve continues to rise, *the maximum effect being produced some time after the cessation of radiation.*

(b) *Maximum after-effect.*—Now for visual analogue. We may take a tube at the end of which is fixed a glass disc coated with lampblack, on which, by scratching with a pin, some words are written in transparent characters; the other end of the tube is applied to the eye. Turn the blackened disc towards a strong source of light, with an interposed cardboard. By a quick movement of the latter a short exposure is given; the eye which saw the transparent letters for a moment is immediately closed. It will now be found that there is at first hardly any well-defined visual sensation; the maximum effect being produced some time after, it will be noticed that the after sensation of the luminous characters gradually attains a maximum intensity and then fades away.

(b^1) *Positive after-image.*—If the closed eye be turned towards a well-lighted landscape and the eyelids suddenly opened and closed, the *positive* after image will be distinctly seen. It would be advisable to bear in mind the different nature of the stimuli that cause the positive and the negative after images. In the case described above, the stimulus is of short duration, the light being cut off before the maximum effect is attained; *in such a case the after-effect is positive, there being no reversal or interval of darkness between the direct image and the after image, one being merely the continuation of the other.* It will be shown that in the other type of after image there is an intervening reversal.

(3) From an inspection of the two curves it will be noticed that the maximum effect is attained much more quickly and the ascending curve is steeper, and the decline from the maximum is earlier and more rapid (at least in the first part) with intense radiation than with feeble radiation. Hence it follows that with intermittent

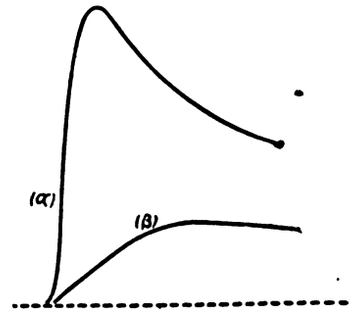

Fig. 10.—Effects due to (a) to Strong Radiation (b) to Feeble Radiation.

radiation, at a certain rate of interruption the curve of action for feeble radiation may be continuous, whereas for the same rate the curve for strong radiation will be jagged; in other words, a "flicker" will be produced in the latter case.

(b) *Visual flicker due to Intermittence.*—Now the visual flicker due to intermittence is precisely similar. In the phenomenon of vision "the interval between successive stimuli at which fusion takes place and flicker disappears *varies according to the intensity of the light, being shorter with the stronger light.* When a brighter illumination is used the rapidity (of intermittence) must be increased before the flickering disappears; *this is owing to the decline of the stronger sensation beginning earlier and being more rapid than that of the weaker sensation.*"*

Effect of Continued Action of Moderately Strong Radiation.

I have previously described the summation effect of rapid succession of radiation stimuli on inorganic sensitive substances.

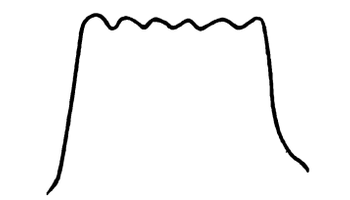

Fig. 11.—Tetanic Effect in Fe_3O_4 Receiver produced by Continuous Radiation.

It was shown that under such circumstances the individual effects are fused together, and there is produced a "tetanic" effect which gives rise at first to a continuously ascending curve. It was also shown that the elasticity increases with the increasing strain, and that in the neighbourhood of maximum strain the curve tends to become horizontal; that there is a fluctuation in this portion of the curve; and, lastly, on the cessation of stimulus the fall curve is very steep, specially in the first part of the fall. Now a continuous light

* Foster "Text-book of Physiology," p. 1,327.

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is in reality a rapid succession of radiation impulses, and we may therefore expect an effect of a tetanic nature to be produced by it.

I now pass on to the corresponding visual phenomena.

(*b*) (1). In the curve given above, the first part is ascending; when the *maximum is reached there is a fluctuation.* With the eye, the first part corresponds to an increasing sensation of light. At the maximum stage the curve is horizontal. This explains why it is easier to distinguish a slight difference between two feeble lights than the same difference between two bright lights. After the maximum stage, the fluctuation would correspond to a visual flicker. This flicker is to be distinguished from that due to intermittence. I have been able to detect this curious flicker effect by a special method to be presently described.

After-Oscillation and Visual Recurrence.

As the strained substance is set free on the stoppage of radiation from the distorting force, it rebounds towards the normal state, and in so doing may, under certain circumstances, overshoot the position of equilibrium and an oscillation may thus be produced. With the magnetic oxide of iron the rebound towards recovery sometimes carries the curve below the original conductivity, but there is little further oscillation. In living substances, however, the after-vibration is more pronounced, and in the retinal substance the after-oscillation is very persistent. It is to be remembered that the number of oscillations which can be detected depends not only on the intensity and duration of the stimulus, but also on the sensitiveness of the detector; allusion has already been made of the extraordinary sensitiveness of the brain as a current detector.

It is evident how these oscillations cause current impulses in the visual circuit which are alternately weaker and stronger than the normal retinal current (which corresponds to the intrinsic light of the retina); a diminished current would produce a sensation of darkness, and an increase of current would mean an increased sensation of light. The after-oscillation would thus give rise to recurrent series of negative and positive images.

If we look for a long time at a bright object (preferably with one eye) and then close the eye, there is an immediate *dark sensation* due to the rebound. This is unlike the effect with short exposure, where the immediate after-effect is positive. With long exposure, owing to the steep fall of the curve, the immediate after-sensation is, as has been said, one of darkness; the subsequent oscillations then give rise to a recurring series of images.* A more detailed account of this phenomena will be given under "Binocular Alternation of Vision."

I will now proceed with certain phenomena connected with after-oscillation. In my fuller Paper will be found accounts of other interesting effects produced on the artificial retina, which throw much light on several obscure visual phenomena, such as the chromatic after-effects, the reversal effect due to radiation below the critical intensity, the recurrent reversal effects and irradiation.

Binocular Alternation of Vision.

In the curve for the artificial retina there was seen a fluctuation after the maximum stage was reached. It is, however, difficult to detect the corresponding visual fluctuation owing to a very remarkable pecularity of binocular vision. When we continue to look at an object with both the eyes there is produced a fluctuation in each eye. The fluctuations are, however, not coincident in the two eyes, there being a difference of half a period between the two. It thus happens that one eye, as it were, gradually falls asleep, while the other wakes up to the maximum consciousness; the second eye then gradually ceases to see, while the sensitiveness of the first gradually waxes to a maximum. The visual effect in an individual eye undergoes fluctuation from moment to moment and in such a way that the sensation in the one eye is complementary to that in the other, the sum of the two sensations remaining approximately constant. In this way the two eyes take up the work of seeing and taking rest alternately. This relative retardation of half a period in the effects produced in the two retinas is extremely curious. It is evident that this alternate division of labour in binocular vision is of much advantage to the animal economy. Ordinarily, the effect described above is not noticed, owing to the summation of the two partial effects in the brain, and also to the exposure of fresh portions of the retina by the constant movement of the eye. But the phenomenon is clearly brought out by the experiment to be presently described, in which it was necessary to pay particular attention to the following points:—

1. That a definite portion of the retina should be exposed to light, and this was to be secured by preventing any movement of the eye.

2. That the impression produced on the two eyes should be kept distinct, so that the effects produced could be subsequently compared.

3. It was also necessary that the two eyes should be kept in a state of relative ignorance, so that there could be no question of predisposition or judgment.

For carrying out the above conditions, I took a stereoscope, and provided the ocular ends with two soft pads, with small circular apertures through the centre for looking through. The eyelids rested lightly on the pads; any unconscious movement of the eye was thus partially prevented. It is indeed very difficult to keep the eye from unconscious movement, but the friction thereby produced against the pads at once gives timely warning of the tendency, which may then be easily checked. The partition inside extends right up to the design which is to be looked at. The design consists of two slanting cuts in a blackened cardboard at a suitable distance from each other, the one cut, R, slants to the right, and the other, L, to the left. When the design is looked at through the steroscope the right eye will see, say, R and the left L; the two images will appear superimposed, and we then see an inclined cross. The object of making the cross inclined is to distinguish the after-image of this particular form, from the visual memory of the erect cross.

When both the eyes are open, what the eyes see is the complete cross, it being impossible for the individual eye, say the right, to find out whether it is the image of the right or the left arm of the cross that is formed in it. At the end of the experiment one eye may be closed and the component of the cross thus localised.

When the stereoscope is turned towards the sky, and the cross looked at steadily for some time, owing to the alternation referred to above, it will be found that while one arm of the cross begins to be dim, the other becomes bright and vice versa. This alternation could not be due to any "rivalry" or struggle between the two eyes, for there is nothing particular to struggle about, nor can this be due to any difficulty of accommodation at the same time for two different colours, for the two slits are illuminated by the same light of the sky.

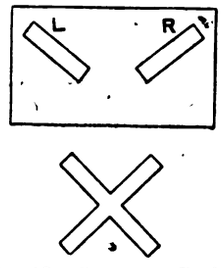

Fig. 12.—Sterescope Design.

The alternate fluctuations become far more prominent when the eyes are closed; the pure oscillatory after-effects of the strained sensitive molecules, unaffected by the disturbing effect of further light stimulus, are then obtained in the most vivid manner. To observe merely the oscillation, one eye may be used for observation; after exposure and subsequent closing of the eye, it will be found that the slanting arm of light appears and then disappears. To observe *alternation*, both eyes look at the pattern in the cardboard in the manner described above. After an exposure of 10 seconds or more, the eyes are closed. It is to be noted that the two retinas are subjected to the same length of exposure, and the length of nerves that convey the visual impulse are the same in the two eyes. The first effect after closure of the eye is one of darkness due to the rebound. Then one luminous arm of the cross projects aslant the dark field. As every portion of the retina is not equally sensitive, the after-image is not instantaneously formed in the field, but appears to jut out from one end to the other. This arm now slowly disappears, and then the second arm of the cross (produced in the other eye) shoots aslant the field. This alternation proceeds for a long time, and produces the curious effect of two luminous blades crossing and re-crossing each other. Owing to the relative retardation of after-effect due to different coloured lights, the two crossing blades successively exhibit a gorgeous display of chromatic effects.

There are several very interesting investigations rendered possible by the method of binocular alternation; of these I mention a few, the detailed accounts being postponed for a future occasion. It has been shown that under normal condition the two retinas have a relative natural retardation of half a period. Now if one retina be kept under standard condition, and the other subjected to a different condition of temperature, pressure, different lengths of exposure to different coloured lights, &c., then the natural retardation of half a period will be disturbed; one oscillation being accelerated or retarded will gradually overtake the other or be overtaken by it. Hence from such "beats," the effect of various influences may be studied.

There are several other ways in which the alternation of vision may be demonstrated. One striking method is to look at two different sets of writing with the two eyes; the resultant effect is a blur due to superposition. But on closing the eye the complex image is analysed into its component parts.

* For two other methods of observing recurrent phenomenon of vision see Charpentier (*Phil. Mag.*, 1891, p. 397) and Bidwell (*Proc.* Roy. Soc., June, 1894). Mr. Bidwell describes a beautiful method where the "ghost" follows the trail of the primary light stimulus.

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An Important Element of Retinal Fatigue.

While describing the peculiarity of the magnetic oxide receiver it was shown that the rise curve for feeble stimulus is very gentle, whereas the fall curve after strong stimulus was very steep. It is thus easy to see that the feeble radiation stimulus is unable to arrest the rapid fall which follows as an after-effect of strong radiation. This inference I have been able to verify with the magnetic oxide receiver. The above considerations explain certain type of the fatigue of the eye, the phenomenon being a little different from the other fatigue phenomenon hitherto studied. For in addition to the partial loss of sensitiveness due to the overstrained condition of the sensitive elements, there is added a rebound which gives rise to a negative image. When we stare for a long time at a white patch on a dark background and then turn the eye to a moderately lighted wall, we see a grey or dark patch corresponding to the original white patch.

Theory of Exhaustion.—It is usually supposed that the portion of the retina affected by light is "tired," and a negative image is formed owing to exhaustion. If we try to find the meaning of the figurative terms used above, we may, from analogy of muscles, suppose the exhaustion to be due either to the presence of "fatigue stuffs" or to the breaking down of the sensitive elements, or to both. The above explanation leads to the conclusion that the fatigue and the consequent negative image should gradually and finally disappear and the retina thus restored to the normal condition.

Theory of Strain.—But if the fatigue is due to the strained condition of the retinal substance, then we may expect an oscillation as an after-effect: a rebound towards the negative stage, to be followed by a springing back to the positive stage, and these to alternate for some time. The negative image should not, on the above supposition, finally vanish on the first disappearance, but ought to disappear and re-appear in succession.

We have thus a crucial test for the two theories, and the test consists in finding out whether the disappearance of the negative image is non-recurrent or recurrent. If we look for a time with one eye at the slanting arm of the cross in the stereoscope, as described in the previous section, and then turn the eye to a dimly lighted wall, it will be found that the dark negative arm of the cross gradually disappears; but this is not all, the negative image after a while again appears (with an intervening positive image) and then disappears, and this recurrence continues for a considerable length of time. From this experiment it is seen that the theory of strain alone explains the observed effects in a simple and satisfactory manner.

There are other interesting experiments by which the binocular alternation may be exhibited; of these I will here mention one. If the cross be looked at for a long time through the stereoscope with both the eyes, and we now turn one eye, say the left, to the wall, keeping the other eye closed, there will be seen, as mentioned before, the negative and the positive images of one arm of the cross in succession. When the intensity of the negative image with the left eye is a maximum, if we suddenly open the right eye (and close the left eye) the positive after-image will be seen; but if the right eye is opened when the positive image with the left is a maximum, then the image seen by the right eye will be negative.

On Certain Phenomena Analogous to Memory.

The gap which at present exists between the physiological and the beginning of psychological processes is very wide. Some transitional phenomena may perhaps be found to bridge over the discontinuity. Certain effects will now be described which appear to be very suggestive. I need only add that the deductions drawn are mere inferences, and as such are to be regarded with caution.

In the experiment with the stereoscope and the design of the cross, the after-images of the cross are at first very distinct—so distinct that any unevenness at the edges of the slanting cuts in the cardboard can be distinctly made out. There can thus be no doubt of the "objective" nature of the impression made on the retina, which consists in the strain produced in the sensitive particles. The objective nature of the strain is further seen after the stoppage of the light stimulus; a twisted wire suddenly released gives rise to oscillation, and the suddenly-released strained particles in the retina give rise to a similar oscillation, as is demonstrated by the phenomenon of recurrent vision. This recurrence may therefore be taken as a proof of the physical strain produced on the retinal substance by light. The after-image of the cross is, as has been said before, very distinct at the beginning, and becomes fainter at each repetition; a time comes when it is difficult to tell whether the image seen is the objective after-effect due to strain or merely an effect of "memory." In fact, there is no line of demarcation between the two, one simply merges into the other. That this "memory" image is due to objective strain, is made evident by its recurrence. How long does the objective impression on the visual centres last? The answer to this could only be given if we knew the limit of sensitiveness of the brain. We know that under favourable circumstances it can detect impulses which are extremely feeble. I have many instances where the persistent nature of these after-oscillations appeared long after, as spontaneous memory revivals. Thus a friend repeated the experiments with the stereoscope and the design of the cross; he watched the recurring after-images for a long time till they failed to be seen, owing to "certain feeling of irritation in the brain." This was in the afternoon, and my friend spent the evening in other occupation, having in the meanwhile completely forgotten all about the experiment. But at night, preparing to go to sleep, he noticed all of a sudden the recurrent image of the cross. Putting out the light and closing the eye made matters worse; the image instead of being shut out became all the more vivid. This went on for a very long time. In the case mentioned above, it is noticeable that the image, owing to other distractions, remained unperceived, and became only visible as soon as they were removed. In another case the recurrence was observed in a dream, about three weeks after the original impression was made.

In the cases just described, owing to the definite and somewhat unusual nature of the image, it is not difficult to connect the "memory image" with the objective impression previously made. But in other cases of spontaneous revival the connection is not so evident. "Not only single and simple sensations, but also complex group of sensations may be excited by other means than that of light falling on the retina, and we may thus experience varied and intricate perceptions which have no objective reality at all. . . . . Sometime the sensations and perceptions thus occurring, specially those which are met with on closing the eyes at night, *may be recognised as revivals more or less altered of sensations experienced during the day*; something sets going again the series of cerebral events which were set going by actual rays of light."* I have explained by what mechanism the recurrent phenomenon may have been set a-going.

In the experiment described at the beginning, it was shown that the after-effect phenomenon of retinal impression merges into the phenomenon of memory. Are the two identical, at least in many cases? One peculiarity of retinal impression is its recurrence. Now it is interesting to observe that the phenomenon of memory is also recurrent. "Certain sensation for which there are no corresponding processes outside the body are generally grouped for convenience under the term (memory). If the eyes be closed and a picture be called to memory, it will be found that the picture can not be held in memory, but will repeatedly disappear and appear."†

Conclusion.

I have shown how the theory of molecular strain explains in a satisfactory manner the varied phenomena connected with the molecular receivers. The effects are seen to be perfectly regular and not capricious, as is generally supposed. The method of conductivity variation affords a new and powerful means for the study of many molecular phenomena at present beyond the means of investigation. The extension of the hypothesis of molecular strain will, I am convinced, afford satisfactory explanations of many obscure physical problems, and will bring together, under a simple generalisation, phenomena which at present are regarded as entirely disconnected. In support of the above I have obtained very interesting results which I hope to publish at an early date.

Passing from the physics of inorganic substances to that of living tissues, we enter into a field of phenomena where an antecedent event is followed by a chain of reactions of the most complex kind. The strain produced by an external stimulus in a portion of tissue may, for example, give rise to variation of electric potential; this leads to volta-chemical action and the chemical combination product may in its turn act as a poison. The final result may thus be a very complicated one. But at the root, and as primary cause and effect, we find the stimulus or stress and the corresponding strain. From such a consideration a series of diverse phenomena obtain the most simple explanation. It has been shown how the stress and strain phenomena in living tissues appear to be but repetitions of similar phenomena in inorganic substances. Are the resemblances merely chance coincidences? They are too numerous and too consistent to be due to mere chance; they rather point to some fundamental similarities.

Matter when overstrained by stimulus recovers slowly. This overstrain produces the same fatigue in inorganic matter as in the living tissues of our own body. Vibration removes the fatigue in both.

Injection of certain foreign substances may either by increasing the viscosity or diminishing the elasticity cause partial or entire loss of recovery and subsequent response; this effect is seen to be produced in both living and non-living forms of matter. Injection of other substances may give rise to the opposite effect of an increase of excitability.

On the cessation of stress the substance may rebound; this gives rise to a fluctuating current in the retina, attended by the phenomena of recurrent vision; the persistent oscillatory after-effects due to previous strain may give rise to the beginning of the psychical process of memory.

In the phenomena described above, there is little breach of continuity. It is difficult to draw a line and say "here the physical

* Foster, "Text-book of Physiology," p. 1,387.

† E. W. Scripture, "The New Psychology," p. 101.

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process ends and physiological process begins" or "that is a phenomenon of inorganic matter and this is a vital phenomenon peculiar to living organisms" or "these are the lines of demarcation that separate the physical, the physiological and the beginning psychical processes." Such arbitrary lines can hardly be drawn.

We may explain each of the above class of phenomena by making numerous and independent assumptions; or finding some property of matter common and persistent in the living and non-living substances, attempt from this common underlying property to explain the many phenomena which at first appear so different. And for this it may be said that the tendency of science has always been to attempt finding, wherever facts justify it, an underlying unity in apparent diversity.

THE ACCURATE MEASUREMENT OF ALTERNATING AND MULTIPHASE CURRENTS.*

BY G. L. ADDENBROOKE.

For many years past I have given much attention to this subject, and I have now the honour to lay the results of my experience and work before the International Congress. One main point which struck me several years ago was the desirability of looking at the question as a whole. In measuring alternating currents it is necessary to take into account the fact that if there is inductance or capacity in the circuit, as is usually the case, the current which flows is influenced by three factors: (1) The resistance of the circuit and the work done within it; (2) the inductance of the circuit; (3) the capacity of the circuit. The inductance and capacity effects being exactly opposite in phase, counterbalance each other as far as they can, the larger factor predominating, the phase of which will be either 90deg. behind or in advance of the phase of the energy current, according as the self-induction or capacity of the circuit predominates. This current, when further combined with the energy current, produces a resultant current which is that actually flowing in the circuit, and which I prefer to call the "total" current rather than the "apparent" current and which, it is clear, will not be in phase with either of its components.

In carrying out measurements in practice, the wattmeter principle has come to be almost universally used in practice. Assuming that this principle is the one employed, there are three measurements which must be made to obtain the fundamental factors of an alternating current. When these factors are known other characteristics of the current can be deduced. A measurement must be made of: (1) The impressed volts; (2) The apparent amperes, or as I prefer to call them, the "total" amperes; (3) the effective amperes or wattts. (If the effective watts are measured, knowing the impressed volts we can directly deduce the effective amperes.)

Having these quantities, we can directly deduce in addition the power factor, the angle of lag, and the magnetising or capacity current or their resultant, if both are present. Also, if we know the periodicity, the coefficient of self-induction of the circuit and other characteristics may also be obtained without further observations. Finally, if both inductance and capacity are present, by measuring the capacity we can with the above data find the inductance.

To adapt the electrometer for use as a wattmeter I insert a series non-inductive resistance in the circuit to be measured, across which the quadrants are connected, while the needle is connected to the other side of the circuit so that the potential difference of the circuit is established between the needle and the quadrants. By arranging the instrument in this way and calibrating it properly, it is possible, under the right conditions, to make the electrometer a direct-reading wattmeter. Having the above-mentioned resistance necessarily in the circuit, it was clear that if it were possible to make an electrostatic voltmeter sufficiently sensitive to measure the drop of volts across this non-inductive resistance such an instrument so coupled would become a very handy form of ammeter. I have been able to attain such sensitiveness in the instrument employed as an ammeter that it is possible to get good readings with a drop of from 1 volt to 2 volts across the non-inductive resistance inserted in the circuit. As a matter of fact, I am arranging my instruments in practice now so that the non-inductive resistance inserted in the circuit shall cause a fall of potential of about 1½ volts as an average, which answers very well for the wattmeter also; this is a handy drop because it approximates to the E.M.F. of a Clark cell which is used for standardising the instruments, and consequently the readings come near the portion of the scale for which the instruments have been standardised. To attain this object, namely, to always obtain a good deflection on the instrument, a set of non-inductive resistances formed of strips of maganin are used. These strips in practice are about a metre long, and a handy way to arrange them is by beginning with a wire or strip to carry, say, one ampere, to make the next strip carry about two amperes, and the third four amperes, so that about ten strips will usually cover the full range of currents which are likely to be required in practice. For special purposes, of course, higher or lower resistances can be made, and since the instruments take infinitesimal currents, the same set of instruments will measure currents varying from, say, $\frac{1}{1000}$th of an ampere to 1,000 amperes or more, with equal percentage of accuracy in each direction if required; consequently the instruments are practically universal in this respect. By arranging these resistances so that they can be placed in parallel, the same deflection approximately on the instruments may, if desired, always be worked to.

As regards the measurement of currents of high voltages, there are two ways of proceeding. The instruments themselves can be made so that they can be directly connected to the high voltage circuit, but I usually prefer to employ instruments standardised for working direct on circuits of from 100 volts to 200 volts as a standard; and for higher voltages, to connect a high non-inductive resistance across the circuit, making the instrument connections across some known fraction of this over which there is a fall of 100 volts or 200 volts.

It now remains to describe this method and the design of the apparatus and instruments, and to show how they are used and

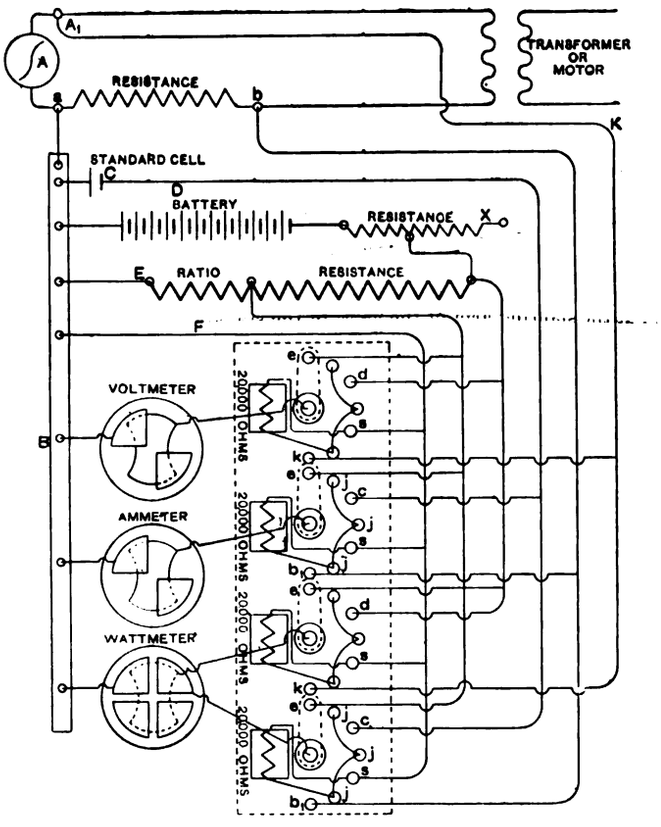

FIG. 1.

applied to the purpose in view. Fig. 1 is a diagram showing the method of connecting the instruments in practice to a circuit on which measurements are to be made, and the figure also shows diagrammatically the method of standardising the instruments and the switching arrangements by which the different connections are made, this is done by merely turning certain handles after the instruments are once set up.

In the diagram, A indicates the alternating-current generating machine having a main circuit A_1, wherein is placed a non-inductive resistance *ab* as mentioned above. From the point *a* a connection is shown to an omnibus bar or common terminal bar B to which most of the circuits hereinafter mentioned are joined. These are best arranged in the following order: C is a standard Clark cell, D is a battery of sufficient power to give rather more than the maximum voltage required for standardising the in-truments. I find a battery of small accumulators very convenient for this purpose, but if such a battery is not accessible the instruments can be standardised by making use of an electric lighting circuit instead, provided that readings are taken at similar pressures, which can be observed by connecting the electric light circuit to the voltmeter while readings on the wattmeter are being taken. X is a variable resistance in series with the battery. E is a box of resistance coils so arranged that a resistance of 100,000 ohms is always maintained between the

* Abstract of a Paper read at the International Electricity Congress at Paris.

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terminals, but by means of movable switches a third connection can be made to the resistance at any point desired. The outside terminals of this, which I call the "ratio" resistance, are connected to the common bar and to the resistance X, so that the ratio resistance forms a shunt across the battery and the resistance X. Let us suppose that the E.M.F. of the battery is 105 volts. By altering the resistance X suitably we can so arrange matters that there is exactly 100 volts pressure between the outside terminals of the ratio resistance E, under which circumstances we can, by setting the switches of the ratio resistance to the proper points, obtain any voltage we like accurately between 0 and 100 volts. F is a short-circuit connection between the bar B and a terminal *s* in each of the switches indicated below whereby any of the instruments may be short-circuited and their zeros adjusted. The electrostatic voltmeter, ammeter, and wattmeter are also connected to this bar. The voltmeter switch has four terminals, *e*, *d*, *s*, and *k*, the terminal *s* short circuiting the instrument as above stated. With the switch in contact with the terminal *d*, the instrument is connected to the battery D; and, similarly, when in contact with the terminal *e*, the switch puts the instrument in connection with the ratio resistance E, so that a desired part or ratio of the whole resistance can be measured off and any required voltage within the limit of the battery put upon the needle *g* of the voltmeter G, its quadrant plates s_1 being connected to the bar B. By this means the voltmeter can be calibrated throughout the whole length of its scale. The terminal *k* serves to place the needle *g* in connection with the circuit K, on which measurements are to be made.

The ammeter switch s_1 is provided with four similar terminals, indicated by the reference letters *e*, *c*, *s*, and b_1. The terminal *c* is for connecting the needle h_1 with the standard cell C. The terminals *e* and *s* correspond to the similar terminals of the voltmeter switch, and the remaining terminal, b_1, connects the ammeter to the main circuit A_1, at the *b* end of the measured non-inductive resistance *ab*. The wattmeter has a double set of switch terminals, one set, *e*, *d*, *s*, *k*, being exactly the same and with the same circuit connections as for the voltmeter, and the other set, *e*, *c*, *s*, b_1, being similar to those of the ammeter switch.

In changing the instruments from one set of connections over to the other, it is very desirable to have a means of separately short circuiting each of the instruments through a high-resistance of about 20,000 ohms while the operation is performed, otherwise the quadrants must be left unconnected for a period of time, which sometimes leads to violent deflections of the needles when connected to alternating currents and from charges on the ebonite or other adjacent surfaces otherwise difficult to avoid. This is provided for by the intermediate contacts *jj*... in each of the switches, as shown in the figure, which are connected to bobbins containing a resistance of about 20,000 ohms, one for each set of switch contacts.

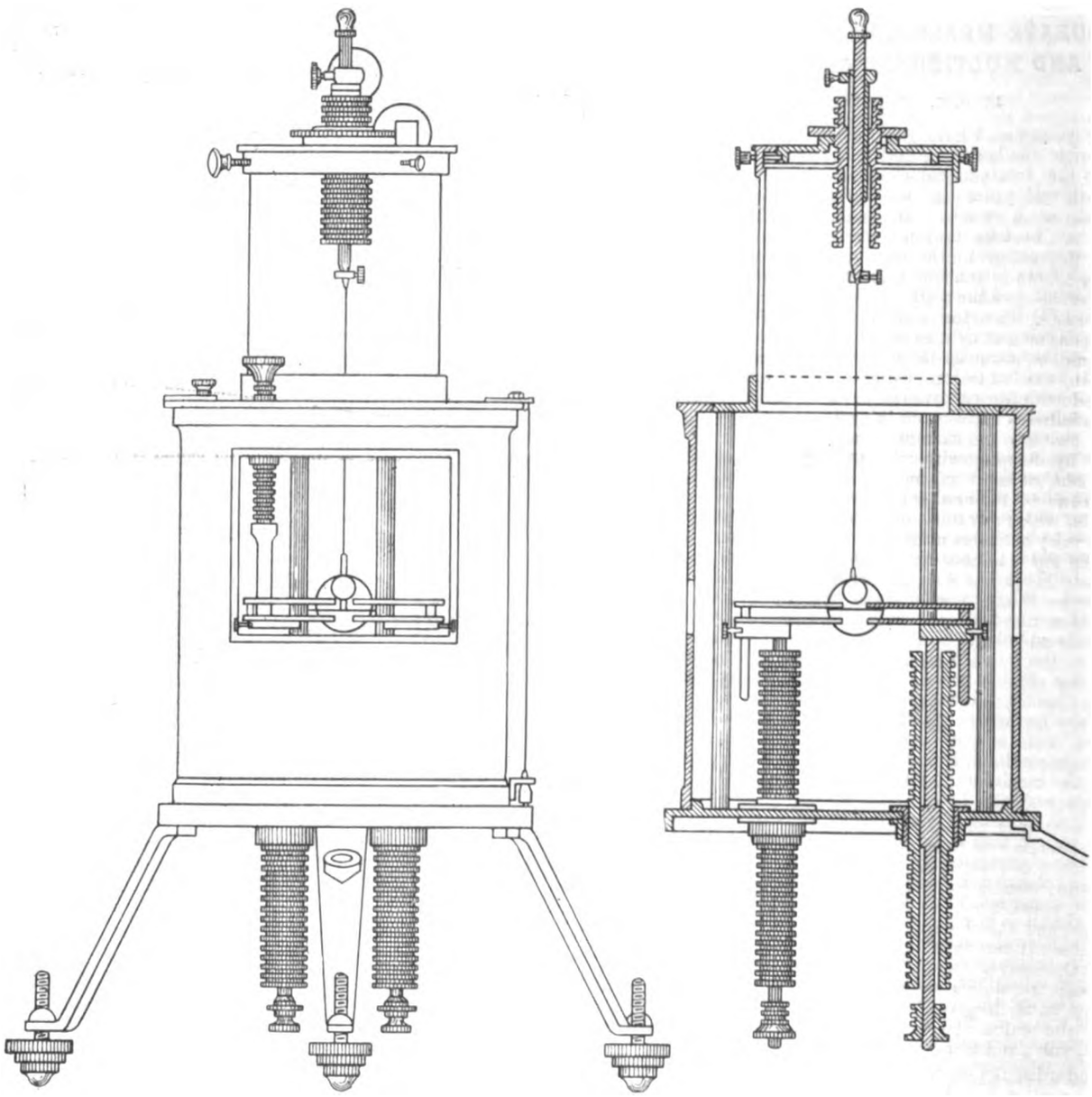

FIG. 2.

We now come to the instruments themselves. They are electrostatic, and are all built on the same general lines, which can best be seen by referring to Fig. 2, which represents the wattmeter. It may be noted that this one instrument will perform also the functions of a voltmeter and of an ammeter or low-reading voltmeter by simply altering the suspension of the needle and appropriately adjusting the quadrants. The instrument as shown is provided with a very high insulation, so that it can be used for measuring high resistances, capacities, &c., but such insulation is not specially necessary where

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the instrument is to be used for measuring currents only, or as a low-pressure voltmeter.

The suspension consists usually of a flat phosphor bronze strip of the kind which was brought into use by Messrs. Ayrton and Perry and which is so largely used in connection with the d'Arsonval galvanometer. This, of course, forms an excellent connection to the needle, so that there is no necessity to use sulphuric acid. Further, by using a specially light needle, I find that I can get sufficient decrement without any other form of damping, and consequently the needle may hang perfectly free in air, and there is nothing which can interfere with its proper movement in any way. It will be noticed that the quadrants are not made in the form of a box, as is usually the case, but consist of two sets of flat plates, the one set of which, usually the upper, is adjustable and can even be taken off altogether if required. This simple improvement, while it does not interfere with the action of the instrument in any way, greatly increases its range, adjustability and portability; in fact, it is much like adding an universal shunt to a galvanometer. The needle, it will be noticed, can be moved up and down by means of a rack motion, and can thus be set in the centre of the quadrants whatever the action of the upper and lower plates. For high voltages the upper plates can be removed altogether, and the needle removed some distance from the lower set of quadrants. On the other hand, the needle may be brought down close to the bottom set of quadrants and the top set brought down until the space between is not more than a millimetre. Under these conditions a deflection of 50mm. to 100mm., with the scale at a distance of 2 metres can be obtained with the most sensitive strip with a pressure of 1 volt only when the instrument is connected up idiostatically or as a simple voltmeter, and it is in this sensitive form that the instrument can be used as an ammeter by coupling it across a resistance in which from 1 volt to 2 volts is lost, as mentioned above. If we take this ammeter as our basis instrument, then the wattmeter to go with it must have a thicker suspension and be used with the quadrants further apart; in fact, it should be about $\frac{1}{100}$th of the sensitiveness of the ammeter. Then, again, the voltmeter requires to be much less sensitive still, this reduction in sensitiveness being obtained by the use of only one set of quadrants and a much thicker and shorter strip, and in the latter case, owing to the strength of the torque, it is best to reduce the period by damping with oil. In each of the instruments, by taking off one or more of the top quadrants and unscrewing the centring screws of the head, the head can be lifted off, carrying with it the needle, which can thus easily be changed. For carriage it is merely necessary to let down the needle on the bottom quadrants and let down the top quadrants on the needle, which firmly clamp it, so that the instrument can be shaken or turned upside down without any damage resulting. Owing to the fact that the needles are flat and very light they are exceedingly little affected by vibration, so that the instruments can be used on upper floors and near moving machinery. In use it is well to put in the circuit of each needle a 250-volt lamp of 5 c.p. I find this better than any form of fuse, as the current which can then pass through the instrument is too small to hurt the strip or needle, and at the same time instant warning is given by the lighting of the lamp if by any chance the needle should get attracted to the quadrants. The instruments are reflecting, and I usually arrange the scales at a distance of about 2 metres from the instruments.

With the help of the standardising arrangements, approximate deflections are taken on them for the scale readings they are intended to give with given voltages on the needles and quadrants. The requisite sensitiveness is then obtained approximately by varying the distance between the upper and lower quadrants in two of the instruments, and the distance of the needle from the quadrants in the voltmeter till very nearly the deflections required are obtained. The scales themselves are on sliding supports, and the final adjustment is made by sliding the scales nearer to or further from the instruments until the given voltages produce deflections of the right length on the scales. In this way the instruments can be made to read watts, volts, and amperes directly.

To standardise the wattmeter the needle switch is turned to the battery connection *d*, and the quadrant switch to the Clark cell connection *c*, the ratio resistance being set to 1,140 (supposing the resistance is 100,000 ohms as a total and that the voltage across the ends of it is 100 volts). The quadrant switch is then turned so that the quadrants are connected to the positive end of this ratio instead of to the positive of the Clark cell, and the resistance X is adjusted so that whether the electrometer is connected to the Clark cell or to the point of ratio resistance the deflection is the same. It is obvious that under these circumstances the voltage across the outside terminals of the ratio resistance must be 100 volts. Consequently we know the voltage on the needle and the voltage on the quadrants which are the factors requisite for obtaining the constant of the electrometer. If the scale is graduated in millimetres it is now convenient to adjust the instrument and the distance of the scale, so that the reading is 144 millimetres. If this is done, then if the quadrants are connected across a resistance, the value of which is known in ohms or fractions of an ohm inserted in a circuit, and the needle is connected to the other side of the circuit, presuming the voltage does not fall very much below 100 volts then the instrument will read directly in watts when multiplied by the reciprocal of the resistance, or if the resistances are numbered by their conductivities instead of by their resistances, then we have simply to multiply the reading by the conductivity, so that the instrument becomes a direct-reading wattmeter of almost universal range. Having now got 100 volts exactly across the battery by altering the value of the ratio in the resistance, the calibration of the electrometer throughout its whole scale can be made by simply turning the resistance switches to the appropriate points. If this is done it will be found that the scale is proportionate within half per cent. over a range of about 200 millimetres, and is within 1 per cent. over 300 millimetres. It will be observed that by calibrating under the exact conditions of use we do away with the necessity of applying any formula to the deflections of the instruments.

To calibrate the voltmeter, all we have obviously to do is to put it across the whole of the ratio resistance, since the drop across this is 100 volts exactly. The sensitiveness of the instrument should then be so adjusted by raising the needle or lowering it, and by moving the scale in or out that when the instrument is so connected it deflects to the point marked 100 volts on the scale. The instrument can be calibrated for any lower reading than this throughout the scale by altering the ratio point by the proper amount.

The sensitive electrostatic voltmeter which is used as an ammeter is now calibrated by connecting it directly by means of its proper switch across the poles of the Clark cell or the corresponding points on the ratio resistance, and this instrument also can further be calibrated in the same way throughout its whole scale by using the ratio. Owing to its delicacy and construction, however, the scale of this instrument is not quite so proportionate as in the case of the other two, and therefore it is well to construct a scale for it by setting the ratio resistance at the required points and noting the corresponding deflections. This can be quickly done, and when once the scale is made the instrument can afterwards be adjusted to read to this accurately, as described for the other instruments.

The instruments are now all calibrated, and nothing remains to be done but to turn their switches to the circuit connection, when they will give direct readings on any circuit to which they may be connected, the reading of the voltmeter being, of course, multiplied by the ratio of the high resistance across the circuit (if such is used), the reading of the ammeter being multiplied by the value of the known resistance (its conductivity) in the circuit and the wattmeter reading being multiplied by both these factors.

If the circuit is non-inductive the ammeter and voltmeter readings, when multiplied together, correspond with the wattmeter reading. If the circuit is inductive this, of course, will not be the case, and if we divide the watts as shown by the wattmeter by the volts as shown by the voltmeter, then we get the effective amperes flowing in the circuit. On the other hand, the ammeter gives us the total, or as they are sometimes called, the "apparent" amperes flowing in the circuit. The ratio of these two gives us the power factor, from which, by merely consulting a table of sines or cosines, we find at once the angle of lag. If we know the periodicity of the circuit the co-efficient of self-induction can be obtained without further observation.

By having a revolving contact connected to a small synchronous motor it is obvious that by the aid of the above instruments it is also easy to take a set of readings from which the actual curve of E.M.F. and current in the circuit can be plotted, with their lag or lead.

Where great accuracy is required in the readings it is obvious that all we have to do is to take a set of readings on any circuit and then turn over the switches one by one on to the ratio resistance, altering this until the deflections of the instruments on the circuit are reproduced. We then can read off directly and without calculation the continuous E.M.F.s necessary to produce these deflections from which the value of the E.M.F. and the current in the circuit (the resistance across which measurements were made being known) is at once deduced.

It is obvious that the instruments are equally suitable for measuring continuous currents over almost any range, so that the instruments practically form a universal set of measuring instruments whether for alternating or continuous currents. They can also be used for hysteresis and permeability tests, and for a number of other purposes to which I need not more directly allude.

For multiphase work, when the circuits may be unequally loaded, two sets of resistances may be used and the instruments can be quickly switched from one to the other. Or two sets of instruments may be used. Or instruments, particularly as wattmeters, may be employed with a double set of quadrants and double needle, the top needle being insulated from the lower, which receives its charge through a jar of acid. By means of the adjustable quadrants, it is easy to make both needles deflect equally for equal charges, so that when both are employed to read together their readings are added. For other purposes it is possible to use this double instrument as a zero instrument, and balance a known continuous against an alternating voltage.

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CORRESPONDENCE.

CARBON FILAMENTS AND LIGHTNING FLASHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Andrews' letter on the above subject in your last issue, and your own editorial note in that of the 31st ult., I think that, in view of Prof. Chunder Bose's recent deeply interesting and significant communications (significant, because his discoveries may conceivably be the first stone of the bridge which is eventually to span the gulf between the organic and the inorganic world—*Quien sabe?* The mere thought, and what it would mean, is sufficient to captivate the imagination!) on the subject of the similarity of effect of electrical stimulus upon organic and inorganic substances, we may perhaps accept the ingenious theory propounded in your editorial as being the correct interpretation of the phenomenon noticed. But we should now learn to regard the coherer, and in this instance also the carbon filaments of the lamps as "molecular receivers" of a positive or negative nature as the case may be—that is to say, substances which exhibit either a diminution or an increase of electrical conductivity under the influence of a certain degree of electrical stimulus, though it by no means follows, apparently, in the light of the professor's experiments, that they would always remain positive or negative under varying degrees of stress, and this latter consideration may possibly account for the occasional dimming of the incandescence observed by your anonymous Wisconsin correspondent. Regarding the phenomenon from this point of view, its explanation *seems* simple enough, and the gradual diminution, or the reverse, of the light again to its normal brightness after the lightning flash presents us with a visible "curve of recovery" for carbon filaments from the state of stress produced by electric discharges of infinitely great potential. It seems to me that the electric welding theory of the coherer should now go, and that we ought no longer to speak of "decoherence," but of "recovery" from molecular stress or strain, be the effects of the latter condition either of a positive or negative nature, or a resultant of both.—Yours, &c.

Oct. 1, 1900. F. ALEX. TAYLOR.

LEGAL INTELLIGENCE.

National Telephone Co. v. De Pass and Co.

At the City of London Court on Tuesday the National Telephone Co. sought to recover £50 for the use of a private telephone wire supplied to defendants, Messrs. Daniel de Pass & Co., merchants, 1, Fenchurch-buildings, London, from their City office to their branch establishment at Barking. Defendants pleaded that the wire had never been efficiently fixed; that when they used it they heard voices in the exchange, although the line was supposed to be a private one. Plaintiffs contended that the wire had been fixed as well as it was possible to fix it. Great difficulties had to be contended with in carrying the telephone service to Barking, as for 4 miles the wires had to stretch alongside the sewer bank, where the rowdier inhabitants of Barking amused themselves by throwing old domestic implements and other missiles at the wires. On several occasions whole lengths of wire had been cut off and removed. The company could not guarantee the telephone would always work. Defendants said they wanted the private wire urgently, but repudiated liability under the contract, which was for five years, as the telephone had never worked efficiently. The jury found for defendants, and Mr. Lewis Glyn for the defendants said his clients had offered, before the trial, to pay plaintiffs £25, without costs, but the offer had been declined.

South African War Fund.—Shortly after the commencement of hostilities in South Africa a fund was organised by Mr. Alfred Colson, engineer and manager of the gas and electric lighting works at Leicester, to assist the wives and children of soldiers called out to join the colours. A most satisfactory response was made, and altogether £322. 4s. 6d. was received during the 42 weeks of the fund's existence. The fund has now been closed with a balance of £101. 9s. 6d. in hand, and Mr. Colson, in a statement announcing the closing, congratulates the members of the staff on the hearty response they have made to the call for funds.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Battersea (London).—An amended estimate for laying electric light mains in several chief thoroughfares has been prepared, and the Vestry have resolved to carry out the work at a cost of £1,850.

Bermondsey (London).—A resident electrical engineer will be appointed at the next and final meeting of the present Vestry. On Monday the applications already received were referred to the Electric Lighting committee in order to permit the selected candidates to appear at the next sitting.

Birkdale.—The Council have resolved to purchase the local tramways of the Birkdale and Southport Tramways Co.

Blackpool.—Parliamentary powers to construct an electric tramway along Clifton-street are to be obtained The offer of the Blackpool and Fleetwood Tramroad Co. to give a temporary supply of current for working the Corporation tramways at 2d. per unit has been accepted.

Blackrock (Dublin).—The advisability of engaging in electricity supply is being considered by the Works committee. A proposal has been made to approach the Kingstown Council with a view to erecting joint electricity works for Blackrock and Kingstown.

Bolton.—At the Council meeting on Wednesday the chairman of the Tramways committee (Ald. Nicholson) replied to various questions as to the working of the electric tramways. He said that, owing to delay in the delivery of tramcars by makers, the St. Helens Corporation had offered them a number of new bogie cars which they had built, but were not quite ready to use. Their nine months' experience of tramway working in Bolton was that, considering the sharp curves, cars on the bogie principle seemed to be the best suited for the work. The tramway track was to be relaid at an estimated cost of over £100,000, and with this and other improvements he looked forward to greater financial and other successes for the undertaking.

Brisbane (Queensland).—The committee of the Brisbane Hospital contemplate installing the electric light. At present the building provides for 300 inmates with a probable increase in the near future to 500. Communications on the subject of the proposed works should be sent to the secretary of the Brisbane Hospital, Brisbane, Queensland.

Cardiff.—The Town Council and Electric Lighting committee have at last, we are glad to see, attacked the question of friction amongst the members of the electricity staff in the right way. It was decided at last week's meeting that a good deal of the trouble with which Cardiff has been visited in connection with electric lighting matters is due to what Mr. I. Thomas described as "the unwarrantable interference of the committee in matters of petty detail." It was further decided that letters from members of the staff under Mr. Applebee's control should be referred to that gentleman and not be dealt with in committee. It must be matter for regret that this course has not been adopted from the first. There is no doubt that Ald. Sanders hit the nail on the head in expressing his "disapproval of the principle of a subordinate official making suggestions to the committee. These suggestions should be made to the recognised head of the electrical department, and that official alone should be answerable to the committee."

Carmarthen.—The Electric Light committee have decided to retain Messrs. Medhurst and Lloyd, at a fee of 50 guineas, to report upon a system of public electric lighting. In the event of electricity works being erected the usual commission of 5 per cent. is to be paid.

Cassier's Magazine.—The October issue contains articles on "The Paris Exhibition," "Electric Cables for High-Tension Service," "Transition to Electric Power," "Some Gearing for Electric Motors," and "Recent American Steam Engine Practice."

Central London Railway and the Omnibuses.—To meet the depletion in the receipts from the omnibuses on the route of the Central London Railway a reduction of fares has been made by the two leading omnibus companies, with the result that the receipts are increasing, but apparently not at the expense of the railway company, whose receipts also show an upward tendency.

Chesterfield.—Mr. R. L Acland, who was recently appointed electrical engineer to the Corporation, has taken up his duties.

Colne.—The Board of Trade have approved the system of electricity supply proposed to be adopted by the Council.

Crook (Durham).—The Council have decided to light the Hill Top district electrically. Messrs. Pease Partners, from whom the incandescent electric lamps are to be rented, are laying down electricity generating plant.

Croydon.—An agreement has been entered into with the National Electric Wiring Co. for wiring premises in this district on the easy payment system.

Dublin.—The new tramline from Ballybough Bridge through Summer Hill and Great Britain-street to Capel-street and the Northern Quays was opened on Monday.

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Dudley-Cradley Electric Tramway.—On Friday Col. von Donop officially inspected this line as well as the reconstructed line from Dudley to Sedgley. Electric current for working both lines will be supplied from the Corporation station. The electrical equipment was inspected by Mr. A. P. Trotter six weeks ago, and the cars have commenced running.

Eccles.—There is at present the equivalent of 8,044 8 c.p. lamps connected. The Council have approved the appointment of Mr. H. W. Angus (late chief assistant at Bolton) as borough electrical engineer.

Edinburgh —On the motion of Bailie Mackenzie, convener of the Electric Lighting committee, it was decided on Tuesday to place the balance of the electric lighting account (£3,674. 9s. 4d.) to the credit of reserve.

Election Note.—By the narrowest of minorities Mr. F. Hastings Medhurst, B.Sc., M.I.E.E., was defeated in his attempt to secure for the Unionist party the Radical seat at West Islington, London. Mr. Medhurst's minority was only 19, and there is some talk of a scrutiny.

Electric Traction in Italy.—The steam tramway between Caivano and Naples is to be converted into an electric line.

Erdington.—At the next meeting of the Council the subject of applying for electric tramway powers will be discussed.

Glasgow.—The Tramways committee have decided to promote a bill for power to extend the electric tramways to Clydebank, Bishopbriggs, Rutherglen and Cambuslang, and also along Cumbernauld-road.

Last week permission was granted to the Glasgow Telephone committee to lay underground cables. The master of works reported that cables were to be laid in nearly every street within the district bounded by the river Clyde, Hope-street, George-street, High-street, and Salt-market. He saw no objection to the work being proceeded with except that there would be an enormous interference with the public use of the streets for a considerable time to come. None of the streets could be put into a satisfactory condition for more than 12 months from the time of the first opening. Permission has, however, been granted on the understanding that, with the view of minimising inconvenience to the public, the telephone department carry out, as required by the master of works, the work in streets that may be for other purposes opened up, and that the pavements of streets be, as far as possible, utilised instead of the roadway.

Hospital Lighting.—The Thanet Joint Hospital Board have referred the question of the electric lighting of the building to their Electric Lighting committee.

Leeds.—Application is to be made for sanction to borrow £510,500 for electric lighting and power extensions. At the meeting of the Corporation on Wednesday Ald. Wigram said the Electric Lighting committee had already received permission to apply for sanction to borrow £177,000, regarding which an inquiry had not yet been held. They had also to look to the future demand for electric current throughout the whole of Leeds. The proposed loan included £100,000 for general extensions and £80,000 for extensions on the main road to Wortley, New Wortley, Armley and Bramley, and on to Stanningley. It also covered a scheme for crossing the river again and extending up with the West Hunslet district through Globe-street, that would require at least £80,000. It would also cover £140,000 for development and extension, and the provision of new buildings and of machinery on the site already occupied.

Leicester.—The accounts of the electricity department for the past half year show that the profits, after paying interest, were £1,430, of which £1,068 was handed over to the sinking fund, and £362 to the relief of rates.

Leith.—Application has been made to the Secretary for Scotland for sanction to borrow £20,000 additional for electric lighting extensions. The electric lighting mains are to be extended to Denham Green, and the electrical engineer (Mr. J. G. Scott) has been instructed to prepare plans and estimates of the cost of lighting the whole of the Trinity and Newhaven districts by arc lamps.

Light Railways.—An inquiry was held last week into the application of the Hyde and Dukinfield town councils to construct an electric tramway between Hyde and Dukinfield, and also to connect Stalybridge with the two boroughs. To carry out this scheme the Councils propose to borrow £75,000 each. The tramway would also serve the still wider tramway scheme which is proposed by the Hyde, Dukinfield, Stalybridge and Mossley Councils. For the promoters Mr. Sutton said it could scarcely be said they were competing with the Oldham, Ashton and Hyde electric tramway. The difficulty apprehended in reference to a bridge over the Sheffield and Midland joint line at Hyde could be got over. The consulting engineer (Mr. A. H. Gibbings) gave evidence and said he considered the estimates and proposals reasonable. After hearing Mr. Balfour Browne, Q.C., for the Oldham, Ashton and Hyde Electric Tramway (Ltd.), the Commissioners granted the application in practically its original form.

Carnarvon Council will support the scheme for constructing a light (electric) railway from Carnarvon to Dinas Dinlle.

An inquiry was also held last week into the application of the Wigan and District Tramways Co. to construct a light (electric) railway from Ashton to Pemberton, and after hearing evidence, the chairman of the Light Railway Commissioners (the Earl of Jersey) announced that the order would be granted, subject to the plans being revised and certain protective clauses inserted.

Macclesfield.—A provisional order is to be applied for by the Council.

Maidstone.—Sir William Preece, who was recently appointed to report upon the electric lighting scheme of the Corporation, has visited the town, and his report is generally favourable to the original proposals, but he pronounces against the refuse destructor.

Malton (Yorks.).—Terms have been arranged between the Council and the Northern Counties Electricity Supply Co. by which the latter will apply for a provisional order, and erect electricity works in this district.

Melbourne (Victoria).—A conference of representatives of 11 of the municipalities affected by the Melbourne district electricity supply scheme was recently held at Melbourne to consider the applications and agreements of the Victoria Electric Light, Heat and Power Distributing Corporation, which proposes to supply the whole of the suburban municipalities with electric current for all purposes. Mr. T. Holroyd, secretary and engineer of the promoters, gave an outline of the scheme. Mr. F. G. Wood said he thought the conference should ascertain what guarantees the municipalities would have that the promoters would exploit the concessions if granted. It was pointed out that the corporation would have to obtain an act of Parliament within two years, and would have within the two subsequent years to complete the scheme. Councillor Boyd, of Port Melbourne, had doubts as to the genuineness of the scheme, and expressed the opinion that the Councils should demand a deposit of, say, £50,000 as a guarantee of good faith. The prospectus was drafted "too much on Yankee lines," as the corporation proposed to run the railways, trams, factories, mangles, sewing machines and so forth. If they could do one-tenth of what was proposed he would be satisfied, but the promoters might get the concessions merely to float a company on a large scale in England amongst people who did not understand local conditions, and so make a great profit, and then let the whole thing fall in. Mr. Holroyd explained that the promoters had the assurance of Major Cardew and others that the money could be obtained and the scheme could be carried out provided the concessions were obtained. Eventually it was decided, in view of the fact that the Prahran Council had convened another conference, to remit the whole question to the new conference.

Montrose.—The Lighting committee have engaged Mr. W. W. Lackie, of Glasgow, to report upon an offer received from an electric lighting company to establish electricity works in the district.

Municipal Telephony.—The question of applying for a telephone licence is at present under consideration by the Cheltenham Town Council, and a preliminary report has already been presented by the town clerk (Mr. E. T. Brydges), who has been instructed to approach Mr. A. R. Bennett with a view to preparing a report.

Nelson.—An inquiry was held here last week into the application of the Corporation to borrow £2,500 for electric lighting. The town clerk (Mr. R. M. Prescott) said a provisional order was obtained in 1883. In 1892 borrowing powers to the extent of £10,000 were obtained, and the present loan was needed for additional plant, including extensions to the storage battery. There was no opposition.

Newcastle-under-Lyme.—The Council have decided to advertise for an electrical engineer to report upon the proposed electric lighting scheme.

Paisley.—In response to a numerously-signed requisition, Mr. W. M. Murphy has consented to promote a fresh bill next session for powers to construct a system of tramways for this town and district. The new scheme is to be called the Paisley District Tramways.

Presentation.—On Saturday afternoon (Sept. 29) Mr. John Moore, managing editor of the "Central News," was presented by the indoor staff with a gold watch and chain, suitably inscribed. Reference was made to Mr. Moore's long connection with the Central News Agency, and to the financial success which has resulted from his labours.

Rickmansworth.—After hearing Mr. George Offor, on behalf of the Electrical Power Distribution Co., who are seeking to obtain electric lighting powers for this district, the Council decided to assent to the company's application.

St. Helens.—The borough electrical engineer (Mr. J. S. Highfield) is preparing plans and estimates of cost of carrying out extensions of the electric tramway system.

Salford.—At Wednesday's meeting of the Council a motion was presented by Mr. Makin on the subject of what are called "fair' clauses in contracts. Mr. Makin moved that the Council declare that:—

(a) Contractors tendering for or executing work under this Council must be paying the standard rate of wages to the whole of their workpeople

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and observing the hours and conditions of labour now recognised by the local organised bodies of workers, and be subject to such alterations as may occur in the various trades, &c. No tender to be accepted from any firm who prohibit their workpeople from joining organised bodies. Any contractor from an outside district whose tender may be accepted shall be required to conform to the rates and conditions of such district.

(*b*) Should the Council have reasonable grounds for believing that the above conditions are not being complied with, the contractor shall be called upon to produce his books to the town clerk for inspection, showing the names of, wages paid to, and the hours of labour observed by all those employed by him.

(*c*) The contractor shall not assign or underlet the contract, or any part of it, or sub-contract, except with the consent of the Council, and upon such conditions as they may think fit; but if the tenderer at the time of tendering states his desire to sublet any portions of the work not usually done by him, the Council will agree to do so with an approved person, the principal contractor being responsible to the Council for the work being done under the same conditions as if done by himself. And should the contractor or agent give or offer any gratuity to any officer of the Council, the Council shall be at liberty to determine the contract. Compliance with this standing order shall be of the essence of every contract, and non-compliance therewith, after notice to the contractor, shall entitle the Corporation absolutely to determine the contract.

The drastic nature of these clauses was recognised, and after some discussion it was decided to leave the subject over for settlement to a special committee to be appointed by the new Council.

Shoreditch (London).—The Vestry have decided to renew the insurance of the electricity and the dust destructor works in the sum of £52,000 at 4s. 6d. per cent.

Stockport.—The Electric Tramways committee have ordered 20 additional tramcars complete, at £675 each.

Tariff Changes.—Under the new customs tariff for British North Borneo railway, telegraph and tramway materials and scientific apparatus and material are admitted free of import duty.

West Bromwich.—It is proposed to supply electric current for private lighting at 6d. per unit for the first hour and 2d. after, and for power at 3d. and 1d. per unit respectively. It has been decided to apply for sanction to borrow £10,000 for the wiring of houses, and also to advertise for a borough electrical engineer at a salary of £250 per annum. (This advertisement appears in another column).

Wigan.—Application has been made to borrow a further £16,500 for electric lighting extensions.

Worcester.—The Electricity committee unanimously reported that it was inexpedient to extend the present generating station, but the proposal to purchase a site for a new generating station in Hylton-road at £3,750 has been postponed.

Workhouse Lighting.—The Poole Guardians are considering the question of lighting the workhouse electrically, and the Bournemouth and Poole Electricity Supply Co. has been asked to submit terms for the supply of current.

York.—In presenting the minutes of the Electric Lighting committee on Monday, the chairman (Ald. Dodsworth) said that during the past six months the electricity department had made a trading profit of over £200. That was very satisfactory, and pointed to even better results in the future.

Marriage.—Mr. Bertram Thomas, proprietor of the Cornbrook Telegraph Works, near Manchester, was married on Thursday last to Miss Ethel Benham, daughter of the late John Benham, of Clapham Park, near London. Mr. Thomas is well known in electrical engineering circles in Manchester, and has been associated with electric lighting and traction work in the Midlands for many years past.

EDUCATIONAL NOTICES.

Electro-Deposition.—At the City and Guilds Technical College, Leonard-street, Finsbury, London, a special course of 10 lessons in practical laboratory instruction in electro-deposition will be given on Wednesday evenings from 7 to 9, commencing Oct. 10. Particulars will be found in an advertisement, and programmes, &c., may be obtained at the College or at the head office of the City and Guilds of London Institute, Gresham College, Basinghall-street, E.C.

Polarisation of Light.—A special course of six lectures on this subject will be delivered by Prof. S. P. Thompson at the City and Guilds Technical College, Leonard-street, Finsbury, London, on Friday evenings from 8 to 9, beginning October 12. Some particulars will be found in an advertisement, and complete programmes can be obtained at the College or at the head office, Gresham College, Basinghall-street, E.C.

"Program" and Calendar.—We have received a programme and calendar of the day and evening classes at the Municipal Technical Institute, West Ham, London, which, following the now general rule, contains some well-executed illustrations of the laboratories, workshops, lecture-rooms, &c., at the institute, showing every indication that the course of technical training, under the able direction of Mr. A. E. Briscoe, B.Sc., Principal of the Institute, has been well designed. The workshops are fully furnished with up-to-date machines and tools, and a prominent feature is the physics and engineering department. The programmes are issued at 1d. each, or post free 3d.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

The Directors of the *Great Western Railway Co.* invite tenders for various stores for twelve months from Dec. 1st next. Among the articles required are telegraph poles and yellow pine, telegraph instruments and apparatus, copper wire, telegraph ironwork and tools, drysalteries, electric light carbons, incandescent electric lamps, brass work, &c. Samples and patterns may be seen at Swindon from 9th to 18th inst., and specifications may be obtained at the office of the stores superintendent. An advertisement gives further particulars, and tenders addressed to the secretary (Mr. G. K. Mills), Paddington Station, London, W., must be in by 22nd inst.

By command of the *Postmaster-General* tenders are invited for red fir telegraph poles and for creosoting. These tenders will be received until 10 a.m. of Monday, 22nd inst. Further particulars will be found in an advertisement, and forms of tenders may be obtained of Mr. Chas. E. Stuart, controller of stores, General Post Office, London.

Whitechapel (London) Electrical committee require tenders for a hand-driven overhead travelling crane for their electricity station. Specifications may be obtained at the electricity works, 27, Osborn-street, E., and tenders (addressed to chairman) must be delivered by noon of 23rd inst. An advertisement gives further particulars.

Glasgow Corporation invite tenders for cables for connecting up plant and transformer connecting bars for the Pinkston power station. Specifications from general manager of tramways department (Mr. John Young), 88, Renfield-street, Glasgow, and tenders to town clerk (Sir J. D. Marwick) before 1 p.m. Oct. 13. An advertisement contains some further particulars.

Glasgow Corporation also require steel straight track and curved rails and fish-plates. Tenders by 23rd inst.

The Streets committee of the *City of London* Corporation are again advertising for a mechanically-driven dust cart. Further information can be obtained from the electrical engineer (Mr. A. A. Voysey), Public Health Department, Guildhall, E.C. Tenders addressed to the town clerk (Sir J. B. Monckton), must be in before Nov. 10. See advertisement.

Cardiff County Borough invites tenders for slow-speed vertical engines, slow-speed converters, and boilers and economisers, &c. Specifications can be obtained from the tramways engineer (Mr. Arthur Ellis), Old Post Office-buildings, Cardiff, and tenders must be sent to Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 23rd inst. An advertisement gives further particulars.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for supply of stores during the 12 months ending Oct. 31, 1901. Among the articles required are brake blocks, copper, india-rubber, castings, ironmongery, sundry tools, &c. Tenders to secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 8.

The *Secretary of State for India* invites tenders for (1) a complete electrical installation for supplying power to a factory from a waterfall 3 miles distant, and (2) a complete hydraulic installation to develop about 500 H.P. Tenders to India Office, Whitehall, S.W., by 2 p.m. Oct. 16.

Bermondsey (London) Vestry invite tenders for steam, feed exhaust, and drain pipes, feed pumps, water storage tank and sundry ironwork, and also for steam dynamos, battery charging motor, booster, and balancer. Tenders to vestry clerk by Oct. 15.

Swansea Corporation invite tenders for cast-iron arc and incandescent lamp standards. Tenders to Messrs. Kincaid, Waller and Manville, 29, Great George-street, London, S.W., before noon Oct. 10.

Sunderland Corporation invite tenders for the supply of 24 car bodies, trucks, and electrical equipment. Tenders to chairman Tramways committee by noon Oct. 15.

Bootle Corporation invite tenders for a steam dynamo. An advertisement gives further particulars. Tenders to chairman Electric Traction and Lighting committee before Oct. 13.

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Aberdeen Town Council invite offers for 25 electrical tramcars, and for equipments for six horse cars about to be converted. Tenders before noon of Oct. 17.

Bradford Corporation require tenders for an engine and dynamo, switchboard apparatus, &c., for their destructor works. Tenders to town clerk before Oct. 9.

Ilford District Council invite tenders for direct-current meters and cutouts. Tenders to clerk by noon Oct. 8.

Nottingham Council invite tenders for 1,500 tons steel girder tram rails and 76 tons fishplates. Tenders to town clerk before Oct. 8.

Maidstone Corporation invite tenders for surface condenser and feed pumps. Tenders to town clerk before 10 a.m. Oct. 16.

Ayr Corporation invite tenders for tramway rails and fish-plates. Tenders by 12th inst.

Dartford Council invite tenders for the erection of electricity station buildings. Tenders by 20th inst.

Tenders are invited for re-wiring the abattoir premises, *Brighton*. Tenders to town clerk by Oct. 11.

Tenders are invited until Nov. 2 by the municipality of *Piatra Neamtz* (Roumania) for the electric lighting of the town for 30 years.

Tenders are invited by the *Stavanger* (Norway) Corporation for erecting plant for the transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres. Tenders by Jan. 2. Further information from the British Vice-Consul at Stavanger (Mr. E. Berentsen).

It is announced that tenders will be received up to Nov. 8 (not Oct. 13, as erroneously given last week) by the municipality of *Velez Blanco*, Spain, for the concession for lighting the town by electricity for 20 years.

Tenders will be received up to Nov. 27 for a tramway concession for *Zaragoza*, Spain. Particulars of the conditions were published in the *Madrid Gazette* of Sept. 27.

TENDERS RECEIVED AND ACCEPTED.

Worthing Town Council have received the following tenders for the supply of electricity generating plant :—

Contract No. 1.—Steam Dynamos.

Ernest Scott & Mountain (*accepted*)	£2,850 0	Westminster Eng. Co.	£3,520 0
Brush Co.	4,500 0	Ditto	3,176 0
Ditto	3,600 0	J. H. Holmes & Co.	3,500 0
Siemens Bros. & Co.	4,063 0	Ditto	3,400 0
Ditto	3,895 0	Ditto	3,300 0
Ditto	3,821 0	Ditto	3,000 0
E.C.C. Co.	3,956 0	British Westinghouse Co.	3,490 0
Ditto	3,614 0	Ditto	3,310 0
Ditto	3,432 0	Mather and Platt	3,475 0
Laurence, Scott and Co.	3,800 0	Ditto	3,415 0
Ditto	3,459 0	Ditto	3,100 0
Ditto	3,285 0	Rosling, Appleby & Fynn	3,466 0
Ditto	3,205 0	British Schuckert Co.	3,422 0
Ditto	3,203 0	Ditto	3,190 0
Ditto	2,952 0	Ditto	3,158 0
Ditto	2,932 0	Electrical Co.	3,420 0
P. R. Jackson & Co.	3,730 0	Ditto	3,230 0
Ditto	3,590 0	Ditto	3,225 0
Ditto	3,470 0	General Electric Co.	3,408 0
Thos. Parker (Ltd.)	3,669 0	Ditto	2,890 0
Ditto	3,488 0	W. H. Allen, Son & Co.	3,371 0
Ditto	3,270 0	Lancashire Dynamo and Motor Co.	3,332 0
Clarke, Chapman & Co.	3,664 0	Ditto	3,230 0
D. Bruce Peebles & Co.	3,654 0	Ditto	3,102 0
Ditto	3,490 0	Ditto	3,054 0
Ditto	3,405 0	Thames Ironworks, Shipbuilding and Eng. Co.	3,257 0
Ditto	3,402 0	Ditto	3,181 0
D. Selby Bigge & Co.	3,650 0	Ditto	2,750 0
Johnson and Phillips	3,640 0	Dudgeon & Co.	2,995 0
Ditto	3,110 0	Reavell & Co.	2,868 0
Ditto	3,090 0	Ditto	2,772 0
Crompton & Co.	3,633 0	Mavor and Coulson	2,836 15
Ditto	3,487 0	C. A. Parsons & Co.	2,818 0
Ditto	3,225 0		

Contract No. 2.—Boilers, &c.

E. Danks & Co. (*accepted*)	£1,130	Fraser and Fraser	£1,627
Tinkers Limited	1,975	Taylor & Sons	1,580
John Fraser & Son	1,900	Davey, Paxman & Co.	1,500
Ditto	1,330		

Contract No. 3.—Steam Pipes, Condensing Plant, &c.

Blackwell & Co. (*accepted*)	£1,731 15	Babcock and Wilcox	£2,252 0
Rosser and Russell	2,756 10	J. Spencer & Co.	2,247 0
Crompton & Co.	2,627 0	Aiton & Co.	2,209 0

Contract No. 4.—Manhole Covers.

Callender's Co. (*accepted*)	£501 3 0	Mackenzie Bros.	£573 15 0
Western Electric Co.	951 10 0	Watson, Gow & Co.	521 7 6
Haley & Co.	586 19 0	Bird & Co.	475 16 6

Contract No. 5.—Arc Lamp Posts.

Mackenzie & Co. (*accepted*)	£1,353 5	Allan (Sen.) & Son	£1,874 4
General Electric Co.	2,347 15	McDowall, Steven & Co.	1,786 0
Haley & Co.	2,075 10	Rowland Carr & Co.	1,631 9
Crompton & Co.	2,010 5	J. Kershaw	1,622 0
Western Electric Co.	1,952 0	Bradley	1,585 0
W. Lucy & Co.	1,883 0	J. and A. Law	1,567 0

Contract No. 6.—Stoneware Casings.

Albion Clay Co. (*accepted*)	£2,102 3 6	Western Electric Co.	£2,298 0 0
		Doulton & Co.	2,102 3 6

Contract No. 7.—Cablework.

Callender's Co. (*accepted*)	£5,967 15 3	Western Electric Co.	£5,406 10 5
Telegraph M'fg. Co.	9,093 4 3	W. T. Henley's Telegraph Works Co.	6,189 2 2
W. T. Glover & Co.	7,059 0 0	Brit. Insulated Wire Co.	6,156 14 10
Siemens Bros. & Co.	6,991 8 8	St. Helen's Cable Co.	5,870 0 0

**Contract No. 8.—Arc Lamps.*

Johnson and Phillips	£1,324 0 0	General Electric Co.	£1,140 0 0
Western Electric Co.	1,324 0 0	Gilbert Arc Lamp Co.	951 5 0
Crompton & Co.	1,166 0 0	Oliver & Co.	850 17 0
Westminster Eng. Co.	1,149 0 0	British Schuckert Co.	765 0 0
Brockie-Pell Arc Lamp	1,143 16 8	Electrical Co.	693 0 0

*Contract No. 8 has not yet been let.

Contract No. 9.—Storage Batteries.

Eclipse Brass and Copper Co. (*accepted*)	£984 4	E.P.S. Co.	£1,973 0
Chloride Elec. Storage Synd.	2,145 0	Tudor Accumulator Co.	1,860 0
		Hart Accumulator Co.	1,535 0
		D.P. Battery Co.	1,386 0

Contract No. 11.—Boosters, &c.

Laurence, Scott & Co. (*accepted*)	£710 0	Rosling, Appleby & Fynn	£980 0
Siemens Bros. & Co.	1,469 0	British Schuckert Co.	976 0
Thos. Parker (Ltd.)	1,047 0	Brush Co.	959 0
J. H. Holmes & Co.	1,040 0	Thames Ironworks Co.	955 0
Crompton & Co.	1,177 0	Mavor and Coulson	912 15
British Westinghouse Co.	1,016 0	Lancs. Dynamo & Motor Co.	838 0
D. Bruce Peebles & Co.	995 0	General Electric Co.	850 0
Electrical Co.	982 0	Dudgeon & Co.	543 10

Contract No. 12.—Economiser.

A. Lowcock (Ltd.) (*accepted*)	£372 10	Roberts Bros.	£390 0
Green & Co.	390 10	Carter & Son	385 0

Contract No. 13.—Travelling Crane.

Carrick & Ritchie (*accepted*)	£165 0	Larmuth & Co.	£230 0
Whitley & Co.	371 0	Pickerings (Ltd.)	229 15
Measures & Co.	300 0	J. Carrick & Son	211 0
Southgate Engineering Co.	244 10	Higginbottom & Mannock	176 0
J. Spencer & Co.	235 0	Chatteris Engineering Co.	157 0

Hull Corporation have received the following tenders for the supply of steam and water pipes, feed pump, water softener, &c., for their Sculcoates-lane generating station :—

Barker & Aspey (*accepted*)	£1,627 0 0	Tyndall, Earle, and Hutchinson	£1,910 3 9
Rose, Downs & Thompson	2,319 0 0		
Aiton & Co.	1,853 0 0		

Water Softener Only.

Lawrence Co.	£520 0	Mather & Platt	£225 10
Desrumeaux & Co.	465 0	Doulton & Co.	225 10

Grays (Essex) Council have accepted the following tenders for the supply of electricity generating plant :—

Callender's Co. (cables)	£3,454 0 0
E. Danks & Co. (boilers)	2,325 0 0
British Schuckert Co. (steam dynamos)	2,147 10 0
D.P. Battery Co. (storage battery)	836 1 0
General Electric Co. (switchboards)	628 15 0
E. Green & Son (economiser)	241 10 0
Carrick and Ritchie (crane)	96 10 0

Tenders have also been let for the erection of electricity station buildings at £4,174, and for roadwork, &c., at £1,005. 14s. The total of the accepted tenders is about £15,000.

Bradford Corporation have accepted the tender of the Lorrain Steel Co. (U.S.A.) for the supply of 2,000 tons of tramway rails at £7 per ton, with the necessary fish-plates at £8 per ton, subject to such conditions as may be specified by the borough engineer. Ald. Smith, at the Council meeting on Wednesday, wanted to know why the Tramways committee had gone to America for their rails, and the chairman of the committee (Ald. M. Booth) replied that they were £1 per ton cheaper than English rails.

Eleven tenders, varying in amount from £130 to £412, were received for wiring and supplying electric lighting fittings for the new Connaught Drill Hall, Portsmouth, now being erected for the 3rd V.B. Hants Regiment. The lowest tender, that of Messrs. Pyke, Harris & Co., was accepted.

The tender of the Hart Accumulator Co. has been accepted for the supply of the storage battery required for the electric lighting of the Cotsworth Sanatorium.

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The tender of Messrs. Dick, Kerr & Co. has been accepted by Dundee Council for the supply of a water cart, sweeper and rail cleaner for the electric tramways at £795.

Barrow-in-Furness Corporation have accepted the tender of Messrs D. Bruce Peebles & Co. for one year's supply of electric motors. (1 H.P. to 10 H.P.) for hiring-out.

Glasgow Tramways committee have accepted the tender of Messrs. Babcock and Wilcox for steam piping, &c., for Pinkston power station at £21,051.

Newcastle-upon-Tyne Tramways committee have accepted the tender of the National Construction Co. for the supply of conduits.

APPOINTMENTS VACANT AND FILLED.

West Bromwich Corporation invite applications for the post of borough electrical engineer. Commencing salary, £250 per annum. An advertisement contains further particulars, and applications must be sent in to Mr. Alfred Caddick, Town Hall, West Bromwich, by 17th inst.

Poplar (London) District Board of Works require an accountant and chief clerk for their electricity department. An advertisement gives further particulars, and applications must be lodged with the clerk (Mr. Leonard Potts), 117, High-street, Poplar, London, E., by 12th inst.

West Hartlepool Corporation require two assistant engineers for their electricity department. Applications to borough electrical engineer (Mr. H. F. Friederichs), by Oct. 13. See advertisement.

The Southampton Corporation require a mains superintendent. Applications to the town clerk (Mr. R. R. Linthorne), Municipal Offices, Southampton, by 12th inst. See advertisement.

There is a vacancy for a shift engineer at the Blackpool electricity works. Applications to chief engineer and manager (Mr. A. S. Giles) by Oct. 11. See advertisement.

Islington (London) Vestry require a draughtsman, an engine driver and also stokers for their electricity department. Applications to the vestry clerk (Mr. W. F. Dewey), Vestry Hall, Upper-street, London, N., by Oct. 8. See advertisements.

Belfast Corporation require a principal for their proposed technical institution. Salary £600 per annum. Applications by 22nd inst.

An assistant master for physics and chemistry is required in the secondary school, Rutherford College, Newcastle-on-Tyne. Applications by 12th inst.

An assistant science master is required for physics and chemistry for the High School, Newcastle-under-Lyme. Applications to head master.

Mr. Wm. Stevenson has been appointed telegraph superintendent and electrical engineer of the Caledonian Railway Co. in succession to Mr. A. S. Dunn, who recently resigned. Mr. Stevenson has been assistant to Mr. Dunn for many years.

Mr. J. W. A. Binner, of the Blackburn electricity works, has been appointed chief assistant engineer at Accrington.

BUSINESS NOTICES.

Prof. Alex. B. W. Kennedy informs us that in future the style of his firm will be Kennedy and Jenkin, and all communications should be addressed in this manner.

Mr. J. Wemyss Anderson has entered into partnership with Mr. Alfred Hay, B.Sc., M.I.E.E., and the firm will carry on business as consulting electrical engineers at Pearl Assurance Buildings, Liverpool.

Mr. Robert Green has arranged to take over the interest of his late partner (Mr. Edward Pritchard) in the firm of Pritchard & Co., consulting engineers, Birmingham, and in future practice will be carried on under the style of Pritchard, Green & Co.

The London offices of the Lilleshall Company have been removed to 71, Finsbury-pavement, E.C. Telephone 1,691 London Wall.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the Burnley Bankruptcy Court last week the public examination took place of Robert Foster and Walter Baker, electrical engineers, &c., trading as Robert Foster & Co. at Burnley, and also as the Nelson Electrical Engineering Co. at Nelson. The bankrupt Foster said he commenced business in 1895 with £30 borrowed capital. He entered into partnership with Baker in Jan., 1899. Between 1895 and Baker coming into the business he had been making a profit. Baker brought about £350 into the business. Witness had put about £1,000 into the business since 1895, obtained from his father and brother, and none of it had been repaid. All the money went into the business, £500 of it after Baker came into partnership. He first discovered that he was insolvent in January. It was not a fact that his business was insolvent before the partnership. The reason it did not pay after the partnership was that they extended the business and sold goods at too little profit. Foster was cross-examined at some length, and eventually the examination was adjourned. Baker was not examined, his examination being also adjourned until the next court.

T. W. Greaves and W. G. Randall (trading as T. W. Greaves & Co.), electrical engineers, 230, East India Dock-road, and 6, Nelson-street, Greenwich, London, have been adjudicated bankrupt.

A first and final dividend of 2s. 8½d. is payable in the bankruptcy of B. Symmons (trading as B. Symmons & Co.), electrical engineer, 2, North-street, Quadrant, Brighton, and 15, Holland-road, Hove.

On Sept. 24 it was resolved to wind up voluntarily the St. Stephen's Electrical Syndicate (Ltd.). Mr. A. N. Tessier, 1, Arthur-street, King William-street, London, E.C., is liquidator.

Claims against the Roller Bearings Co. (Ltd.), in liquidation, must be sent by Nov. 9. Mr. F. L. Fisher, Portland House, Basinghall-street, London, E.C., is liquidator.

Telegraph Stores Sale.—The Postmaster-General invites tenders for the purchase of old stores, including about 40 tons of gutta percha, 90 tons of copper wire, plates, &c., indiarubber covered copper wire, tools, &c. An advertisement contains further particulars, and tenders, on forms to be obtained from the Controller of Stores (Mr. Chas. E. Stuart), G.P.O., West, London, E.C., must be in by 10 a.m. 18th inst.

Plant for Sale.—Leeds Corporation invite tenders for the purchase of plant at present in use in connection with their system of electric tramways. Further particulars are set out in an advertisement. The plant, which is in excellent condition, can be inspected on application to the engineer-in-charge at the Corporation generating station. The consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., will supply additional information; and tenders (addressed to Tramways Committee) should be sent to town clerk's office, Town Hall, Leeds.

Messrs. Wheatley Kirk, Price & Co., 49, Queen Victoria-street, London, E.C., and Albert-chambers, Manchester, have for disposal a quantity of electrical plant in excellent condition. An advertisement contains further particulars.

Oldham Electric Light committee invite tenders for two 40kw. shunt-wound dynamos and a spare armature, which will be for disposal in December next. An advertisement gives further particulars, and offers must be sent to the superintendent (Mr. Arthur Andrew), Gas and Water Offices, Oldham.

To Let.—An advertisement contains particulars of a water-power-driven flour and grist mill situate at Lindfield, Hayward's Heath, Sussex, which is to be let. The mill is suitable for electrical or mechanical engineering works. Applications to Mr. J. G. Marshall, consulting engineer, Norwich Union-chambers, Birmingham, or to Messrs. F. Morrell & Sons, solicitors, Oxford.

Fire.—A fire broke out on Tuesday morning at the works of Messrs. Stephens, Smith & Co. (Ltd.), electrical and marine engineers, Millwall. The premises were severely damaged by fire, the cause of which has not been ascertained. The contents and building were insured.

Arc Lamp Coupling.—Mr. G. Braulik, 217-218, Upper Thames-street, London, issues a circular illustrating and describing his patent coupling for arc lamps, which he claims to be specially adapted for high tension. The coupling consists of two contact covers—one fixed and one movable. The springs are so arranged that all the parts are fixed on the lower plug, and can be readily examined when the carbons are being renewed or the lamp cleaned. All the current-carrying parts are securely mounted and highly insulated with porcelain and protected from the weather by a solid cap. When the lamp is lowered current is switched out by double poles. A special base plate for use with these couplings is also illustrated.

Telephones and Telephone Apparatus, &c.—Messrs. L. M. Ericsson & Co, of Temple-chambers, Temple-avenue, London, E.C., and Stockholm, send a copy of their latest catalogue of telephones and telephone apparatus, in which is illustrated and described every requisite for public and private telephone installations. The catalogue is in three languages—English, German and French, and is well executed. Prominence is given to a number of instruments of which large quantities are in use in this country and on the Continent. The illustrations include a fine view of the interior of the Copenhagen telephone exchange for 10,000 subscribers, equipped by Messrs. Ericsson & Co., and of the Stockholm exchange for 7,000 subscribers, erected as far back as 1886. Sections of the catalogue deal with telegraphic apparatus, testing instruments and electric fire alarms.

Paris Exhibition Award.—Messrs. W. A. S. Benson & Co., art metal workers and electrical engineers, New Bond-street, London, have received the only gold medal awarded to the British section at

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the Paris Exhibition for electric lighting and fittings. This firm make a speciality of electrical work, and are responsible for the installations at Cambridge University and St. Paul's Cathedral, to mention two only out of many. The handsome fittings in the British National Pavilion at Paris were mainly lent by Messrs. Benson & Co.

Mather and Platt Plant.—A revised list of steel-clad motors and accessories is issued by Messrs. Mather and Platt, and can be obtained on application.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 26 to Oct. 2, with the ports of destination :—

Africa.—Cape Town, £158; Durban, £271; East London, £15; Port Elizabeth, £22; Port Said, £8. *Argentina*—Buenos Ayres, £924 (including £799 telegraph material); Rosario, £219. *Australasia*—Auckland, £20; Brisbane, £178 (telegraph cable); Fremantle, £164; Melbourne, £162; Port Chalmers, £38; Sydney, £1,477. *Belgium*—Ostend, £154. *Brazil*—Rio Janeiro, £142. *Chili*—Valparaiso, £414 (including £344 telegraph wire). *Cochin China*—Saigon, £20. *Denmark*—Copenhagen, £379 (telegraph wire). *France*—Calais, £52. *Germany*—Hamburg, £606 (including £200 telegraph material). *Gibraltar*, £650 telegraph apparatus). *Holland*—Amsterdam, £30; Rotterdam, £44 (including £28 telegraph material). *India*—Calcutta, £57. *Malta*, £308 (including £152 telegraph material). *Portugal*—Lisbon, £50. *Russia*—St. Petersburg, £54. *Spain*—Grenada, £28 (telegraph material). *Straits Settlements*—Singapore, £50,054 (including £50,000 telegraph cable). *Sweden*—Stockholm, £510 (telegraph material). *Uruguay*—Monte Video, £46. Total £57,254, against £14,896 in the corresponding week last year (Sept. 27 to Oct. 3).

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Ltd.).

The ordinary general meeting of this company was held at the Victoria Works, Rugby, on Wednesday, under the presidency of Mr. MARK ROBINSON, M.Inst.C.E.

The SECRETARY (Mr. C. S. Essex) having read the notice convening the meeting,

The CHAIRMAN said: Ladies and gentlemen, in proposing the adoption of the report and accounts, there is one feature only which is unpleasant, and which is so new and so marked that we have thought it right to mention it in the report—namely, the very large sum locked up in what is known in the accounts as "Work in Progress," though it really includes all work, whether finished or not, which we have not been able to send away by the end of the half-year, and to invoice. Over £61,000 of the whole sum shown represents engines, all of which were on order, and a very large number of which were finished at the end of the half-year, though for reasons beyond our control we were not in a position to send them away to the buyers. The activity of the electrical trade has led to some of the dynamo makers getting greatly behind with their orders, and as we have hitherto managed, by the aid of our late extensions, to keep up with our work better than was previously the case, the engines have gone ahead of the dynamos, and have to be kept waiting here until the latter are ready. Of course, there are also cases where engines wait for some fault of ours. From the one cause or the other there is always a large sum locked up in the form of work in progress, but this time it has risen beyond all precedent. Understand that this is no question of safety of our funds, only of unprofitable employment. The engines are in our hands, and they are on order from people who represent largely the most sound and solvent, though perhaps not always the most considerate, class of customers—the municipal corporations and electric light companies, or else the important electrical firms who in many cases stand as over-contractors between us and the buyer. That so much money is locked up through the delays of other people gives us, of course, ground for complaint against them, and it may perhaps be asked whether it does not justify a demand for compensation. If so, I can only answer that there must be give and take in business. There were days when we were behindhand with engines and when we kept the dynamo people waiting for their money, and we remember that they treated us then with forbearance. How we should deal with such cases must depend upon considerations of general policy, and I am sure you will be glad to leave this in the hands of the directors. The present great lock-up from this cause has every appearance of being temporary, but it is incontestable that such matters grow rapidly in a business like ours, and that we must reckon upon a large part of our capital being more or less permanently locked up in a form not directly productive. It is an incident of our class of business, and if the business continues profitable I think we shall have to allow not only that it is a necessary incident, but that it is one of the conditions which enable us to work the remainder of the capital to advantage. It will be noticed that the half-year's net profit is slightly decreased, but it has often been pointed out that half-yearly periods are too short to give anything like fair average results. In this case the profit locked up in finished engines far more than accounts for the difference. You see we are still able to carry forward an increased balance. The new issue of shares was in all respects successful. We took much pains to do justice among those who applied for the small balance not taken up by the original allottees; but, as usual, I am afraid the disproportion between the number of shares and the number of applicants leaves us no hope that the latter were satisfied. The large engine working at the Paris Exhibition has been a great success. It is the first engine of its size—namely, 2,400 I.H.P. as normal maximum load and 3,000 I.H.P. as "emergency load," or just twice the power of the previous "large" engine, of which we have made so many for various lighting stations. It is gratifying that Messrs. Siemens Bros. (Ltd.) received a Grand Prix for their fine dynamo, as we did for the Willans engine. We think the experience gained, to say nothing of the credit, will be extremely useful to us, and I may say at once that it has altered my views, and I think those of my colleagues, as to the supposed limitations upon the profitable increase of size in Willans engines. We are prepared now to take orders for Willans engines of any size, though still ready, for large powers, to make other patterns as well. It is a fortunate thing that an international exhibition of this magnitude has been held at the very time of our new departure in the construction of very large engines, so that the first of them has been thus admirably introduced to the public. Perhaps the greatest use to us of the Paris Exhibition has been the introduction of the engine to English engineers and electricians, and to English municipal authorities, all of whom have visited the exhibition, and from whom we have heard many gratifying things. Two other engines of the same size are on order for a British lighting station, and good progress has been made with them. Under the circumstances we have felt justified in recommending that the cost of carrying out this important exhibit at Paris should come out of the money we have received as premiums on shares. It is an expenditure made once for all, because this kind of demonstration need not be repeated, at least on anything like the same scale; and, further, its object is to facilitate the work which the new capital was expressly subscribed to effect—viz., the opening of a trade in engines of large power. Those expenses exceeded £2,000 in June last, and when the engine is brought home again they will certainly have exceeded £3,000. We also propose to debit the premiums account with the cost of removal from Thames Ditton and with the depreciation of the plant and property there. We propose in these two ways to apply about £5,000 out of the total balance of £44,656. 2s. which, either in hand or to come, now remains unappropriated of a total of £92,500 received for premiums on issues of capital. The remainder, £39,656, will be carried to the reserve fund. We trust these arrangements, which have been the subject of much consideration, may meet with your full approval. When I last addressed you our new boiler works near Chester had faded almost into the clouds, for the very site was then uncertain. The validity of the lease (through no fault either of the landlord or ourselves) was impugned, and tedious, though not costly, law proceedings lay before us, before we could again call the site our own. Well, it is ours at last, and we have made the most of the time which elapsed since we secured it. The new works, the sidings, and the pier on the river Dee, all make good progress. But we must be under no delusions as to the time we shall have to wait for the more important and heavier articles of plant on order. These will keep back the starting of actual work for a great many months, probably until some time after the buildings are finished. Meanwhile, our satisfaction with the boiler itself, and our belief in its future, continue to increase, and though marine work is not our main object, the shareholders will doubtless have seen with pleasure the announcement that the Admiralty intends to fit the Niclausse boiler not only in another small vessel, but also in one of the new first-class cruizers, carrying 22,000 H.P. Six months ago I said that the starting of the boiler works must result in still larger necessities in the way of capital, beyond what we have lately issued. The truth of this is increasingly evident, for we have before us now not only the future exigencies of the boiler business, but the very present fact of the greatly increased cost of all building operations, especially those involving the use of much constructional steel work. We are suffering much from this cause at Chester, and equally so in the large extensions we are making in the shops at Rugby. Beyond all these causes of increased expenditure is the constant and apparently inevitable increase in the lock-up which I have dealt with in the beginning of my speech. We shall be able to speak more definitely in the spring upon this subject. We propose to carry the usual amount to the reserve, and it may be pointed out that before the summer of next year the reserve fund may probably be brought up to £100,000, or the full amount of the debenture debt, irrespective of about £19,000 which will then stand in the debenture sinking fund. While the general body of our shareholders has certainly applauded the rapid building up of this magnificent reserve, there are some who have disapproved, and we think it might well be considered whether we need continue to add more to the reserve fund when it has reached £100,000. Many shareholders would like to see the goodwill written down. Personally, my view is that our goodwill is worth enormously more than it stands at in the accounts; the history of the company proves this. Nevertheless it will be prudent finance, when we have put by so much against a rainy day, if we turn our attention to the goodwill. Profit reserved for that purpose, it will be noticed, is not required to be invested, as that put to the reserve ought to be; it remains in the business, and earns dividend, though it takes none. We therefore suggest, for further consideration at a later meeting, that when the reserve fund reaches £100,000, we leave it at that, at least, for a time, and turn our attention to writing down the goodwill. Gentlemen, I beg to move—

"*That the report and accounts for the half-year ended June 30, 1900, submitted to this meeting be and the same are received and adopted.*"

Capt. BECKFORD seconded the motion.

Mr. G. W. ANDERSON contended that the share premium account was an account of capital received and that the reserve account should be reserve of profits on the business, which were kept for the equalisation of dividends and other purposes. He therefore moved that the expenses

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incurred at the Paris Exhibition should be placed to a suspense account, and written off from the profits by instalments, so that the expenses might not fall unduly in any one half-year.

Mr. J. C. PEACHE seconded the proposal. He contended that the engine shown at the Paris Exhibition was simply by way of advertisement, and that it was as much chargeable against profit and loss as the advertisements that were put down in that account.

The DEPUTY CHAIRMAN (Sir Gilbert A. Clayton East, Bart.) said it was quite right for Mr. Anderson to raise the question whether premiums were capital. He did not consider they were, but his opinion or a shareholder's opinion was of no value. The moment the question was started, it was a legal one, and it was quite right to refer it to a solicitor to deal with. He believed that in the case of all companies established of late, the premiums had been devoted to reserve. The auditors had agreed to what the directors proposed.

The CHAIRMAN held that premiums on shares were not capital in any sense of the word. It would be a foolish thing to do, but legally he thought the shareholders had power to divide the premiums among themselves. In answer to Mr. Anderson, he would say that the original patent for the Niclausse boiler had about nine years to run, but there were plenty of patents even up to the present year. They arranged to write off the sum paid for the original patent within the term of its life. With that exception they had never put anything down for patents. He believed that the company would go on just as well without patents as with them.

Mr. LAZENBY said he considered that premiums were a realisation of the improved position of the company, and that they were therefore in the nature of a deferred profit.

The report and accounts were then adopted unanimously, and the payment of a dividend for the half-year ended June 30 last at the rate of 6 per cent. per annum on the preference shares and at the rate of 10 per cent. per annum on the ordinary shares was approved.

A cordial vote of thanks to the chairman and directors terminated the proceedings.

Typewriting Telegraph Corporation (Ltd.).

The first ordinary general meeting of this corporation was held yesterday (Thursday), the Right Hon. Sir JAMES FERGUSSON, Bart., M.P., presiding.

The SECRETARY (Mr. J. Sampson) read the notice calling the meeting.

The CHAIRMAN said that was the first or statutory meeting since the incorporation of the company, and the financial position was that 26,800 shares had been taken up and allotted, making available £15,000 clear for the development of the business of the company. That would be quite sufficient because they did not require a great deal of capital to carry on the business, as the General Post Office and the National Telephone Co. were very large customers with them, and paid for the instruments as they acquired them. Negotiations were in progress for the sale of certain of the patent rights, including those for America, Germany, South Africa, France, and Scandinavia, the profit in respect to which would come entirely to this company, because they had acquired the whole of the patent rights. Inquiries were being received for installations which would be fitted as fast as the instruments could be supplied. Contracts with the General Post Office and the National Telephone Co. were being completed, and would in all probability be sealed almost immediately. Perhaps the shareholders were aware that the General Post Office and the National Telephone Co. had for a considerable time been taking the instruments and supplying them for private wires, and the company would inherit that business. This invention was particularly suitable for private wires, as it required no technical experts to work it. It was also of great value in large engineering and other important works, also in exchanges for the distribution of parliamentary, racing, cricket and other telegraphic news, which could be done far more cheaply by this method than by that now in use. It was also specially useful in military operations, because the instrument was of a very portable nature, and by a very simple arrangement the messages sent could be kept absolutely secret. The wires were not able to be tapped and the message, instead of being delivered in cipher, was in plain printing. He felt confident as to the success of the extremely clever invention which the company possessed, and referred to the fact that he had been approached to take the position of chairman, he being a director of the National Telephone Co., which was one of their chief customers.

In reply to a question, the CHAIRMAN said the total number of shares issued was 71,000, leaving a balance unallotted of 29,000.

Mr. CROUCH said that he presumed, therefore, that they would have to pay dividend upon that 71,000 shares, and he would like to know whether it was contemplated to begin to do so soon.

The CHAIRMAN said not before the expiry of six months.

Mr. GIBSON asked if the chairman was aware there was a rival instrument on the market, and whether it was likely to damage the prospects of this company.

The CHAIRMAN said that he had seen the rival instrument, and it was a very ingenious invention. He was exceedingly amused with it. It had not been tested over very long distances, he believed. It was claimed for it that it reproduced the sender's handwriting, which was perfectly true, whereas their own company claimed as a greater merit that it reproduced a clearly typewriten message. He supposed there always would be rivals in the field.

Mr. W. M. MORDEY (consulting engineer to the company) gave a technical description of the machine, and pointed out that it could be used in conjunction with the telephone, and said that should the intended recipient of a message be absent he would find upon his return to his office the message clearly typewritten. Used in conjunction with the telephone it had the advantage of setting down in typewriting the essentials of telephone messages, and, moreover, an additional advantage was that messages in foreign languages, which perhaps could not be translated by a clerk in the office, were placed on record in plain writing.

No resolution was submitted to the meeting beyond a vote of thanks to the chairman, which was carried unanimously, and the proceedings terminated.

HAWAIIAN TRAMWAYS CO. (LTD.)—At a recent meeting, the chairman (Col. C. M. Davidson) said the question of the adoption of electric traction had had careful consideration, but progress had been checked by a rival company in Honolulu, and that this opposition had resulted in litigation. Everything requisite to equip and work a mile of road electrically was in hand and had been paid for; and the directors were anxious to make a start as soon as this could be legally done. The company would have to generate their own current. They had been anxious to use water power, as it would be much cheaper, but this could not be arranged, and they would have to employ steam power.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—An extraordinary general meeting of this company was held yesterday (Thursday) at Newcastle-on-Tyne, when a special circular issued by the directors was read. Reference was made to the bills promoted by the company in Parliament this session for powers to supply electric current outside the area defined by the original provisional order, and also to the provisional order which has been obtained for the supply of electric current to Gosforth. The circular continues: The acquisition of these extended powers entails upon the company the obligation of taking immediate steps for generating and supplying electricity in the whole of the area for which they have powers. As soon as plans are matured the directors intend to propose to invite applications first from the shareholders and then, if necessary, from the public, for the additional capital required for carrying out this programme. Sir Lindsay Wood, Bart., and Mr. John H. B. Noble have been elected additional directors of the company.

RECORDING TELEGRAPHS (LTD.)—An extraordinary general meeting of this company was held on Tuesday, Mr. J. A. Sillars presiding. Mr. Sillars said they had to consider a resolution for winding up the company voluntarily. The labours of the board and of himself as chairman were rapidly approaching completion. They had succeeded in transferring the concern, but it had been necessary for them to distribute £15,000 of their profits in order to enable them to secure £6,000, a sum they were compelled to obtain, as without it the transfer could not have been carried through. The new company, the Typewriting Telegraph Corporation (Ltd.) had been successfully launched, and he believed had a great future before it. The first meeting of that company would be held this week, when the chairman, Sir James Fergusson, M.P., would have an interesting statement to make respecting the invention forming the company's patent. The motion for winding-up was agreed to. (On Oct. 24 a motion is to be heard in the High Court for winding-up Recording Telegraphs (Ltd.) under the supervision of the Court. Messrs. Maddisons, 6, Old Jewry, London, are solicitors for the plaintiffs.)

ST. HELENS AND DISTRICT TRAMWAYS CO. (LTD.)—The directors' report for the 19 months ended June 30, just issued, states that the Corporation of St. Helens have made great efforts to lay down and equip the tramways within the district, but the work has not been completed as expeditiously as the directors desired. For seven months no part of the electrical system was available for use, and up to June 30 only one-half of the projected lines had been handed over to the company. The service of cars has given general satisfaction, and the traffic receipts have been larger and progressive. In consequence of the delay the net revenue has not been sufficient to provide for the whole of the rental charged by the Corporation and the premiums upon the redemption policies, and it has therefore been decided to carry forward £1,500 of the rentals to be extinguished out of future profits, and to treat the premiums already paid as an asset.

NEW COMPANIES, STATUTORY RETURNS, &c.

GENERAL ELECTRIC CO. (1900) (LTD.)—This company was registered on Sept. 27, with a capital of £800,000 in £10 shares, to acquire the business of the company of the same name (registered in 1889), to manufacture and deal in electrical appliances, machinery and apparatus, and to carry on the business of electricians, electrical and general engineers, ironmongers, makers of electric tramcars, motor cars and carriages, dynamo and motor manufacturers, and makers of telephones, bells, electroliers, arc and other lamps, electric light fittings, indiarubber, asbestos and other insulating materials, &c. The subscribers (with one share each) are Gustave Byng (manufacturer), Max Byng (electrical engineer), H. Hirst (electrical engineer), A. Eckstein (electrical engineer), W. White (electrical engineer), E. Wilson, and T. J. K. Alwood. The first four subscribers are the first directors. Qualification, 1,000 shares. (See also notice under "CITY NOTES."

SUSSMANN ELECTRIC MINERS' LAMP CO. (LTD.)—This company was registered on Sept. 26, with a capital of £30,000 in £1 shares, to acquire the business of the Sussmann Electric Miners' Lamp Co. (Ltd.), and to carry on the business of manufacturers of miners' and other lamps, galvanic battery manufacturers, manufacturers of and dealers in electrical, chemical, and other apparatus, appliances and materials, &c.

WALKER AND HODGETTS (LTD.)—This company was registered on Sept. 27, with a capital of £5,000 in £1 shares to acquire the business carried on by Messrs. E. O. Walker and W. H. Hodgetts, and to carry on the business of electricians, electrical and mechanical engineers, electrical and other engine, motor, and machine makers, &c. The first directors are F. A. Moershell, A. Tongue (chairman), E. O. Walker, and W. B. Hodgetts.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 28 15/16d. per oz. (Oct. 4). Consols (2¾ per cent.) 98 1/16—98 3/8 for money, 98 3/8—98 7/16 for account; 2½ per cent. 96 7/8—97 1/8 (Oct. 4). Stocks and Shares Continuation Days, Oct. 10 and 24; Ticket Days, Oct. 11 and 25; Pay Days, Oct. 12 and 26; Mining Share Carry-over Days, Oct. 9 and 23.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—After placing £6,000 to renewal fund the directors have declared an interim dividend for the quarter ended Sept. 30 of 15s. per cent. on the ordinary and and £1. 10s. per cent. on the preferred stock (less tax), payable Nov. 1.

GENERAL ELECTRIC CO. (LTD.)—In reference to an announcement which appears in another column under "New Companies," the prospectus of the General Electric Co., inviting applications to a capital of £800,000 will, we are informed, be issued early next week.

MUNICIPAL LOANS.—During the week the Huddersfield Corporation invited applications for £750,000 3 per cent. redeemable stock at £96. 10s. for tramway, electricity supply, and other purposes.

Croydon Corporation have also this week made an issue of £500,000 3 per cent. stock at £96 to provide money for the construction and completion of electric lighting and electric tramway works, &c.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed 11th inst. a special settling day in the further issue of 50,000 £10 shares (issued at £3 premium), £6 paid (£3 capital and £3 premium), and numbered 250,001 to 300,000, of the *Eastern Extension Telegraph Co. (Ltd.)*, and has ordered the securities, as well as the further issue of 1,600 5 per cent. non-cumulative £10 fully-paid preference shares (Nos. 37,001 to 38,600) of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted in the official list. Application has been made to the committee to appoint a settling day in and to grant a quotation to the further issue of 23,361 £5 5 per cent. cumulative preference shares of the *United River Plate Telephone Co. (Ltd.)*. The committee has also been asked to allow £500,000 4 per cent. debenture stock of the *National Telephone Co. (Ltd.)* to be quoted in the official list.

SUBMARINE CABLES TRUST.—The coupon due Oct. 15 will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, E.C., on that date, as announced in an advertisement on another page.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Sept. 29	4,902	+ 322	12	55,147	+ 2,394
Blackpool Corporation...	„ 27	1,034	+ 459	26	24,472	+ 6,248
Blackpool and Fleetwood	„ 29	768	...	13	17,663	+ 127
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 30	571	+ 219	26	13,489	+ 2,861
Brisbane Trams	Aug. 15	2,364	+ 600	6	11,218	+ 2,166
*Bristol Trams & Carriage	Sept. 28	3,403	+ 343	13	46,271	+ 96
*Buenos Ayres & Belgrano	„ 2	2,085	- 37	9	19,146	- 590
Central London Railway	„ 29	5,208	+ 317	9	42,407	...
City & South London Ry.	„ 30	1,574	+ 611	13	19,621	+ 7,436
Cork Elec. Trams	„ 27	444	+ 48	39	16,167	+ 1,318
Dover Corporation	„ 29	255	+ 44	26	6,364	+ 337
Dublin & Lucan Rly. ...	...	...	...	...	...	...
Dublin United	„ 28	3,679	+ 682	13	50,436	+ 6467
Dublin Southern Dist....	„ 28	855	+ 70	13	14,700	
*Glasgow Corporation ...	„ 29	9,748	+ 229	...	...	...
Hull Corporation	„ 29	1,277	+ 672	13	17,234	+ 9,490
*Liverpool Corporation...	„ 22	9,874	+ 2,768	38	296,137	+ 35,764
Liverpool Overhead Rly.	„ 30	1,685	+ 204	13	22,680	+ 1,063
*Sheffield Tramways	„ 30	2,514	+ 807	39	86,203	+ 30,690

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 26.		Price Wednesday, Oct. 3.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 3.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£96,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July.....	...	...
35,000	10	...	Amazon Telegraph.....	...		...		...	June and December ...	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£822,720	Stock	15/0	Anglo-American	59	62	59	62	5 13 3	Feb., May, Aug., Nov.	61¼	61
£3,088,640	Stock	30/0	Do. Preferred	110	111	109⅛	110⅛	5 9 10	„ „	110⅛	110
£3,088,640	Stock	27/0	Do. Deferred	11⅛	12	11	1[illegible]	11 14 9	„ „	11⅜	11⅛
$13,333,300	$100	$1½	Commercial Cable Capital Stock .....xd	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock .....xd	101	103	102	102	3 18 5	„ „	102½	..
16,000	10	6/0	Cuba Submarine Ordinary	6½	7½	6½	7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15	16	15	16	6 5 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference ...xd	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures .....xd	100⅞	104⅞	103⅞	104⅞	4 6 7	January and July.....	...	...
60,710	20	5/0	Direct United States Cable	10¾	11¼	10¾	11¼	6 4 5	Jan., Apr., July, Oct.	11⅛	...
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 0	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary	149	154	149	154	4 11 6	Jan., Apr., July, Oct.	152½	151
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	99	102	99	102	3 9 0	„ „	...	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	114	119	114	119	3 8 1	May and November ...	118¾	114
250,000	10	2/6	Eastern Extension.....	15	15⅛	15	15½	4 10 4	Jan., Apr., July, Oct.	15⅝	15
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	118	113	118	3 8 6	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 6	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	103⅞	103⅞	103⅞	103⅞	3 17 8	May and November ...	...	...
180,227	10	4/6	Globe Telegraph and Trust	10⅞	11¼	10¾	11¼	4 13 4	Jan., Apr., July, Oct.	11 1/16	10⅞
180,042	10	3/0	Do. 6 per Cent. Preference	14½	15½	15	15½	3 17 5	„ „	14⅞	14⅝
150,000	10	5/0	Great Northern of Copenhagen	32	34	31	35	3 11 5	January and July.....	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)..	98	101	93	101	4 9 1	June and December ...	...	...
17,000	25	37/6	Indo-European	49	53	49	53	4 14 4	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	103	106	103	106	5 13 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100	103	100	103	3 17 8	June and December ...	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126	131	123	131	4 13 5	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	98	101	93	101	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America	⅛	1	⅛	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	103	103	3 13 4	January and July.....	...	...
88,321	10	1/0	West India and Panama	¾	1	¾	1	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½	7½	6½	7½	8 0 0	„ „	6⅞	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference.....	6	7	6	7	8 11 6	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	103	4 13 6	January and July.....	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜	15½	14⅜	15½	4 11 10	Mar., June, Oct., Dec.	15½	14⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103	106	103	106	4 14 4	June and December ...	...	...
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2½	3½	2½	3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...		...		...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	½	½	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„ „	...	...
500,000	5	3/0	National	4½	4¾	4⅝	4⅝	6 9 9	February and August	4⅝	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	13	15	13	15	4 0 0	„ „	14	13 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	13	15	13	15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5	5½	5½	5⅝	4 13 0	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	93	101	97	10[illegible]	3 10 8	June and December ...	98¼	...
171,504	1	0/8	Oriental	⅞	1⅛	⅞	1⅛	4 8 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4⅜	5⅛	4⅜	5⅛	6 13 4	July	4 15/16	...
16,639	5	2/6	Do. 5% Cumulative Preference...	4⅜	5⅛	4⅜	5⅛	4 15 3	June and December ...	5 1/16	...
£1[illegible],947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	104	107	104	107	4 13 6	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 23.	Price Wednesday, Oct. 3.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 3. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜ ⅝	⅜ ⅝	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	12½ 13½	3 14 1	...	10⅜	10½
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	10 11	4 1 10	...	103	102¼
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red.)	100 103	100 103	4 7 5	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 6¾	6½ 6¾	...	...	...	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp.	9 10	9 10	4 12 6	February and August	9⅜	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6¾ 7¼	6¾ 7¼	4 0 0	March	...	...
†£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8½ 9¼	8½ 9¼	4 4 3	February and August	...	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12¾ 13¾	12¾ 13¾	4 9 0	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124 129	124 129	3 18 2	June and December	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½ 9½	8½ 9½	6 6 4	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11 12	11 12	5 0 0	March and September	1⅛	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1¾ 2⅛	1¾ 2⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½ 5⅛	4½ 5⅛	5 9 1	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	101½	101
85,000	10	6/0	Metropolitan Elec. Supply Ord.	12½ 13½	13 14	3 18 7	April and October	13⅜	13⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	111 114	3 18 11	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	97 100	3 10 7	...	9⅝	9⅛
6,452	10	6/0	Notting Hill Electric Ordinary	14½ 15½	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5⅜ 6⅜	5⅜ 6⅜	3 16 11	,,	...	...
300,000	1	1/6	Rand Electric	1/16 1/8	1/16 1/8	10 18 2	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures xd	104 107	103 105	4 5 9	,, ,,	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14½ 15½	15 16	4 10 8	February and August	15½	15
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	,, ,,	8 15/16	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 3	—	...	...
65,000	5	...	South London Electric Supply Ordinary	3 4	3 4	...	...	3⅜	...
79,900	5	5/0	Westminster Electric Supply Ordinary	11½ 12½	12 13	5 0 0	March and September	13⅛	12½
29,437	5	...	Do. Do.	8½ 9½	11 12	...	...	11¾	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	⅞ 1⅛	⅞ 1⅛	4 8 11	...	...	...
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅝ ¾	⅝ ¾	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅜ ½	⅜ ½	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅜ ½	⅜ ½	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅜ 6⅛	5⅜ 6⅛	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4½ 5½	4½ 5½	...	...	...	...
90,060	2	1/2½	Brush Electrical Engineering	1¾ 2	1¾ 2	6 0 0	September	...	...
15,731	2	...	Do. £1 paid	...	...	...	...	...	...
90,000	2	1/2⅜	Do. 5 per Cent. Pref. Non-Cum.	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2 5/16	...
15,731	2	...	Do. £1 paid	...	...	...	...	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	106 111	106 111	4 0 11	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	101 103	102 104	4 7 2	January and July	103	102¾
30,000	5	10/0	Callender's Cable Construction Ord.	12⅛ 13⅛	12⅛ 13⅛	5 11 1	,, ,,	13⅛	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 5⅛	5 5⅛	4 10 11	,, ,,	5 1/16	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	6 8 0	...	...	...
£160,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	100	99
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary xd	¾ 1	¾ 1	6 10 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference xd	¾ 1⅛	¾ 1⅛	5 6 8	...	...	...
54,000	3	2/4⅜	Crompton and Co. (Nos. 1 to 32,098)	3¾ 4¼	3¾ 4¼	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	1¾ 2¼	1¾ 2¼	8 0 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3¾ 4¼	3¾ 4¼	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	90 92	90 92	4 7 5	June and December	9⅜	...
£100,000	Stock	22/4⅜	Do. 5% 2nd Deb. Standing Prov. Certs (all pd)	68 72	93 100	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4¾ 5	4¾ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	100 103	100 103	4 8 0	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 6 8	January and July	2⅜	2⅛
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2¾ 3¼	2¾ 3¼	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	102 105	3 16 2	January and July	101	...
30,000	5	4/0	Henley's Telegraph Works Ordinary	12⅛ 13⅛	12⅛ 13⅛	5 11 1	February and August	...	...
30,000	5	2/3	Do. 4½ per Cent. Preference	5 5⅛	5 5⅛	4 1 10	,, ,,	5⅜	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	108 112	108 112	4 0 4	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	3 9 9	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) xd	90 102	90 102	3 18 5	March and September	100	...
37,350	12	12/0	Telegraph Construction and Maintenance	34 36	34 36	4 14 8	March and July	35	34½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11⅛	10½ 11⅛	5 4 4	...	10 11/16	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference xd	5½ 5¾	5 5⅛	4 10 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10⅜ 11⅛	10⅜ 11⅛	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7¼	6½ 7¼	4 2 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	4/0	Blackpool and Fleetwood Tramways	14 16	14 16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures xd	103 105	101 103	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	21½ 22½	21⅜ 22⅛	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10½ 11½	10⅜ 10⅞	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
13,600	10	5/0	British Columbia Electric Railway 5% Pref.	10 10½	10 10⅜	4 15 3	May and November	10 7/16	...
45,000	10	11/0	British Elec. Trac. Ord.	14 15	14 15	6 13 4	...	11⅜	...
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12⅜	12⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures xd	123 124	120 123	4 1 4	...	122	121⅜
£150,000	Stock	52/2	Do. Do. (Issued Feb. 5, 1900) xd	122 125	120 123	4 1 4	...	121	...
40,000	5	3/0	Buenos Ayres & Belgrano 6% "A" Cum. Pref. xd	4⅝ 5⅜	4¾ 5	6 0 0	...	4	...
27,500	5	...	Do. "B"	3¾ 4¼	3¾ 4¼	...	...	3 7/8	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104 107	104 107	4 14 8	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	96 99	96 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10 10⅛	10 10⅛	2 17 2	June and December	10⅛	10 3/16
£355,000	Stock	1½%	City and South London Railway Con. Ordinary	58 61	58 61	2 5 2	February and August	...	...
37,500	10	1/0 7/16	Do. (Nos. 22,501 to 60,000)	5 6	5 6	2 9 4	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	138 143	138 143	3 9 11	,, ,,	...	...
£200,000	Stock	5%	Do. (1898)	130 135	130 135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	20½ 21½	20½ 21½	3 12 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15	14½ 15	3 18 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9¾ 10½	9¾ 10½	4 17 7	May and November	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary	8 1/16 8 1/8	8⅝ 9	4 8 11	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13½	3 15 6	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	104 106	3 16 0	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¼ 3⅜	3¼ 3⅜	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	0/0	Do. 5 per Cent. Preference	10⅜ 10⅝	10½ 10¾	4 14 1	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅜ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	104 107	104 107	...	...	...	...
240,000	Stock	3%	Waterloo and City Ordinary	92 95	92 95	3 3 7	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,169. [No. 25. Vol. XLV.] FRIDAY, OCTOBER 12, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 80c., or 70pf.

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NOTES.

In another column will be found a translation of an important Paper by M. LEBLANC, read before the International Congress of Electricians, held recently in Paris. The Paper describes M. LEBLANC's method of compounding for both continuous and alternating-current machines, the chief advantage in the case of the former being that a machine with a very small air-gap, somewhat after the fashion of the carcass of an induction motor, can be employed; while in the case of the alternator the excellence of the compounding is the more noticeable feature. The method can be applied to alternators of the polar as well as what may be called the "induction" type (though the regulation with the latter type is the better of the two), and in outline it may be said to consist in the excitation of the alternator field by means of a special form of exciter which in turn is excited partly by a circuit in series with the alternator armature, and partly by a second circuit in shunt with that armature, the proportions being so arranged that the alternator gives a constant voltage with varying load and power factor. Machines constructed in accordance with this principle are now at work at the Paris Exhibition with more or less satisfactory results, though it can scarcely yet be said that sufficient experience has been gained to admit of prophecy as to the ultimate value of the method in practice. Descriptions of two of these machines have already appeared in our columns. The idea of compounding alternating-current machines is of course not a new one, and the author makes reference to the work of MM. BLONDEL and BOUCHEROT in this connection. We might further add that the General Electric Co., of America have manufactured similar machines, in which the compounding is effected by means of an exciter on the main shaft, through the armature of which currents from the alternator pass, and by their reaction upon the exciter fields vary the exciting voltage proportionately to the requirements of the alternator field. These machines are said to give excellent results. The success of M. LEBLANC's proposed continuous-current machines will depend chiefly upon whether or not they can be more economically built than machines of the ordinary bipolar or multipolar type, and here also we must wait for further experience to be gained.

A bold attempt towards an extension of facilities for municipal trading is about to be made by the Bradford Corporation. By a large majority, the Corporation has decided to apply next session for parliamentary powers to acquire a coal mine for the purpose of coal supply to their various undertakings. We shall be curious to see whether the new Conservative Parliament will offer any encouragement to novel proposals of this kind.

SHEFFIELD has had full opportunity to discover the disadvantages of a single-phase alternating current system for general supply purposes. A year ago, Mr. ROBERT HAMMOND, being consulted as to what had best be done, advised a change-over to continuous current in the central supply area, but the late Mr. JOHNSON, the resident engineer, thought that the expense of Mr. HAMMOND's scheme was too great, and recommended that in view of local conditions, of which Mr. HAMMOND could not have such an intimate knowledge as himself, it was preferable to forego all idea of a continuous-current system for the present. Mr. HAMMOND being asked to report on Mr. JOHNSON's report, explained at length that he was not convinced by Mr. JOHNSON's reasoning. Nothing definite in the way of modifying the present system was decided upon, however, and Mr. FEDDEN, who was appointed to succeed Mr. JOHNSON, in turn presented his report—the fourth of the series. We published an abstract of this

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document in our issue of September 7th, and commented on it. Its main recommendation is to retain the single-phase system and reduce the frequency from 100 ∿ per second to 50. This week we give in another column an epitome of the fifth report, in which Mr. HAMMOND announces himself to be in "entire accord" and "complete agreement" with Mr. FEDDEN, having on this occasion had "fuller data laid before him." It is encouraging to find a consulting engineer with such an open mind, but notwithstanding this the play is hardly concluded yet. Mr. FEDDEN is visiting Paris, Frankfort, and Nuremberg with a view to gaining still further knowledge for the benefit of his Corporation, and, when he returns, no doubt the sixth report on the question will be presented. But what if in a seventh report Mr. HAMMOND is no longer in entire accord and complete agreement with Mr. FEDDEN? With its great caution and anxiety to do exactly the most correct thing with regard to electric lighting, it is surprising that the Sheffield Corporation ever made up its mind to buy out the old company.

A YEAR of unexampled prosperity in New Zealand has operated beneficially upon the finances of the Telegraph Department of that colony. According to the annual report of the Telegraph Commissioner for the year ended March 31st last, the increase of revenue from the combined telegraph and telephone services amounted to no less than 13·13 per cent. over the previous year, which itself exceeded the year 1897 by 4·73 per cent. Like the same services in the mother country, and in some other of the colonies, the telegraph and telephone of New Zealand are still worked at a loss—but a loss which shows signs of gradual conversion into a profit. On the telegraphs the balance of expenditure over revenue is about £17,000; on the telephone service a little over £8,000. Considering the comparative newness of both services, and the adverse tariff with which the telegraph was handicapped prior to 1896, their present position and prospects may be regarded as fairly satisfactory. We should be glad to see its differential element removed out of the tariff altogether—the so-called "urgent" telegrams bearing no sort of proportion to the "ordinary" either in number or in their tendency to grow. The department, we are sorry to notice, has suffered severely during the past year from mortality among its principal officers, foremost of these being Mr. E. H. BOLD, Inspector of Telegraphs, and Mr. W. C. SMYTHE, electrician.

Appointment.—It is announced that the First Commissioner of Works has appointed Mr. W. H. Massey to be consulting electrical engineer to Her Majesty's office of works for the Royal Palaces and public buildings in charge of that department.

The Galveston Disaster.—The damage caused to the shore ends of the cables and to the land telegraph lines by the terrible hurricane which visited Galveston, U.S.A., on the 10th ult., has now been repaired, and we are able to announce the complete restoration of telegraphic communication via Galveston with Mexico and Central and South America.

Institution of Electrical Engineers.—The first meeting of the new session of the Institution of Electrical Engineers will be held in the rooms of the Institution of Civil Engineers at 8 p.m. on Thursday, November 8th, when the premiums for the session 1899-1900 will be presented, and the president, Prof. John Perry, F.R.S., will deliver his inaugural address.

The Chifu-Tsin-tau Cable.—Reuter states that the cable between Chifu and Tsin-tau, laid for account of the German Government, was opened for the transmission of messages on the 5th inst. The territory of Kiao-Chau is thus joined to the international cable system of the Eastern Extension and Great Northern Companies. No change is made in the tariff.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Zanzibar—Mombasa	Sept. 20, 1900
Paramaribo—Cayenne	Oct. 6, 1900

The "Twopenny Tube."—In our last issue we referred to the failures predicted for the Central London Railway. The following amusing explanation of its success appears in an American contemporary:—

> The great success of the Central London is just waking things up. The line has an advertising agent that is a corker. He succeeds in getting an article into each of the daily papers every day, and besides this he has an editorial about once a week; then he has a topical song in each music hall every night. The consequence is that the "Twopenny Tube" is the talk of the town and its receipts are beyond expectation.

Electrical Progress in Corea.—*Engineering* states that an electric railway, under the management of an American company, is now open at Söel, and is doing fairly well, although some of the natives view the "spirit" which works it with apprehension, and sometimes make attempts to destroy the plant. Various other developments in the applications of electricity are taking place, and now Söel has the largest electric plant in the Far East, with the exception of that of Tokio. On June 4 it was officially announced that a telegraphic service between the Fusan and Chemulpo post offices on the one side and various places in China, via Söel and Wijn on the other, had been opened. The fee for the service within the limits of Corea is fixed at 20 sen (about 10d.) per word, while that between Corea and China is 62 sen per word.

University of London.—A general meeting of Convocation was held on Tuesday, at South Kensington, to appoint members of the Senate of the reconstituted University of London. Before proceeding to the election a resolution of condolence with Her Majesty the Queen on the occasion of the death of the Duke of Saxe-Cobourg and Gotha was passed. Among the persons nominated for election by the registered graduates in art are Mr J. Fletcher Moulton, M.A., and Sir Albert K. Rollit, LL.D., B.A.; and the following is the result of the election by the registered graduates in science. The figures following the names indicate the number of votes in each case:—

Elected.—Sir Philip Magnus, B.A., B.Sc. (432); Sophia Bryant, D.Sc. (429); Charles William Kimmins, D.Sc. (364); Frank Clowes, D.Sc. (333); Silvanus Phillips Thompson, D.Sc., B.A. (239); Francis Sowerby Macaulay, D.Sc. (226). *Not elected.*—Sydney Russell Wells, M.D., B.Sc. (223); Sydney Howard Vines, D.Sc. (219); George Carey Foster, B.A. (213); Robert Davies Roberts, D.Sc. (147); Charles Henry Draper, D.Sc., B.A. (142).

Central Technical College Old Students' Association.—The Old Students' Association of the Central Technical College held its third annual dinner on Tuesday, October 2nd, in London, Prof. O. Henrici, President of the College and Dean of the Association, being in the chair. The speakers were the Chairman, Prof. W. E. Ayrton, Prof. W. C. Unwin, Messrs. O'Gorman, Armstrong and Ackermann, and Sir A. R. Binnie, who was the guest of the evening. This Association is not the first Old Students' Association that has been formed in connection with the Central Technical College. An Old Students' Association of students of both the Finsbury Technical College and the Central Technical College (then the Central Institution), flourished for several years, and in addition to purely social functions some excellent Papers were read and discussed at its meetings. Unfortunately the Association died a natural death several years ago. The present Old Students' Association of the Central Technical College has now been in existence for three or four years, and it is to be hoped that it will be a permanent one. It is to be regretted, however, that its membership should be chiefly confined to men who were students at the

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college only a few years ago. There are many old students from the earlier days of the Central Institution who hardly know of the existence of the new Association, but who, we are convinced, would gladly join it with a view to renewing acquaintance with some of their former comrades. The name and address of the hon. secretary of the Association is Mr. Maurice Solomon, 12, Edith-road, West Kensington, London, W.

Trials of Electric Motor Cars.—The Automobile Club announces a series of trials of electric vehicles to be held from Monday, November 5th to Friday, November 9th. The following are the preliminary programme and conditions:—

1. Vehicles must be entered on or before Friday, November 2nd. The entry fee is two guineas per vehicle per trial. Forms of entry may be obtained after Friday next, October 12th, on application to the Secretary, Automobile Club, 4, Whitehall-court, London, S.W.

2. Vehicles entered may be subjected to the following trials:—

Monday, November 5th.—A run over a given course for an unlimited distance on one charge, the driver to declare to the observer when the run is to be considered as finished.

Tuesday, November 6th.—A course of 30 miles, to include considerable gradients.

Wednesday, November 7th.—A course of 30 miles of average road.

Thursday, November 8th.—A course of 30 miles of flat or nearly flat road.

3. Vehicles may be entered on or before Friday, November 2nd, for an additional optional trial, viz., on Friday, November 9th, as follows: A run over a given course for an unlimited distance on one charge, the driver to declare to the observer when the run is to be considered as finished.

4. The same batteries will be used throughout, and during the course of the trials will be under the supervision of the Club. Competitors are responsible for the supervision of the charging of their batteries.

5. The energy consumed, number of passengers carried and average speed attained, will be recorded on certificates which will be granted by the Club to competitors, but no speed in excess of the legal limit of 12 miles per hour will be recorded or recognised. Competitors must supply drivers for their vehicles, and must provide on each vehicle a seat for an official observer. The routes on which the trials will take place will be within 50 miles of London, but will not be made known to competitors until immediately before the trials. Competitors are required to fit to their vehicles reliable and accurate voltmeters and ammeters which can be read during the trials by the observers, and these meters must be fitted with terminals by means of which they may be tested by the judges. In entering vehicles, competitors are requested to kindly supply, for the information of the judges only, a diagram of the electrical connections of each vehicle. A competitor, by entering a vehicle, thereby agrees to be bound by the rules and decisions of the Judges' Committee in all matters, and the Judges' Committee reserves to itself the right to amend the rules affecting the trials.

Electric Lighting Provisional Orders.—In the Board of Trade return respecting the applications for provisional orders under the Electric Lighting Acts, 1882-1890, it is stated that during last Session 108 applications were made (59 by local authorities and 49 by companies). A full list appeared in our issue of January 5th last. Only nine of these applications were refused, but some of the orders were only granted with modifications. Thus the Liverpool District Lighting Co. were successful in regard to Allerton, Much Woolton, Little Woolton and Childwall, Garston being excluded. The application of the Urban Electric Supply Co. for Bridge of Allan and Dumblane was only granted for the latter district, as the Board refused to include two non-contiguous areas in one order. The Cheltenham Town Council obtained an order for Charlton Kings, but failed to obtain the consent of the Cheltenham and Winchcombe rural districts. The County of Durham Electrical Power Distribution Co. having failed to produce the sanction of the Chester-le-Street (Seaham Harbour) District Council, their application was refused. This company was successful in regard to Jarrow, but the Hebburn and Felling districts were excluded, the local authority of the latter district having withheld its consent, and the Hebburn Council having itself made application for an order. On the other hand, the Freshwater and Totland (I.W.) Electricity Supply Co. had obtained conditional consent to their application, and after inquiry the Board of Trade decided to dispense with the sanction of the local authority, and granted the order. The County of London Company obtained their order for Battersea, the consent of the Vestry having been dispensed with. The Lambeth application failed, as the promoters were unable to obtain the sanction of the Vestry. An inquiry was held into the application of the Marylebone Electric Supply Co. for an order for Marylebone (London), and the Board of Trade decided in favour of the application, but our readers will remember that the confirmatory bill was rejected on the second reading in the House of Commons. There were two applications for Ramsgate, but preference was given to that of the Corporation, the Isle of Thanet Electric Tramways and Lighting Co.'s application being refused. The Midland Electric Corporation for Power Distribution obtained powers for Upper Penn (Seisdon) and Bushbury (Cannock). The application of the Midland Electric Light and Power Co. for Leamington was opposed by the Town Council, but the Board of Trade decided to dispense with the consent of the Council, and granted the order, subject to its not coming into force until the local authority had made default in putting into operation the order obtained by them in 1899. This has, we understand, taken place, and the company's order has come into force. The Southwold Corporation also failed in their application for a provisional order because "they failed to satisfy the Board of Trade that they were in a position financially to give effect to the order if granted." The Electrical Power Distribution Co. were opposed by the Councils of Neath, Briton Ferry and Aberavon, and consequently the application for these districts was rejected. The same company at Staines, Chertsey, and Egham had won over the local authorities of the two former districts, and the Board of Trade decided to dispense with the consent of the Egham Council and granted the order. The Richmond (Surrey) Electric Light and Power Co. did not proceed with their application for Twickenham and Teddington, and the Twickenham and Teddington Electric Supply Co. succeeded in their application for Twickenham, the Teddington local authority dissenting from the application. The Uxbridge and District Development Syndicate obtained an order for Uxbridge, Hillingdon East, Ickenham, Cowley, Hayes, and Denham. There were no applications for licences during the past year, but the following transfers of orders were effected:—

Audenshaw (1899), Droylsden (1897) and Heaton Norris (1899) to Manchester Corporation; Barnet (1893) and Hertford (1891) to North Metropolitan Electrical Power Distribution Co; Carshalton (1898) and Sutton (1892) to County of Surrey Electrical Power Distribution Co.; Gateshead (1899) to County of Durham Electrical Power Distribution Co.; Godalming (1896) to Urban Electric Supply Co.; Lewes (1898) to County of Sussex Electrical Power Distribution Co.; Margate (1896) to Isle of Thanet Electric Tramways and Lighting Co.; Weston-super-Mare (1891) to Weston-super-Mare District Electric Supply Co.; and Whiston (1898) to British Insulated Wire Co.

From 1883 to date the Board of Trade have dealt with 758 applications for orders, and of these 547 were granted and 541 were confirmed by Parliament. Of the 32 licences granted since 1883 only one, that of the Ingleton Electric Lighting and Power Co. (granted in 1899), is now in force. 111 provisional orders have also been revoked or repealed, but we would like to direct attention to a few of the instances in which local authorities have been in possession of orders for years, but have done nothing to put their provisions into force. Newbury Town Council obtained an order so far back as 1892, Clonmel (Ireland) Town Council and Yeadon District Council in 1894, Swindon New Town District Council in 1895, Kettering District Council in 1896, and Wells Corporation in 1896. It would be interesting to know how these orders have so long escaped revocation by the Board of Trade. Another glaring case is that of Dorking, where the Urban District Council obtained a provisional order in 1897, and actually decided to shelve it for five years, refusing subsequently (in June, 1899) an offer of the Electrical Power Distribution Co. to purchase the order.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

FRIDAY, October 12th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. First Smoking Concert, at St. James's Hall Restaurant.

WEDNESDAY, October 17th.

ROYAL MICROSCOPICAL SOCIETY.

7:30 p.m. Meeting at 20, Hanover-square, W.

FRIDAY, October 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. First General Meeting of the Session. Paper to be read and discussed: "Observations on an Improved Glass Revealer for Studying Condensation in Steam Engine Cylinders, and Rendering the Effects Visible," by Bryan Donkin.

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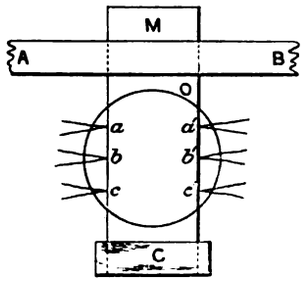
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Thermo-magnetic Phenomena.—When a thin metallic plate is placed in a strong magnetic field perpendicular to the lines of force, there are four electro-thermal phenomena which have been successively discovered by Hall, von Ettinghausen, Nernst, and Leduc. An electric current traversing the plate from one edge to the other produces a difference of potential and a difference of temperature at the other two edges. A current of heat produces the same two effects. All these phenomena are well developed in bismuth, while in the other metals only the Hall effect and the Nernst effect are evident. G. Moreau now shows that these two effects are in reality identical, by proving that the one follows from the other, and that their coefficients are of the same order and sign. The theoretical conection between the two phenomena is traced by means of Kelvin's specific heat of electricity σ, and the relation between the coefficient K of the Nernst effect and the coefficient c of the Hall effect is given by the formula $K=\frac{\sigma c}{\rho}$, where ρ is the resistivity of the metal. The author's experiments were conducted with the device shown in the diagram, where M is the plate under investigation. The current—electric or thermal—is conveyed through the copper bar AB into M, and out by the mercury bath C. A, B and C act either as electric terminals or as heat channels. The temperature gradient is determined by the thermo-couples *abc*, *a'b'c'*, situated within the circle O of uniform magnetic field intensity, and the distribution of potential is found by using one wire out of every thermo-couple. Thus the thermal and electric conditions are completely known. The author shows that in steel, iron, cobalt and nickel, the Hall and Nernst effects are both proportional to



the magnetisation of the plate, and their reversal occurs at about the same temperature. The above formula is verified to within 8 per cent., but certain irregularities observed in the case of nickel lead to its amplification in the sense that the Nernst effect is a Hall effect with respect to Thomson's "true contact E.M.F."

[G. Moreau, *Journ. de Physique*, Sept., 1900.]

Platinum Resistance Thermometer.—H. M. Tory has carried out an investigation, suggested by Callendar, with a view to determining the probable order of accuracy in the determination of high temperatures attainable by the use of ordinary commercial specimens of platinum wire. Five wires in all were compared over the range of 400°C. to 1,000°C. The fundamental temperature coefficients of the resistances varied from 0·003892 to 0·002340, *i.e.*, by 40 per cent. of the maximum value. It was found, however, that the extreme variations of the temperatures observed, when calculated on the platinum scale by the formula $pt=100\,(R-R_0)/(R_1-R_0)$, in which R, R_1, and R_0 stand for the observed resistance at the temperatures *pt*, 100deg. and 0deg. respectively, did not in any case exceed 9deg. at 1,000°C., or were less than 1 per cent. on the interval at any point of the rate of observation, in spite of the larger differences in the samples. It is probable that the platinum wires used were free from contamination with baser metals outside the platinum group. Wire-drawing produced no effect if the annealing was carefully carried out subsequently. In all cases, the wires with the smallest temperature coefficients had the largest specific resistance, and usually gave the lowest platinum temperatures.

[H. M. Tory, *Phil. Mag.*, October, 1900.]

THE ACTION OF WATER UPON INDIA-RUBBER.

BY HUBERT L. TERRY, F.I.C.

Water does not percolate through rubber with any great rapidity, but that it does pass through it to an appreciable extent, and at ordinary atmospheric pressure, was demonstrated a great many years ago by Thomas Hancock, quite the most astute and laborious worker the field of india-rubber has known. To quote Hancock's own words, "I suspected rubber was not entirely impervious to water, and I had the curiosity to make a bag of canvas lined with sheet rubber, which I filled with water and sealed hermetically." The result of this test is shown in the following series of figures:

		lb.	oz.	dr.
The weight on Oct. 21, 1826 was	.....	1	1	4
Ditto Oct. 25, 1827	.....	1	1	2
Ditto Oct. 2, 1835	.....	1	0	0
Ditto Nov. 1844	.....		14	12
Ditto Oct. 1849	....		13	4
Ditto Feb. 1851	.....		7	8
Ditto May 1854	....		3	14

Two years later the bag, when cut open, was found to be quite dry, showing that the whole of the water, rather more than 12oz., had escaped in the 30 years which had elapsed since the bag was filled. It is not every experimenter of the present day who has the patience to wait 30 years for his results, and although many experiments dealing with the absorption of water by rubber have been conducted at various times I do not know of any published results which cover so much time and which are so conclusive as those published by Hancock. A point, however, which must not be overlooked is the fact that the above figures relate to pure or unvulcanised rubber, a body which can be shown by means of the microscope to contain innumerable minute pores. With vulcanised rubber the case is quite different, and this product at ordinary pressures may be considered as almost impervious to water unless it is extremely attenuated, although I am unable, in support of this statement, to give any figures corresponding in value to those of Hancock as far as extended observation is concerned.

Reference has been made to the facts that Hancock's experiment with pure rubber was conducted at the ordinary pressure of the air, and that the impermeability of vulcanised rubber relates also to ordinary pressures. That increased pressures tend to increase the amount of water which rubber will absorb may be considered as proved. With regard to the action of water upon pure rubber under pressure, it may be mentioned that quite recently experiments in relation to this subject have been carried out at the Charlottenburg testing laboratory at Berlin, and as one result it was shown that the same amount of water absorbed in two hours at ordinary pressures was taken up in 5min. when the pressure was raised to 8 atmospheres. With regard to the exact amount of water taken up by rubber at ordinary pressures the figures given by different observers show considerable variation, but this may probably be accounted for by the fact of the thickness of the rubber sheet not being identical in each case. The Charlottenburg authorities give 8 per cent. to 35 per cent., though why the range should be so extensive is not easily apparent. Dr. Obach has given 24 per cent. as the absorption of water in four months, and although I can endorse this figure I have obtained such varying results with rubber of different composition, and have found that so much depends upon the details of the experiments, that I am disinclined to give any definite figure myself until I am in a position to treat of the matter in detail. An important point in connection with such tests is to see that the surface of the rubber is clean, that is, that it is free from the various chemicals which the manufacturers apply to the surface to destroy the tendency of the rubber to adhere when it is rolled up. The exact nature of the treatment to which the rubber is subjected by the different manufacturers to effect this end comes under the category of trade secrets, and need not be entered into here, but it is right that the fact should be mentioned, and it is also advisable to say that the processes adopted by the different manufacturers are not identical. From what has been said it will be seen that the sheet rubber employed in

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one case may have had its tendency to absorb water affected to a greater degree than in other cases, and this I venture to suggest may account to some extent for the discrepancies noticeable in the figures given by various observers in regard to the exact amount of water which such rubber is capable of absorbing at ordinary pressures.

If any further proof is wanted about this absorption we have the evidence which is derived from the washing and drying of the crude rubber in the works. The rubber, which is washed on fluted rollers, is hung up in the form of sheets in stoves maintained at a temperature of about 100°F. The drying process may take four or five days for completion, though over 90 per cent. of the water which is present is removed in a few hours, especially if a current of air circulates in the stove. It is the last few per cent. of water which is so difficult of removal, and it is not at all improbable that this is fixed in some sort of way, chemical or physical, in the pores of the rubber. The thinner the sheet of rubber is, the quicker does the removal of this last few per cent. of water take place, though where the amount of material to be dried is large, the cubic drying space available in a works is not always sufficient to allow of the production of very thin sheets.

To turn now more particularly to the action of water upon rubber it may be asked whether this is entirely physical or if it induces any chemical change in the material. As far as we know with any certainty the change can only be described as a physical one, the effects being increase of bulk and diminution of adhesiveness and tenacity. In driving off the water by heat the rubber apparently suffers some injury, rendering it more prone to decay, but this, it is at once seen, cannot fairly be described as the effect of the water alone. When pure rubber is allowed to stand in water for any length of time it certainly undergoes some kind of decomposition, though I am not aware that the precise nature of the change has been shown. Of course the uses of pure rubber are very limited compared with those to which the vulcanised product is put, and in the case of its principal application for cable purposes—I refer to the layer of sheet usually lapped as a first coating round the wire—it cannot be said that the question of the absorption of water is likely to come into prominence. There may be cases, however, where unvulcanised rubber forms the bulk of the insulation, and I am reminded of some cables for mining explosion purposes which I saw at the exhibit of MM. Geoffry and Delore at the Paris Exhibition, and which were described as being insulated with "natural rubber." This term is usually taken to mean raw rubber which has not undergone any of the processes of mastication, solution or vulcanisation, but in this case presumably means the masticated product referred to in this country as "pure indiarubber."

Although, as has already been stated, the absorption of water by vulcanised rubber is infinitesimal compared with pure rubber, yet figures given by Payen many years ago show that this absorption does take place to some extent, and the fact cannot be ignored by those who propose to put vulcanised rubber cables in water. In this connection it may be said that Mr. Kilgour, in his book on "Electrical Distribution," states that Messrs. Johnson and Phillips believe that the only other system of cable which could compare on the score of efficiency and permanency with the Brooks' oil system is that in which the cables highly insulated with vulcanised rubber or gutta-percha are drawn into iron pipes kept full of water. This no doubt is all right as regards gutta-percha, which remains unaltered under water, but there seems to me to be room for doubt as to the permanency of the rubber cable when laid in this way; at any rate, it seems quite legitimate to prophesy trouble within the limits of infinity, which the term "permanent" rather suggests.

With regard to the important issue of the action of water on deep-sea vulcanised-rubber cables, there seems to be a considerable difference of opinion, and it may be that the idea that rubber is quite unsuitable for this purpose originated in the fact that some of the earlier rubber cables proved unsatisfactory. Perhaps opponents of rubber for this purpose have not paid sufficient attention to the results which have been obtained by improvements in the rubber insulation. Messrs. Hooper recently wrote to the *Indiarubber Journal*, in reply to an article reflecting on the use of rubber for deep-sea work, stating that a vulcanised-rubber cable laid by them 25 years ago in 2,000 fathoms of water is now in perfect condition. The passage of arms which has taken place between Mr. Oscar Schafer in *The Electrician* and Mr. Ira Henry in the *Indiarubber World* has relation more to the probable longevity of the seamless insulation than to any defect which is likely to arise from porosity. But from the fact that the United States Government has recently given an order to the Safety Insulated Wire and Cable Co. of New York, to which firm I understand Mr. Henry belongs, for 400 miles of rubber insulated cable for deep sea purposes, it would seem that the question of porosity is not one that need be seriously considered. In face, then, of what has just been said it would seem that the opponents of rubber insulation from the porosity point of view had perhaps better reconsider their position, which recent experience goes a long way to prove is somewhat untenable. Of course, in referring to the action of water upon rubber it is always necessary to be explicit as to the nature of the rubber, whether highly compounded or not, because the composition of the rubber may have a profound influence in determining its capacity for absorption.

THE PARIS EXHIBITION.—IX.*

(BY OUR SPECIAL CORRESPONDENT.)

Several other countries besides Great Britain, France, and Germany exhibit generating machinery, and, as will have been noticed in the table given in my second article, furnish electrical energy for the light and power supply of the exhibition. The Swiss firms in particular have some fine sets, and the eminent firm of engine makers, Messrs. Sulzer & Co., have been to them somewhat the same as the Augsburg-Nuremberg Co. to the German dynamo firms. Fig. 53 is a general view of the Sulzer exhibit. To the right-hand side is a 1,700 H.P. four-cylinder triple expansion engine, driving a Brown-Boveri alternator, and to the left a 750 H.P. tandem engine coupled to a Rieter flywheel dynamo. The four-cylinder engine is shown in greater detail in Fig. 54, and has the following main dimensions:—

Diameter of H P. cylinder	600mm.
Ditto I.P. ,,	850mm.
Ditto each L.P. cylinder	1,025mm.
Stroke	1,500mm.
Speed	85 revs. per min.
Steam pressure	11 atmos.
Normal output at 30 per cent. cut-off on H.P. cylinder	1,700 I.H.P. = 1,500 E.H.P.
Maximum output at 40 per cent. cut-off on H.P. cylinder	1,950 I.H.P. = 1,750 E.H.P.

The illustration gives a good view of the valve gear, which is of Messrs. Sulzer's usual design, with four-seated valves, the regulator acting on the cut-off of the H.P. cylinder, and the cut-offs of the other cylinder being adjustable by hand. The Brown-Boveri alternator likewise follows the usual lines adopted by its makers. It is designed for 1,000 volts, three-phase current at 42·6 ∽ per second.

Fig. 56 shows a vertical twin tandem engine, driving an Oerlikon 2,200 volts inductor alternator. This develops 350 E.H.P. at 250 revs. per min. Its cylinder diameters are 280mm. and 450mm. with a 400mm. stroke. With 11 atmospheres pressure and at a cut-off of 25 per cent. its output is 385 I.H.P. or 350 E.H.P., and at 45 per cent. cut-off it can furnish 515 I.H.P. or 475 E.H.P. A feature of the engine is the single valve gear for each pair of cylinders. The Oerlikon single-phase alternator coupled to this machine is, as already mentioned, of the inductor type, the stationary field winding being a flat coil of copper ribbon placed between the two sides of the armature winding. The exciter is placed on an extension of the bedplate and is coupled to the main shaft at the end not seen in the illustration. Another similar machine of the inductor type standing near to this one has an

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, September 14 and 28, and October 5.

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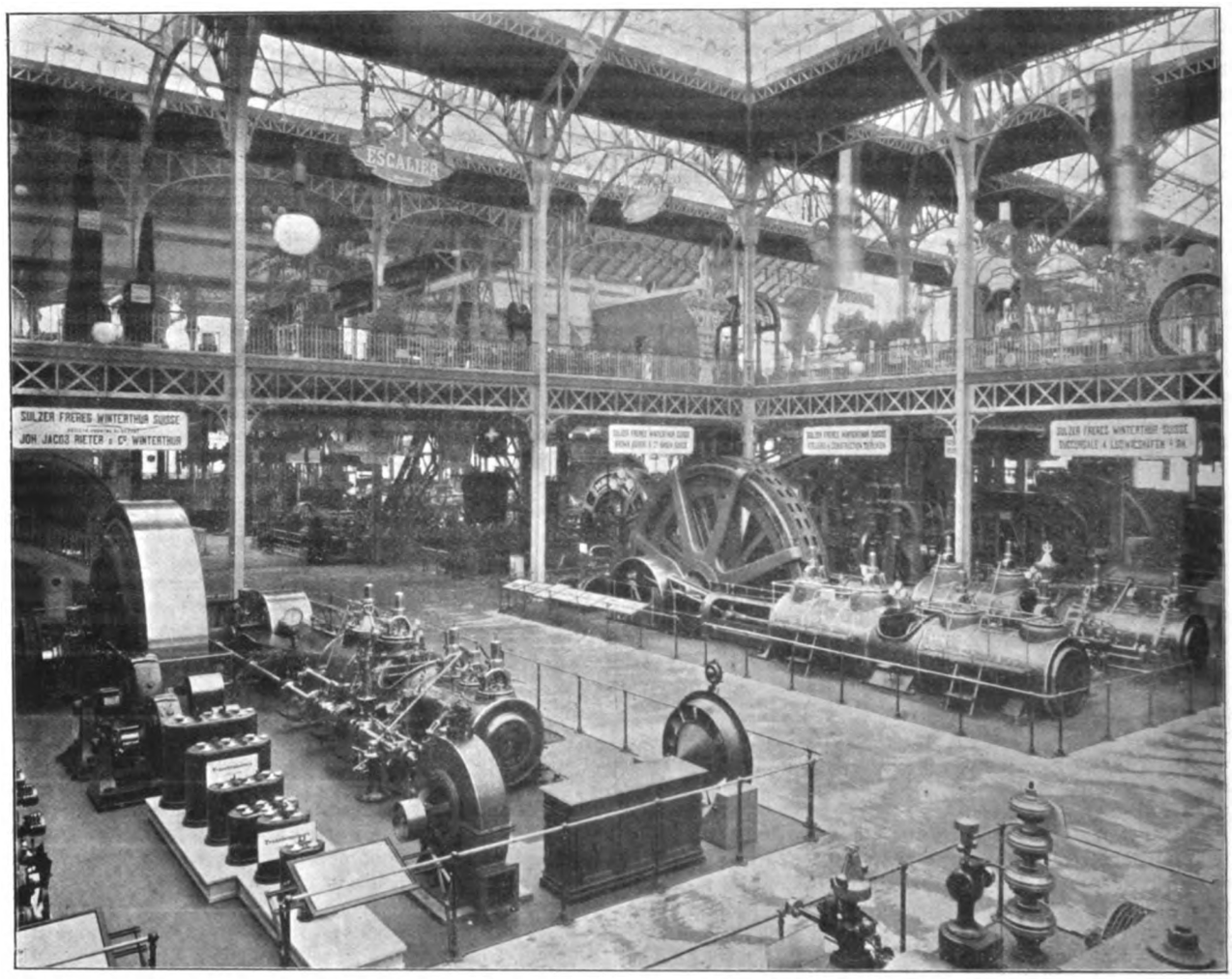

FIG. 53.—GENERAL VIEW OF SULZER EXHIBIT.

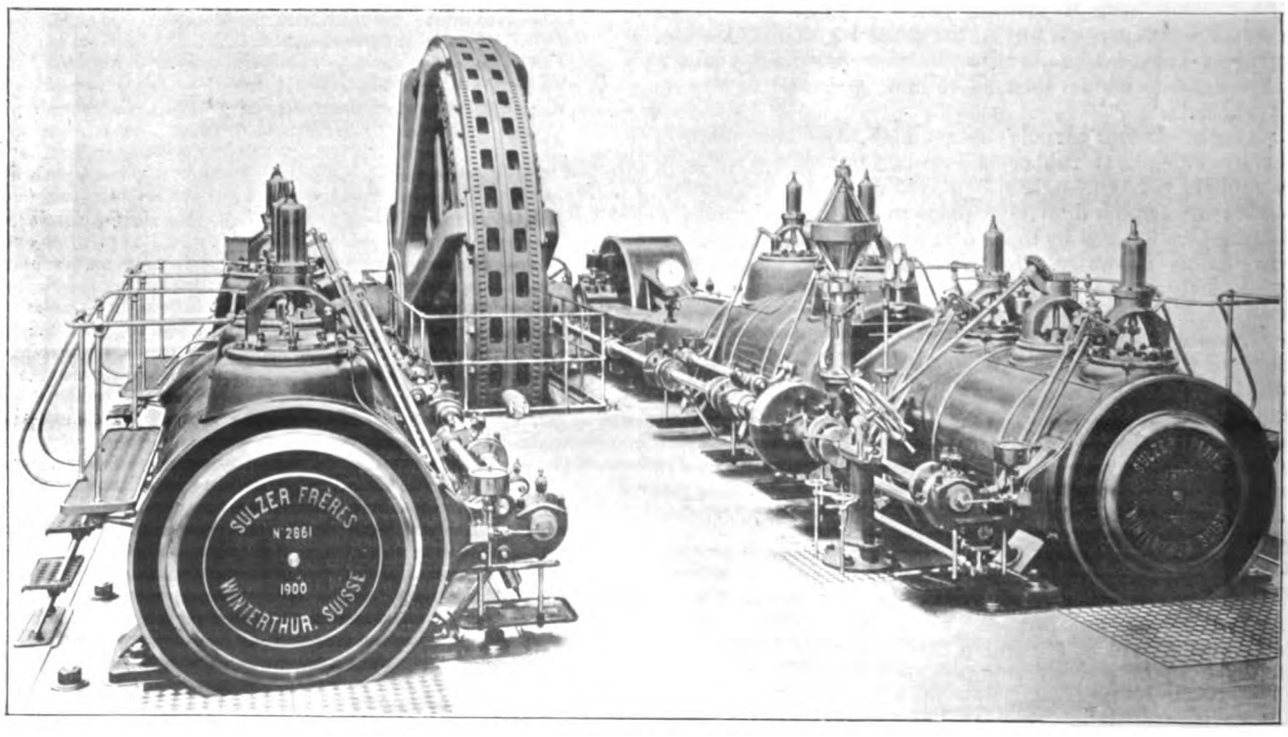

FIG. 54.—SULZER 1,700 H.P. ENGINE AND BROWN BOVERI ALTERNATOR.

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output of 650kw. at 8,000 volts, with a speed of 250 revs. per min., and a frequency of 50 ∽ per sec.

The large machine in Fig. 55 is a 5,500-volt, 1,800 kilovolt-ampere three-phase Oerlikon dynamo driven by an Escher-Wyss engine at 94 revs. per min. It furnishes only about 1,000 kilovolt-amperes single-phase at 2,200 volts, by swallow-tailed keys held by bolts, so that the bolts need only be loosened to remove a pole-piece and its coil. The exciter is a 12-polar ring-wound machine, mounted on the same shaft as the alternator, as seen in Fig. 55, and on account of the slow speed the commutator is of large diameter and has many sections. An exciting current of 80 amperes

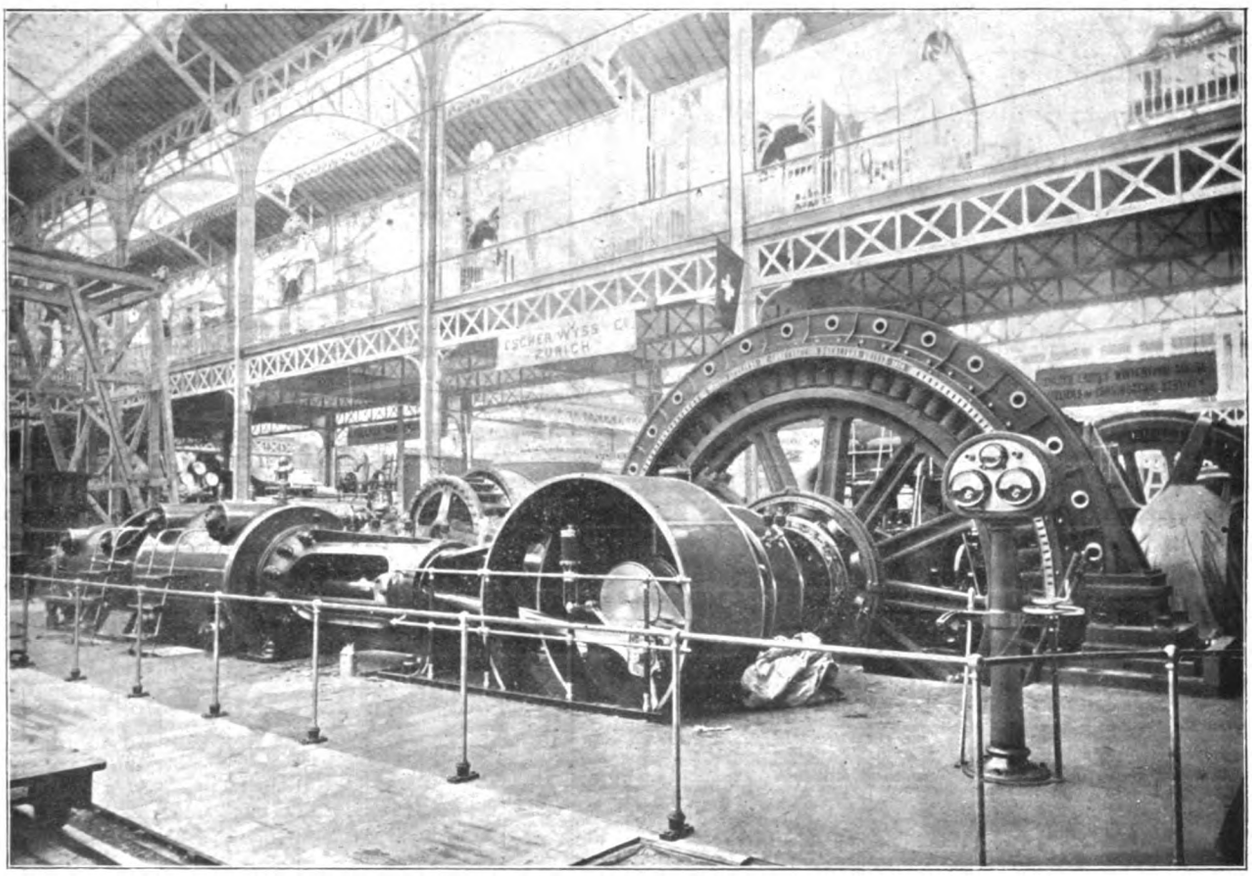

FIG. 55.—ESCHER-WYSS–OERLIKON ALTERNATOR.

however, for the light and power service of the exhibition, the winding of the armature being disposed in parallel to permit of this arrangement. The slots in the armature, which is stationary, are open, and the coils are wound first

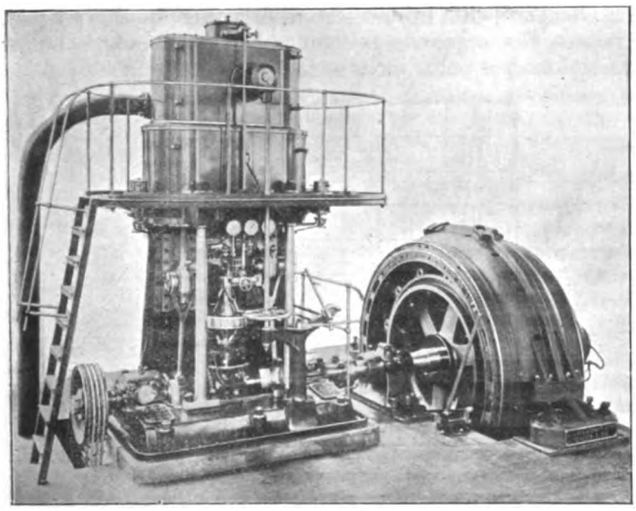

FIG. 56.—SULZER-OERLIKON INDUCTOR ALTERNATOR.

and then slipped in position and held by fibre wedges. As usual, the armature casting is also supported below, as well as on the bed-plate of the dynamo, and on the latter are adjusting screws to permit of exact centreing. The flywheel magnet has 64 poles with laminated cores held in place to 90 amperes at about 100 volts is required. The adjustment of the voltage of the alternator is effected by varying the resistance in the field circuit and in the shunt of the exciter, and following a usual practice on the Continent, the handwheels for making these two adjustments are concentric.

The engine is a tandem Corliss one, with 650mm. and 1,100mm. cylinders and 1,200mm. stroke. The crank-shaft bearings are 400mm. diameter and 750mm. long. A feature is a water cooling arrangement for the crosshead guides. Both cylinders are jacketed, the H.P. cylinder with live steam and the L.P. cylinder with steam from the receiver. Each of the four Corliss valves is driven by an independent eccentric. The ordinary arrangement is adopted of a fixed cut-off, adjustable, however, by hand, on the L.P. cylinder, and a cut-off on the H.P. cylinder regulated by the governor. The latter is of the spring type, and is provided with a speeding gear, by means of which the speed of the engine can be adjusted while the engine is running.

A quaint little barring engine is employed for this engine. It possesses three single-acting cylinders, the cylinders themselves being disposed radially to the crank shaft 120deg. apart. The diameter of each of these cylinders is 110mm., with 100mm. stroke, and the engine runs at 800 revs. per min.

Messrs. Rieter & Co. have a fine exhibit, which includes electrical as well as hydraulic and general engineering apparatus. A three-phase alternator shown by this firm has the stationary armature within instead of external to the field magnets, the latter being a series of poles radiating inwards from the periphery of the rotating wheel. In order to rotate the armature, for inspection and repairs, the latter can be fixed to the field magnet by means of wedges, and rotated with it. An interest-

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ing little detail of this machine is the washers employed to keep the field magnet bolts tight. These have a small indentation in them as sketched in Fig. 57, which coincides with a small hole beneath, and after the nut is screwed up one side of the washer is turned up against one face of the nut. This effectually prevents the bolts from working loose. The Alioth Co., and their French house, the Société des Applications Industrielles, also exhibit some

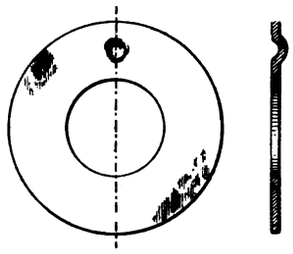

FIG. 57.—WASHER EMPLOYED ON THE RIETER ALTERNATOR.

machinery and apparatus, especially in connection with the sub-stations and moving platform, which will be referred to later.

THE SO-CALLED "SKIN EFFECT," OR THE INCREASED RESISTANCE OF IRON WIRES TO ALERNATING CURRENTS.

BY B. HOPPS.

So few data have been published on this subject that the following results and curves may be of some interest. It is a well-known fact* that the resistance offered by an iron rod or strip to alternating currents depends not only on its length, cross-section, and its temperature, but also on the frequency of the current and the magnetic properties of the iron. It is found that the resistance increases the higher the frequency and the greater the permeability of the iron. This increase is more especially marked in the case of wire or rod of circular cross-section.

The following are results of tests made on straight lengths of iron wires and rods of ordinary commercial value, and to ensure a fair average special care was taken to obtain them from various manufacturers. An observed current was passed through the rod, the volts drop due to a known length being measured by means of a low-reading hot-wire voltmeter:—

Dia. of rod in inches.	Length between volt leads in inches.	Amps.	Volts drop.	Cycles per sec.	Apparent resistance in ohms.	True resistance in ohms.	Mic'hms per cubic in.
0·975	156	91·2	1·15	45	0·0126	...	60·25
,,	,,	96·0	1·39	67	0·0145	...	69·4
,,	,,	91·4	1·69	102	0·0185	...	88·5
,,	,,	14·3	0·0163	0	...	0·00114	5·45
0·77	120	96·0	1·09	44	0·0114	...	44·2
,,	,,	97·8	1·30	64	0·0132	...	51·2
,,	,,	96·9	1·56	100	0·0161	...	62·4
,,	,,	23·6	0·0325	0	...	0·00138	5·35
0·505	120	70·5	1·12	45	0·0159	...	26·5
,,	,,	76·4	1·40	60	0·0183	...	30·5
,,	,,	63·5	1·51	100	0·0238	...	39·7
,,	,,	20·6	0·0775	0	...	0·00376	6·27
0·390	132	63·5	1·39	45	0·0219	...	19·8
,,	,,	51·8	1·46	66	0·0282	...	25·5
,,	,,	55·5	1·88	100	0·0339	...	30·7
,,	,,	17·4	0·116	0	...	0·00667	6·03
0·278	144	39·5	1·41	47	0·0357	...	15·0
,,	,,	36·6	1·57	65	0·0429	...	18·1
,,	,,	40·8	2·07	99	0·0507	...	21·4
,,	,,	7·7	0·104	0	...	0·0135	5·69
0·157	96	31·8	1·24	45	0·0389	...	7·84
,,	,,	26·8	1·27	66	0·0474	...	9·56
,,	,,	27·2	1·54	100	0·0566	...	11·4
,,	,,	4·55	0·119	0	...	0·0262	5·28
0·105	120	15·6	1·47	47	0·0943	...	6·8
,,	,,	15·75	1·63	67	0·01035	...	7·47
,,	,,	21·8	2·31	100	0·01060	...	7·65
,,	,,	19·8	1·5	0	...	0·0758	5·47

* *Proc.* I.E.E., 1889, Vol. XVIII., No. 77, p. 16; *Electrical World*, 1893, Vol. XXI., p. 300; *Trans.* Am.I.E.E.,1893, April 18; *Wiedemann's Annalen*, Vol. LIII., p. 1,353.

Figs. 1, 2 and 3 show curves derived from the above tables. From these results it will be seen that the resistance offered to currents of 100 cycles per second by rods of 0·975in. diameter is roughly 16 times that offered to continuous current, this value decreasing with the smaller diameters of rods to only

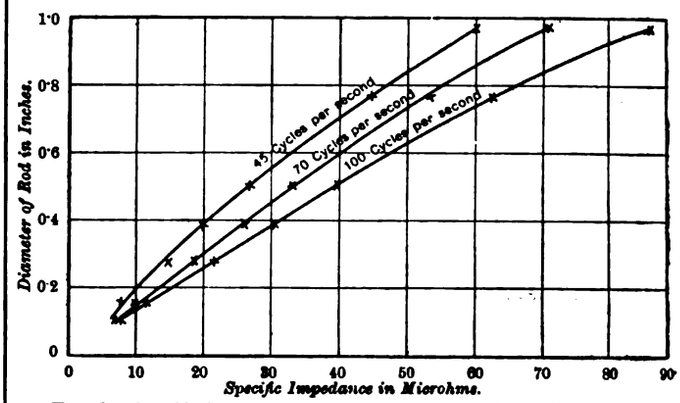

FIG. 1.—Specific Impedance of Iron Rods of varying Diameters at 100, 70 and 45 cycles per second.

1·4 times for a wire 0·105in. diameter. Furthermore, one learns from the results that there is corresponding to each periodicity a certain value for the apparent resistance per unit length below which it cannot be decreased by further increase of

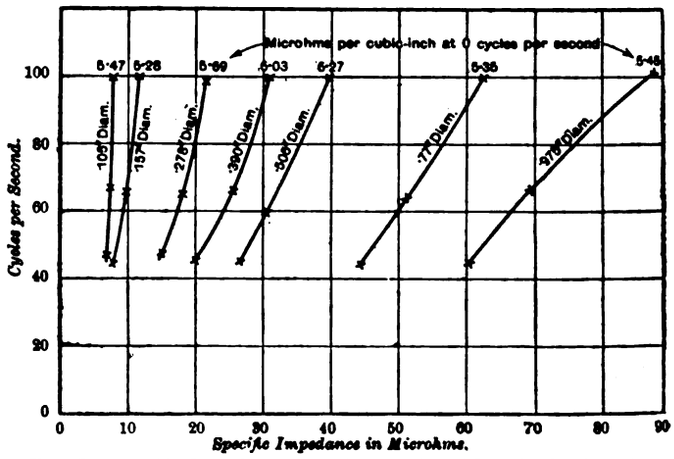

FIG. 2.—Specific Impedance at various Cycles of Iron Rods of varying Diameters.

diameter of the rod. For instance, the curve for 100 cycles, see Fig. 3, shows that no increase of diameter, however great, will reduce the apparent resistance per inch length below 100 microhms per cubic inch.

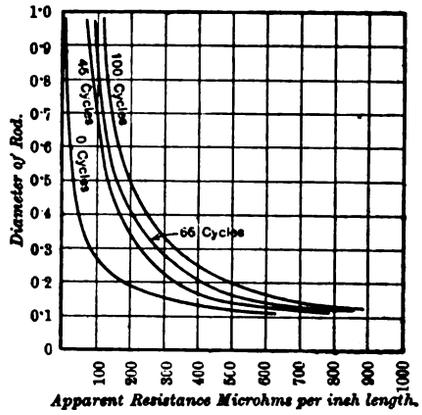

FIG. 3.

It is a matter for further experimenting to determine the nature of this additional resistance, in how far it is of a reactive nature and in how far it is of the nature of ohmic resistance. A delicate wattmeter measurement would enable these resistance components to be separated and would be of still further interest in connection with this subject.

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THE LIGHT EMITTED BY THE CONTINUOUS-CURRENT ARC.*

BY MRS. AYRTON.

Among the curves which Prof. Ayrton showed at Chicago in 1893 there were several connecting the mean spherical candle-power of the arc with the current, for given distances between the carbons. The carbons used in these experiments were a 13mm. cored positive and a solid negative of 11mm. From these curves he concluded that, with the same current, the candle-power increased with the distance between the carbons up to a certain point and then diminished, so that with any given carbons there was, for each current, a definite length of arc at which a maximum candle-power was obtained. This new and unexpected result was confirmed by Prof. Carhart, who deduced it from his own experiments independently, and announced it at the same meeting, but from a rather different point of view. He found that, with a constant current, the candle-power reached the maximum with certain difference of potential between the carbons. Now, with given carbons and a given current, the difference of potential between the carbons depends only on the distance between them; so that the two discoveries relate to the same fact—a fact which, until now, has not been explained.

In order to study this phenomenon, I plotted curves connecting the mean spherical candle-power with the *length of the arc* for constant currents, utilising the experiments of Prof. Ayrton. I found that not only did these curves show the maximum point which Prof. Ayrton announced, but that those which related to currents greater than 10 amperes had also minimum points at a distance between the carbons of about 2mm., the curves having the form indicated in Fig. 1. In order to assure myself that for these minimum points with large currents Prof. Ayrton's experiments were confirmed by the researches of other observers, I examined the remarkable series of experiments which M. Blondel published in 1897. M. Blondel did not trace the curves connecting luminous intensity with length of arc at a constant current, but the connection between the luminous intensity with the difference of potential between the carbons. As he did not employ currents greater than 10 amperes, the indications which his curves give of a diminution in the total flux of light with arcs of about 2mm. seemed only to be errors of observation. Nevertheless, they existed, and, on plotting from M. Blondel's admirable tables the curves connecting the total flux of light with the length of the arc, I found quite a number which showed indentations (for 2mm. or 3mm. arcs), and one especially where there was an actual minimum point. M. Blondel's experiments were very complete. They were made with arcs from 0mm. to 11mm., 12mm., and sometimes even 16mm. long, and they therefore give us the entire form of the curves from an arc of 0mm. to that at which the candle-power practically no longer changes when the arc is lengthened. This complete curve for large currents has usually the form shown in the top curve in Fig. 2.

This curve shows that, after separating the carbons, with a sufficiently large constant current, the light first increases to a maximum as the arc is lengthened, then, with a slightly longer arc, it diminishes to a minimum, and, with a still longer arc it increases again to a second maximum.

To verify the first maximum point and the minimum point, Messrs. Newton and Good carried out some experiments for me at the Central Technical College, and these experiments entirely confirm those of Prof. Ayrton and M. Blondel. Messrs. Newton and Good compared the candle-power of two 30-ampere arcs, one with a length of 1mm. and the other of 2mm., using a 13mm. cored carbon and an 11mm. solid carbon identical with those used by Prof. Ayrton. The experiments lasted four days, and minute precautions were taken to ensure that the conditions were absolutely the same in the two arcs, even to the point of interchanging the positions of the two arcs. In 17 of the 18 experiments which they made, the 1mm. arc had a candle-power greater than that of the 2mm. arc—which appears fairly conclusive.

In order to see how far it would be possible to predict this singular fact, we must examine in detail the different sources of light in the arc. There are five, which I arrange in the order of their importance:—

1. The crater.
2. The white spot at the extremity of the negative carbon.
3. The vapour.
4 and 5. The red parts of the carbons.

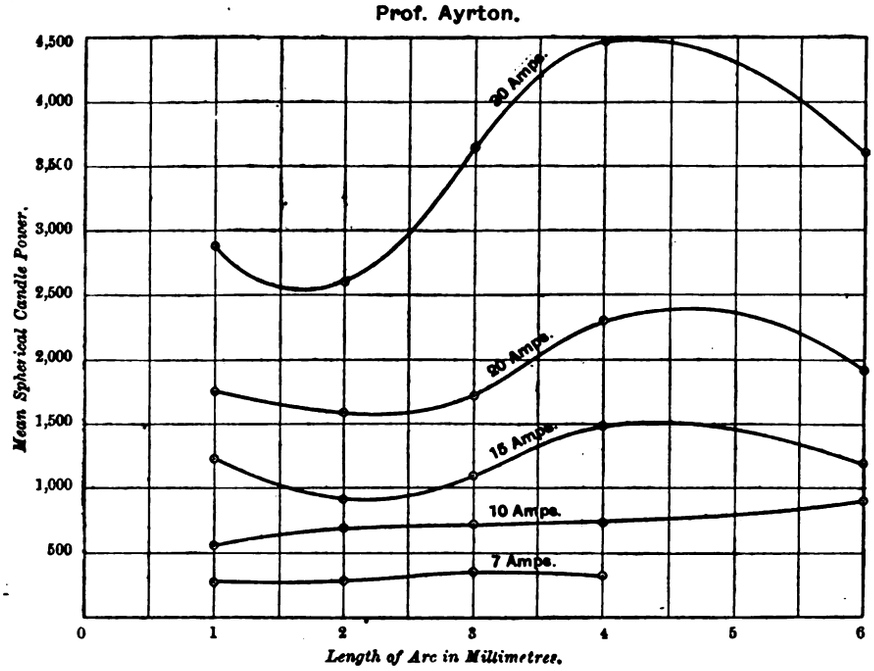

FIG. 1.—Curves connecting Mean Spherical Candle-Power with Length of Arc for Various Constant Currents.
Carbons:—Positive, 13mm. cored; negative, 11mm. solid.

As is well known, it is the crater which gives the greater part of the light, only all that is produced there does not succeed in passing the negative carbon; so that when the carbons are very close together nearly all this light is shut in. The longer the arc the more light can escape from the crater, and the arc does not need to be very long to enable, practically, all the light to pass. Thus, supposing that the intrinsic brilliancy of the crater (the flux of light emitted per square millimetre) does not diminish, and that its area does not diminish either, the quantity of crater light which can pass the negative carbon must increase continuously but at a diminishing rate as the arc is lengthened. Now as long ago as 1881, Capt. Abney (now Sir W. de W. Abney) found that the intrinsic brilliancy of the crater was quite constant for given carbons, depending neither on the current nor on the length of the arc. In 1896 I pointed out, at Toronto, that, far from diminishing, the area of the crater increases a little when the arc is lengthened with a constant current. In consequence, it would seem as if the curve representing the relation between the useful portion of the light of the crater and the length of arc must take the form shown in Fig. 3.

As for the other four sources of light, I have found that the area of the white spot is constant with constant current; consequently, its useful light must increase with the length of the arc, for this light must also escape more easily as the distance between the carbons increases. The light emitted by the red parts of the carbons is quite small; but such as it is, I have found that it

* Abstract of a Paper read before the International Electricity Congress at Paris.

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increases on lengthening the arc, since the lengths of these red portions increases. The light emitted by the vaporous arc must also increase with the length of the arc, since its surface of emission must increase at the same time. Thus the light from each source increases with the length of the arc, and the curve which connects the mean spherical candle-power with this length should, therefore, take the form already shown in Fig. 3. How is it then that the shape of the curve is entirely different when it is determined experimentally? How is it that, instead of increasing continuously, the candle-power shows two maximum and one minimum points?

Let us first seek the reason of the first maximum and the minimum. For this we must consider again the shielding effect of the negative carbon. Up to the present, we have not taken account of the different forms which this carbon assumes according to the magnitude of the current and the length of the arc. Now I showed in 1895, that the shapes of the two carbons change very much when these two variables are changed, and that there even grows a sort of very sharp supplementary point at the extremity of the negative carbon with large currents and short arcs, this point disappearing entirely when the arc is lengthened. Fig. 4 gives four reproductions of the arc and the carbons, which show clearly the difference in shape of the negative carbon with arcs of the same length but different currents. The two to the left are arcs of 1mm. and 2mm. respectively with a current of 6 amperes, and the two to the right are arcs of the same lengths, with a current of 28 amperes. The supplementary point is not seen at all in the first two; but is very distinct in the 2mm. arc to the right, and it is seen still more clearly in the 1mm. arc. It is, above all, the distance between the circle of attachment of this point and the mouth of the crater which determines the amount of crater light which can pass the negative carbon, for the point itself does not stop much of the light. Now the distance between this circle of attachment and the crater in the two 28-ampere arcs is about equal, and when we consider that the whole extremity of the negative carbon is longer and thinner for the 1mm. arc than for the 2mm. arc, we find sufficient reason for the candle-power of the former to be larger, or at least as large as that of the latter.

To sum up, on separating the carbons of a large current arc, the amount of crater light which passes the negative carbon is determined by two opposing tendencies. The increase of distance between the carbons tends to increase the candle-power, but the consequent blunting of the extremity of the negative carbon tends to diminish it. When, in increasing the length of the arc with a constant current, the first tendency predominates, the candle-power increases; when the two effects balance one another the candle-power remains constant, and when the second tendency has the upper hand the candle-power diminishes. The first is what took place with the arcs of 1 mm. and less and the second when the carbons were about 2 mm. apart in the experiments of Prof. Ayrton and M. Blondel.

It would, perhaps, hardly be worth while giving so much attention to the possibility of obtaining more light with a quite short arc than with a longer one, were it not for the following very practical consequences: The difference of potential between the carbons at constant current is less with small arc lengths than with great. The power expended in the short arc is, therefore, less than in the long arc. Thus, with the carbons and the currents of which we are speaking, the arc about 1mm. long gives more light with less consumption of power than an arc of about 2mm. long, i.e., the smaller arc not only gives more light but has actually a better efficiency. Not only that, but I showed in 1896 that the ratio of the power expended in the arc to the power developed by the dynamo increases on diminishing the distance between the carbons at constant current; thus the ratio of candle-power to power developed by the dynamo is also greater with a large current for a 1mm. arc than for a 2mm. arc. Therefore, with large constant currents the short arc with the slender negative carbon has every advantage over an arc a little longer but with a blunter negative; not only does it give more light but it is more efficient.

Let us see if it gives a better efficiency not only than arcs a little longer but also than arcs of every length with the same current. From the point of view of economy two things are essential in the arc. First, it is necessary that the greatest possible quantity of energy supplied to the arc be converted into light, and secondly that the largest possible proportion of this light be utilised. With regard to the first consideration, I have shown elsewhere that the power given to an arc l mm. long between solid carbons of 11mm. and 9mm. diameter with a current of A amperes is $[(38{\cdot}88+2{\cdot}07l)A+11{\cdot}66+10{\cdot}54l]$ watts. Of this power, as I showed at Bristol in 1898, $(38{\cdot}88A+11{\cdot}66+3{\cdot}1l)$ watts are expended at the junction of the two carbons with the arc vapour, and $(2{\cdot}07A+7{\cdot}44)l$ watts are expended in the arc vapour itself. Thus, for every increase of 1mm. in the length of arc there is an increase

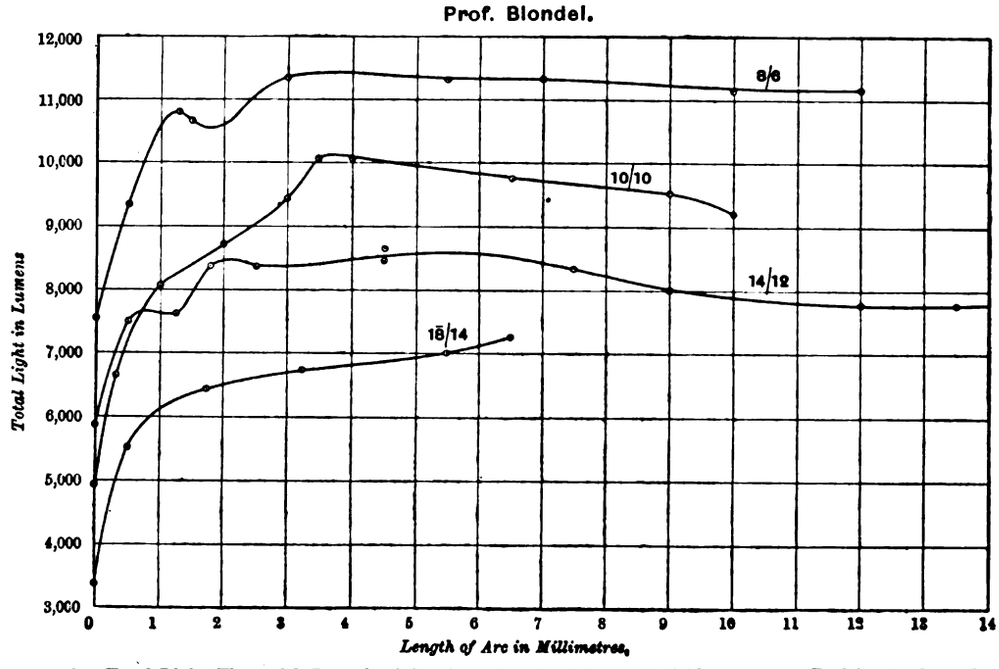

FIG. 2.—Curves connecting Total Light Flux with Length of Arc for a Constant Current of 10 amperes. Positive Carbons Cored. Negative solid.

of 3·1 watts only in the power actually supplied to the junction of the crater with the arc (for the term $3{\cdot}1l$ belongs to the positive carbon alone), and an increase of $(2{\cdot}07A+7{\cdot}44)$ watts in the power expended in the arc vapour. With a continuous current of 10 amperes, for instance, the increase of power required at the crater for each elongation of 1mm. in the length of arc is only 3 watts; while the vaporous arc, which only contributes a minute fraction of the entire light, requires 28 watts. It is therefore evident that the most economical method of converting the power into light is to employ as short an arc as possible. A short arc therefore, no matter what is the current, is doubly economical so far as the production of light is concerned. It is economical, as I have already pointed out, because it utilises a large part of the power developed by the dynamo, and it is economical because it transforms a large part of that power into light.

However, the virtues of the very short arc of 1mm. or thereabouts have not, up to the present, been recognised. They have been obscured, like the light of the crater, by the negative carbon. What is the good of all this economy in the creation of light if, after all, it is hidden under a bushel? It is here that the very short arc with large currents comes in. In this arc the light created is not shut in between the two carbons; the slender point of the negative allows more light to pass than if the arc were two or three times as long, but had a blunter negative. Not only, therefore, does a short arc transform the greatest possible part of the power of the dynamo into light, but if it is also a large-current arc it permits us to utilise the greatest possible quantity of this light. In short, the very short arc with large currents combines all the conditions necessary for the greatest economy.

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To prove that this is not mere theory, we will turn again to that rich mine of experiment, the researches of M. Blondel. In his investigation with continuous currents, M. Blondel employed, among others, four pairs of carbons of the same quality, the positive being cored and the negative solid, the diameters being 18—14, 14—12, 10—10 and 8—6. I have plotted, from the figures which he has given in his tables for each of these pairs of carbons, curves which connect the efficiency and length of the arc for arcs of 0mm. to 10mm. at a constant current of 10 amperes. For one pair (10—10), the maximum efficiency was badly defined, but for the other three the efficiency was a maximum with arcs of 1mm., 0·7mm. and 1·25mm. respectively. Thus, even with carbons as large as 18mm. and 14mm. and currents as small as 10 amperes, the most economical arc is as short as about 1mm.

There is one other consideration which tends to economy with short arcs: it is that the negative carbon, if not both carbons, is consumed more slowly than in a long arc for the same current. There are two reasons for this. First, the short arc extends further along the negative carbon and protects it better from the air. Secondly, the carbon thrown off from the positive, instead of distributing itself and being dissipated, remains on the negative point and forms there, I think, that supplementary point which is the particular cause of economy in short arcs with large currents.

The sharpening of the negative carbons with large currents and a short arc has thus a very practical value. It allows us to approach the ideal conditions for the arc as regards economy. These ideal conditions are: (1) That the distance between the carbons be zero, and (2) That the extremity of the carbon be infinitely thin. It is true that this ideal can never be realised, but it is always well to recognise the ideal for it points the way to progress. The most evident progress in this case would be: First, to employ with given

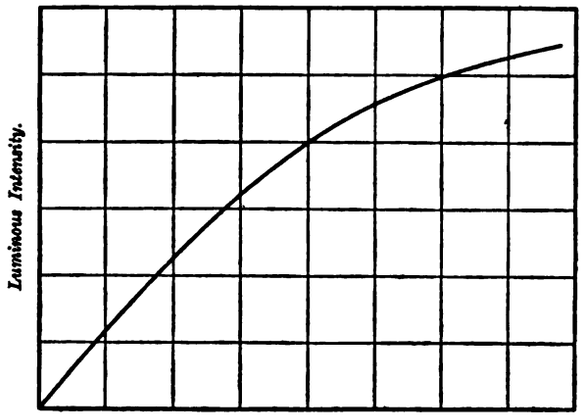

Fig. 3.

carbons, the shortest arcs and the largest currents possible, without approaching too near to the hissing point. Secondly, to find a negative carbon which, when burning in the arc shall have an extremity even longer and thinner than the carbons employed at present and which, nevertheless, shall burn much more slowly.

We now come to the second point of maximum candle-power in the curves which connect the candle-power with the length of arc (Figs. 1 and 2). This point, as we have already seen, depends neither on the changes in the shapes of the carbons nor on variations in the four minor sources of light. It is, therefore, to the amount of light received from the crater that we must attribute the variation of light which produces the second diminution of candle-power after a certain length of arc. This diminution differs from the first of which we have spoken, as it occurs with all currents, whatever their magnitude. The light received from the crater can only depend on three circumstances: First, the area of the crater; secondly, its intrinsic brilliancy; and thirdly, the opposition offered to the passage of the light by the negative carbon or other causes. I have already mentioned that the area of the crater increases with the distance between the carbons, and that Sir William Abney found the intrinsic brilliancy absolutely constant. It is true that in one of his experiments M. Blondel thought he found that the maximum brilliancy of the crater changed from 163 *bougies décimales* per square millimetre with a current of 5 amperes to 210 *bougies décimales* with a current of 25 amperes; but, as he remarked at the time, this kind of measurement is very difficult to make, on account of the continual change in the position of the crater, so that one must not rely too much on this observation. Besides, even if the measurement had been exact, it is impossible to believe that the variations observed denoted changes in the intrinsic brilliancy of the crater. For if this brilliancy is not constant the temperature of the crater cannot be constant either. Now the experiments of Rossetti, Nakano, and several other observers, and, above all, those of Violle, prove conclusively that the temperature of the crater is absolutely constant at atmospheric pressure. Therefore, it is to no real variation in the brilliancy of the crater that these apparent variations can be attributed, and, in consequence, it cannot be a diminution in the intrinsic brilliancy of the crater that can be the cause of the diminution of the candle-power of the arc after a certain length. There only remains one way of explaining this diminution. It is by some sort of screening other than that caused by the negative carbon, for this, as we have seen, screens the light of the crater less and less after a length of arc of 3mm. We must, therefore, see if we can find something else that screens the light of the crater.

Turning over in my mind all the causes which could contribute to such a screening action, it occurred to me that, although the light *emitted* per square millimetre of the crater was necessarily constant on account of the constancy of its temperature, the same did not necessarily hold for the quantity of light which would strike the eye or the screen of the photometer. For in passing from the crater to the eye, the light is obliged to cross a region full of a substance which is called carbon vapour. Now, if this substance could, for instance, absorb a perceptible quantity of light, then lengthening the arc would increase the quantity of absorbent material which the rays would have to traverse, and hence would diminish the amount of light emerging from it. It may be objected that there is never sufficient vapour to absorb the quantity of light necessary

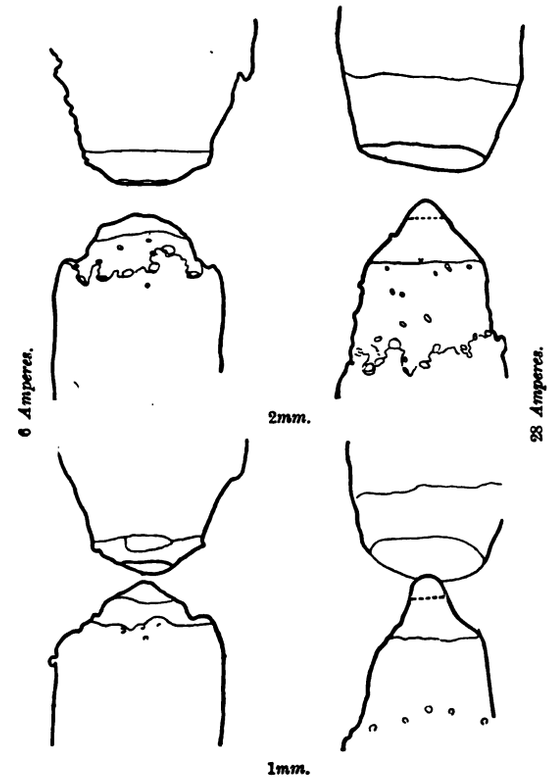

Fig. 4.—Diagrams of Carbons with Arcs of 1mm. and 2mm. and Currents of 6 amperes and 28 amperes.
Carbons: Positive, 13mm. cored; Negative, 11mm. solid.

to cause the diminution of candle-power in question. Perhaps not, if it is vapour pure and simple. But far from this being the case, as long ago as 1822 Silliman, editor of the paper bearing his name, observed that there is always a continuous current of solid particles of carbon rejected from the positive towards the negative pole; a fact frequently observed since. In 1897, also, Herzfeld, as the result of a beautiful experiment, succeeded in attracting these particles out of the arc on to a well-insulated plate charged at a high potential, and placed at 8cm. from the arc. We see, therefore, that the arc cannot be composed of vapour only; on the contrary, it must have a very complex composition of vapour, gas and solid particles of carbon. Now, I argued that the solid particles since they are heated to a white heat must certainly reflect part of each ray that strikes them, and they refract and absorb other parts of the ray. In consequence this arc, which is termed gaseous, but is not at all purely gaseous, must throw a shadow. Hence, on passing the light of a crater of an arc through another arc on to a screen, the shadow of the second arc must be cast on the screen.

To verify this, Mr. Mather was kind enough to try the experiment for me, and unquestionably the shadow of the second arc was defined very clearly on the screen. It had the form shown in Fig. 5, which is copied from a photograph taken for me by Messrs. Fithian and Denny, two students of the Central Technical College. It is very difficult to photograph such a changing shadow, and so delicate

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a one, between dark carbons, and unhappily the tints of the shadow are lost, but one sees distinctly its form and the line of light which surrounds it. Mr. Mather was the first to observe this line, and immediately recognised its significance. It is that the arc is a lens which thus refracts the light that traverses it. From the form of this lens it may be deduced that the arc is less dense than the hot air which surrounds it, for it has a double convex cylindrical form, and if it were denser than the air with this shape its shadow would have a white spot of light *at the centre*. The arc behaves, therefore, as a negative lens. If the arc only refracted the light of the crater, or even if it refracted and reflected it only, this alone would not necessitate a part of the light being lost. It would only change the *disposition* of the light without changing its quantity. It is true that, in refracting the light of the crater, the arc bends into the negative carbon some rays, which otherwise would reach the eye, but after a geometrical examination of several images of arcs of different lengths with the same current, I have convinced myself that this absorption, which is always fairly small, actually diminishes as the arc is lengthened. Thus, so far as this refraction is concerned, the luminous intensity of the arc must *increase* on separating the carbons more and more. No, we have not to do with absorption in the carbons, but with an actual loss of light by absorption in the space between the carbons. For let us see what must happen when the light of the crater traverses the space full of vapour, gas, and solid particles of carbon, which is called the arc vapour.

It may be admitted that the light of the crater is partly reflected and partly absorbed by each particle of solid carbon which it meets. Hence, no ray which meets a particle of the solid carbon will pass straight through the arc. Some rays will, perhaps, not meet any at all, others will only meet a few particles, while others again will be

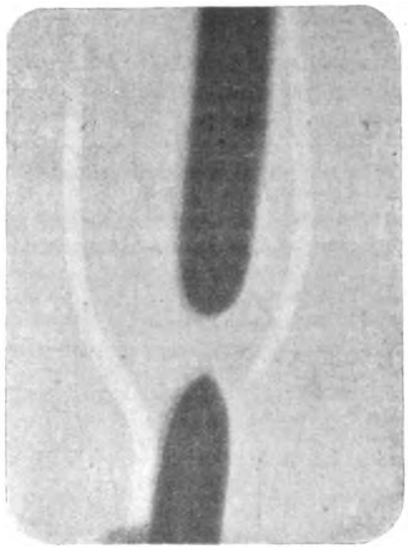

FIG. 5.—Shadow of the Arc.

reflected from particle to particle in and out and up and down, and at each reflection a part of their light will be absorbed. The more particles there are in the arc, the more the light of the crater will be absorbed. Thus, if there are more of these particles in a long arc than in a short one, this is all that is necessary for the light intensity of the arc to diminish after certain lengths. For on separating the carbons (when there is no longer a supplementary point on the negative) there will be an increase in the candle-power on account of the increase of the distance between the carbons and a diminution on account of the absorption of the light from the crater by the solid particles in the arc.

It only remains to show that there are more solid particles in a long arc than in a short one, and this I will endeavour to do. The carbon is evaporated at the surface of the crater. Everyone is in agreement about this, but how is it that everybody also agrees that it remains in this state of vapour even at a distance of 1cm. or more from the crater? Water vapour when it leaves the spout of a kettle only continues as vapour for a short distance, and then becomes mist. What prevents carbon vapour from being transformed into mist at a short—a very short—distance from the crater? For there is much more difference between the temperature of carbon vapour and the air which surrounds the arc than there is between the temperature of the water vapour and the air which surrounds the spout of a kettle. It is true that the current, in flowing through the arc, must heat it, but it heats it equally over its whole length; while the air must cool to a much greater extent that part of the vapour which is far from the seat of vaporisation (the crater) than that which is nearer to it. Thus the arc must have a falling curve of temperature which diminishes in passing from the crater to the negative carbon.

There is a little experiment which I have often made, which shows clearly that the temperature of the arc quite near to the crater is higher than elsewhere. On putting the extremity of a very thin carbon pencil in the arc near the crater, one can bend this carbon pencil sufficiently to make a perceptible angle by pressing it against the positive carbon; but there is no other part of the arc in which this can be done. If, for instance, two of the little carbons be introduced into the arc and pressed one against the other, it is impossible to bend them, and it is the same on pressing one of these carbons against the negative, it will not deflect the least little bit. That shows, I think, that quite near to the crater the arc is so hot that it can soften the carbons, but that further off it is too cold to do this.

Thus it is more than probable that the carbon vapour on leaving the crater acts in exactly the same way as water vapour leaving the spout of a kettle. For a very short distance it remains in the state of vapour, and further on it becomes carbon mist and cools more and more as it gets further from the crater. If the layer of vapour that is spread over the crater is very thin, and if it has (as all pure vapours have) a large specific resistance, the resistance of this layer might be great enough to explain the greater part of the difference of potential—the back E.M.F., as it is called—which always exists between the positive carbon and the arc. The mist, on the contrary, which would be mixed with the burning gases, would have a relatively low resistance, so that the resistance of the gaseous arc would be relatively small; which is what is found in practice. In any case, if the carbon vapour becomes mist at a short distance from the crater (and the solid particles of carbon thrown off by the positive would assist this transformation), then by increasing the length of the arc the quantity of this mist would be increased, and the light of the crater would traverse more of the absorbent material; so that the amount of this light that was absorbed by the arc would increase with the length of the arc.

(To be concluded.)

RECENT TRAMWAY CONSTRUCTION, WITH SPECIAL REFERENCE TO THE DEMERBE SYSTEM.*

BY WILLIAM DAWSON.

It is about 35 years since the introduction of tramways into the large towns of Europe, and an account of the changes and developments which have been made in this means of transport would be very interesting from an historical point of view, but of little technical or industrial interest. The principles of construction, the different systems formerly in use, and the mode of traction have all been revolutionised in the comparatively short time which has passed since the introduction of tramways into this country, so that there is little to learn from the past. It would take up too much time to enumerate and investigate all the systems of tramway construction which were successively tried when tramways were generally worked by horse traction, and which have now given place to other methods more suitable for mechanical or electric traction. The first tramrails were laid on either longitudinal or transverse wooden sleepers, but it was found that the wood soon rotted. The sleepers were therefore discarded, and experiments made with tramways constructed entirely of metal. The Vignoles rail was adapted for this purpose, and, finally, rails of the Brocca (or girder) and the Demerbe (or trough) type were manufactured.

The Brocca rail was aftewards adopted in Germany and England under the name of the Phœnix or girder rail. This form of rail was a modification of the Vignoles rail, as the foot or bottom flange was merely widened and laid direct on the soil or on a bed of concrete. It is now generally adopted throughout England, but in my opinion has not proved a success. When animal traction only was used, very little attention was given to the fishing of the joints of the rails, but on the introduction of steam and electric traction it was soon found that the joints were unable to stand the increased strain. The fish-plates were increased in length and thickness until in some cases they were 3ft. long and 1in. thick; eight 1in. fish-bolts were used, sole-plates were placed under the ends of the rails, narrow steel strips were placed on the top of the bottom flanges of the rails at the joints, and the whole securely bolted together with six ⅞in. bolts. The joints still worked loose, and it is now recognised that all it is possible to do in this direction is insufficient to make a perfect joint. In Germany, the ends of the rails were cut obliquely, afterwards they were halved on to each other, or the ends were notched, and a fish-plate placed in the recess. All possible methods have been tried to prevent the joints working loose, and numerous patents have been

* Paper read before Section G of the British Association at Bradford.

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obtained for different ways of strengthening the fishing—all costly, and not completely satisfactory in spite of the extra outlay. The girder rail joint is undoubtedly defective, and the trouble which arises is to be attributed partly to the fact that the top and bottom of the fish-plates corrode, as also does the under side of the head of the rail. The fish-plates then occupy a less space, and are less in depth than they were when new. The head and bottom flange of the rail is not firmly gripped by the fish-plates, and as their proper work is to maintain the level of the ends of the rails under the action of unequally distributed forces, the joint soon becomes loose. It is not, therefore, surprising that the consideration of the best means of

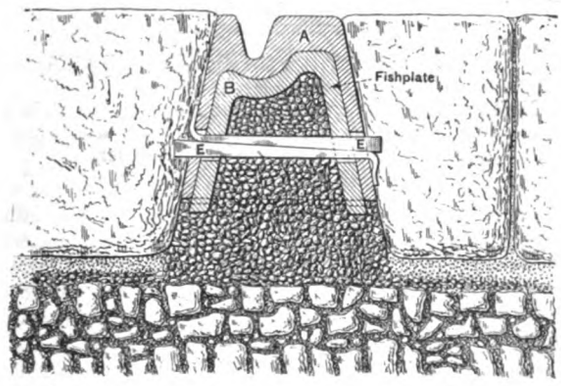


FIG. 1.—Section of the Rail with Fishplate.

fishing the joints of tramways has brought to the surface numerous, complicated, and often very remarkable methods of dealing with this branch of tramway construction.

The Demerbe system of tramway differs entirely from all other types, and possesses in many ways some of the chief attributes of a perfect tramway. It consists of a hollow trough rail (A, Fig. 1), and the fishplate (B, Fig. 1) is placed inside under the ends of the rails, and exactly fits its contour, the point of application being immediately under the head of the rail. When this system was first introduced the fishplate was pressed into the rail by means of bolts, but it was soon found that this was not satistactory, and cotters (E, Fig. 1) were used. As the holes in the fishplates and rails are cut at different depths, when the cotters are driven in the fishplate is forced close up to the underside of the rail. The ends of the cotters are then clinched against the side of the rail, and are thus fixed and prevented by any possibility from working loose. The rail when laid in position in the carriage-way is completely filled, by means of specially-designed tools, with concrete composed of four parts of ¼in. unscreened granite shingle to one part of Portland cement. The tie bars (G, Figs. 2 and 3) used in the Demerbe system are flat, and the use of screw ends, nuts, and bolts is avoided. The rail is inserted into two oblique grooves, one of which is cut so as to exactly fit the outer side of the rail, whilst the other is wider, so as to facilitate the introduction of the inner side of the rail. In the space which is left a wedge of soft steel (D, Fig. 3), a little smaller than the opening it has to fit, is inserted and driven up. This arrangement of the tie bar enables the rails to be fixed to gauge with almost mathematical exactitude.

In England, as a rule, a concrete foundation is laid the whole width of the carriage-way to receive the paving, and when the Demerbe rail is filled with concrete in the manner above described it becomes attached to the concrete foundation, and is practically part and parcel of the carriage-way. It is, therefore, capable not only of withstanding the strains caused by the cars, but also all the strains and vibrations caused by the ordinary vehicular traffic, without any loosening of the joints or displacement of the paving. The girder rail is laid direct on the concrete foundation, and the oblique strains brought to bear on the head of the rail by the tramcars and other traffic causes the extremities of the foot or bottom flange of the rail to have a tendency to crush the concrete, and so allows the rail to oscillate on its base. As soon as the rail is subjected to the least movement or vibration, a narrow fissure is produced alongside, which increases in width as the foot become more movable. Water penetrates between the paving and the rail, and in frosty weather the paving is uplifted. The joint of the rails is also partly responsible for these defects, as the water finds an early passage between the rails and fishplates.

It is necessary to take into account another factor which contributes to the grinding away or pulverisation of the concrete. The ends of the rails rest on a sole plate, which is intended to maintain the ends of the rails at one level. When the cars pass over the track the shock is harder at the joint than on the rest of the rail, where the movement caused by the car is more elastic, because the sole-plate and the concrete do not support the rail with the same rigidity, and the rails become dented at the joints even when they are in perfect alignment. It follows then that the same rigidity should exist at the middle of the rail as at the joint. In the Demerbe system this is so, as the concrete becomes perfectly attached to the rail, and the ridge of armoured concrete becomes part and parcel of the foundation itself. The same resistance is offered to the weight of vehicles for the whole length of the rail, no part being found to be weaker or more elastic than another.

In 1894 a short experimental length of the Demerbe rail was laid in Leeds-road, Bradford, end to end with a similar length of girder rail. Both portions have been subjected to a 5-minute service of steam locomotive cars since that time. About three weeks ago a Demerbe rail was removed, in the presence of the Tramway committee, to ascertain its condition. The rail, joint, and gauge were found to be in every way perfect, and it was only after repeated blows with heavy hammers that the rail could be detached from the concrete foundation, and when raised it dragged up with it part of the foundation. No money whatever has been spent in repairing

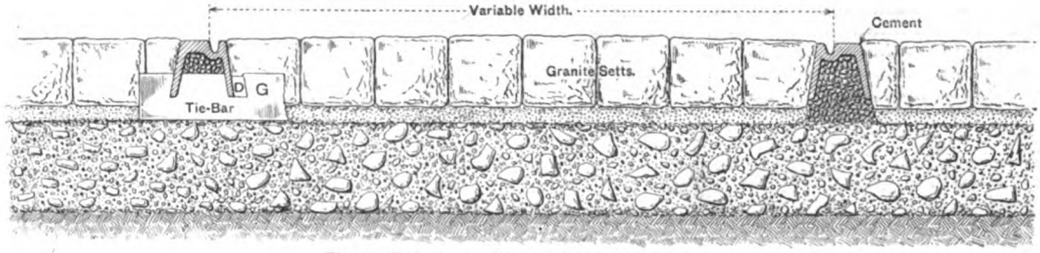


Fig. 2. Transverse Section of the Line Paved.

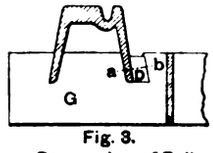
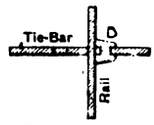


Fig. 3.
Connection of Rail with Tie-Bar.



Section at a.b.

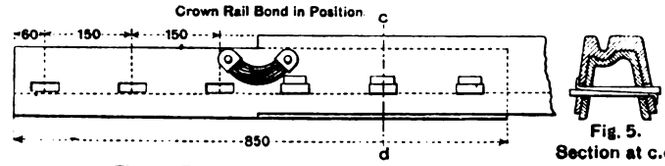


Fig. 4 Elevation of Fishplate and Joint

Fig. 5.
Section at c.d.

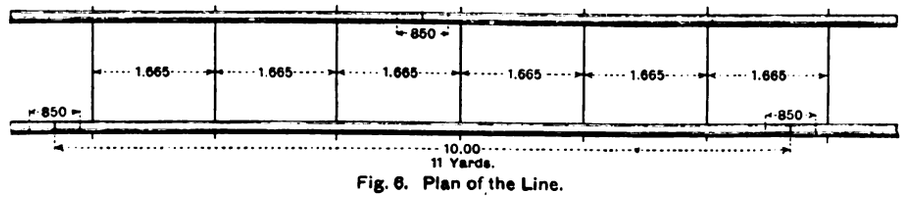


Fig. 6. Plan of the Line.

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this portion of Demerbe tramway, but the adjoining portion of girder rail has been several times repaired during the six years it has been laid down. The setts used alongside the Demerbe rail are splayed to fit the sides of the rail, and laid directly against it, the rail thus serving as a support for the paving: and there is no tendency either for the setts to rise or fall as is the case with the girder rail. There are in Bradford 40½ miles of tramways, of which 36½ miles are laid on the girder system, with rails weighing 105lb. per yard, and fish-plates weighing 80lb. per pair. There are 4 miles of Demerbe tramway, constructed of rails weighing 70½lb. per yard, and fishplates weighing 51½lb. each, and the Corporation have, further, in course of construction an additional 10½ miles of tramway, which they are putting down on the Demerbe system.

The detailed cost per yard of single track on the two systems, based on the price of materials delivered at Bradford, is as follows:—

Demerbe System.	s.	d.
Rails	10	7·9
Fish-plates	0	9·4
Tie-bars	1	6·8
Wedges	0	1·4
Cotters	0	7·1
Track labour, including curve	2	6·0
Rails, &c., carting	0	1·1
Packing rails (labour)	0	11·0
Half-inch unscreened granite shingle	1	0·0
Cement	0	11·5
Team labour	0	3·2
	19	5·4

Girder System.	£	s.	d.
Rails	0	15	11·2
Fish-plates	0	1	8·8
Marshall's patent joints	0	0	9·9
Bolts and nuts	0	0	5·4
Sole-plates	0	1	0·3
Tie-bars	0	0	2·8
Unscreened granite shingle	0	0	4·0
Cement	0	0	5·1
Labour (packing rails)	0	0	3·6
Road scrapings (for plastering rail)	0	0	0·6
Track labour	0	1	3·0
Team labour	0	0	1·6
Sole-plates, punching	0	0	1·9
Blacksmiths' work	0	0	1·3
Repairs to punches	0	0	1·9
	£1	3	1·4

Although it will be seen from the foregoing tables that the first cost of the Demerbe track is cheaper than the girder track, this point is not the most important. There is the cost of maintenance to consider, and judging from the condition of the Demerbe track in Leeds-road after six years' wear and tear, it does not appear that any repairs will ever be necessary during the life of the rail once it is properly laid. This life I should estimate to be about 20 years, whilst the girder rail has to be renewed in 16 years.

The opponents of the Demerbe system when they compare these rails with the girder type, state that the latter rail when laid on two supports will carry a heavier load than the Demerbe rail under the same conditions. This is quite true, but the Demerbe rail does not act, nor is it intended to act, as a girder. It is supported throughout its entire length by a ridge of concrete, and the rail merely acts as a metallic covering.

The advantages of the Demerbe system of tramway over other systems may be summarised as follows: (1) The system is simple, being composed of very few parts. It is also cheaper, and can be laid more quickly than the girder system. (2) The rail and concrete resist the heaviest loads without displacement, depression, or other alteration of the track. (3) The cost of maintenance of rails and paving is reduced to a minimum. (4) The tie-bars are constructed without rivets or nuts. No punching or drilling of the rails is therefore necessary, as the tie-bars can be fixed to any part of the rail by means of the slots. (5) Curves of quick radii are made at the works, and are laid as quickly as straight track. (6) The concrete support effectually prevents water finding its way under the rail.

Having regard to the very large sums spent annually on tramways maintenance, it is of the highest importance that lines should be constructed on a system which promises the longest working life, with a minimum of cost for repairs. The writer after a considerable experience in tramway construction and maintenance, has no hesitation whatever in affirming that the Demerbe system possesses points which place it far before the girder and other systems, and he can confidently commend it to the consideration of those having in any way to do with the development and extension of facilities for public transport by means of tramways. And as Bradford is the only city in the United Kingdom which has tested the Demerbe system, it is perhaps not unfitting that this Paper should form a contribution to the British Association when it holds its meeting in that city.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"*Proceedings* of the Royal Society." No. 435. Vol. LXVII. (London: Harrison & Sons.) 2s. 6d.

"Electric Wiring Tables." By W. Perren Maycock. (London: Whittaker & Co.) 3s. 6d.

"Elementary Questions in Electricity and Magnetism." By Magnus Maclean and E. W. Marchant. (London: Longmans, Green & Co.) 1s.

"The Official Gazette of the United States Patent Office." No. 13, Vol. XCII. (Washington: Government Printing Office.)

ELECTRICITY WORKS ACCOUNTS.

Newcastle-upon-Tyne Electric Supply Co. (Ltd.)

Although there has been somewhat of a retrogression in the results shown by the accounts of this company they are, in all respects, most excellent. Owing to a slight increase in the management and property charges the total costs have also risen, although the works costs have dropped perceptibly. All the several items and the aggregate costs are well below the average of 1898. As a result of the decrease in the total receipts per unit coupled with the increased costs the working profit has suffered, it representing 8·38 per cent. of the mean capital in 1899 as compared with 9·05 per cent. in 1898.

As in 1898 there was a special expenditure on dynamo reconstruction. In that year the amount thus spent was £1,295, last year it was £737. Another item of unusual expenditure was that of £876 incurred in opposing the Newcastle-on-Tyne (Corporation) Tramways Improvement Bill. These amounts have been kept from entering the costs columns in our analysis.

The business progresses well. The lamp connections last year raised the total equivalent in 8 c.p. lamps from 53,500 to 64,156—an advance of nearly 20 per cent. Similarly, the output rose to 967,098 units sold, or 20·3 per cent. Unfortunately the load factor, which was 10·75 per cent. in 1898 has fallen to 10·58 per cent.

Aberdeen Municipal Electric Supply Works.

In our second table we give a summary of the accounts of the Aberdeen undertaking for the two periods—one of seven months and the other of twelve months—which ended respectively July 31, 1899, and July 31, 1900. The results of the working during the latter period affords a striking comparison with the operations of 1898, while the costs figures attained last year are highly satisfactory, even considered in relation with the high load factor of 12·6 per cent., which obtained during the period. Among the generating costs the fuel item represents the average of 1898 under similar conditions. The remaining three items are all much below those averages. The chief seat of the improvement in the aggregate costs as compared with those of 1898 is in the management and property charges. This collective item has dropped nearly 0·28d., and at its present figure of 0·43d. presents an excellent result.

Turning to the business done it will be noticed that the output has made the splendid advance of 105 per cent., or from 412,353 to 846,012 units sold. Of the total, 15·5 per cent. of the output sold was supplied to the tramways and 7·64 per cent. for public lighting. It is no doubt due to the acquisition of the tramways as a customer that the very beneficial rise in load-factor is due. In 1898 this factor was 9·23 per cent.; last year it had risen to 12·62 per cent. An examination of the figures near the foot of our analysis will show how this improved load has been the means of increasing the earning power of the generating plant installed in the station. In 1898 the revenue and expenditure per kilowatt of plant capacity were respectively £3. 7s. 7d. and £7. 12s. 5d. Last year the respective figures were £4. 12s. and £12. 1s. The scheme of payment for the tramway supply is that it be paid for at cost price, inclusive of interest and sinking fund charges. Exclusive of the tramways, the equivalent in 8 c.p. lamps connected during the year ended at June 31 last was—in arcs 1,830, in glow lamps 9,529, and in motors 18,709, being a total (exclusive of the tramways) of 30,068 8 c.p. lamps. The total number of motors now on the mains is 63, representing 198 H P

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	NEWCASTLE-UPON-TYNE.				ABERDEEN.					
Undertaking Worked by	Newcastle-upon-Tyne Electric Supply Co. (Ltd.)				Aberdeen Corporation.					
Date of Commencement of Supply	1889.				March, 1894.					
System of Supply	Alt.-curr. transformers in houses and sub-stations.				Three-wire continuous-current.					
Chief Engineer	R. C. Jackson.				J. A. Bell.					
YEAR ENDED	DEC. 31, **1898.**		DEC. 31, **1899.**		DEC. 31, **1898.**		JULY. 31, **1899.**[e]		JULY 31, **1900.**	
QUANTITIES—										
Units generated	1,275,233		1,517,311		471,965		279,953		1,005,505	
„ SOLD (TOTAL)	803,789		967,098		412,353		256,653		846,012	
„ sold to comsumers	774,788		938,165		376,088		232,172		781,375[k]	
„ sold for public lighting, &c.	29,001		28,933		36,265		24,481		64,637	
„ used on works	18,884		23,453		11,553		8,478		28,933	
UNITS SOLD per 8 c.p. LAMP CAPACITY	19·8		22·6		13·2		—		—	
Maximum supply demanded	853 kilowatts		1,043 kilowatts		510·4 kilowatts		530 kilowatts[f]		765 kilowatts[i]	
Number of public lamps	14		14 arc		36 arc, 200 glow[a]		35 arc, 168 glow		76 arc, 80 glow	
Number of consumers	788		986		395		440		—	
Connections to mains in 8-c.p. lamps	53,500		64,156		35,794		42,127		71,995[j]	
CAPACITY OF PLANT IN 8-c.p. LAMPS	40,600		42,800		31,250		36,860		36,100	
CAPACITY OF PLANT IN KILOWATTS	1,300		1,370		1,000		1,180		1,156	
CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kw. capacity.
AUTHORISED (TOTAL)	£100,000	£76·9	—	—	£67,000	£67·0	£67,000	£56·8	£82,000	£71·0
Share	100,000	76·9	£100,000	£73·0	—	—	—	—	—	—
Loan (including Debenture charges)	—	—	—	—	67,000	67·0	67,000	56·8	82,000	71·0
RECEIVED (TOTAL)	78,149	60·1	107,626	78·6	62,741	62·7	66,811	56·6	81,953	70·9
Share	53,149	40·9	89,526	65·4	—	—	—	—	—	—
Loan (including Debenture charges)	25,000	19·2	18,100	13·2	62,741	62·7	66,811	56·6	81,953	70·9
AUTHORISED, NOT RECEIVED (TOTAL)	—	—	—	—	4,259	4·26	189	0·160	47	0·041
Share (unissued)	46,851	36·1	7,695	5·62	—	—	—	—	—	—
Share (uncalled)	—	—	2,779	2·03	—	—	—	—	—	—
Loan (including Debentures)	—	—	—	—	4,259	4·26	189	0·160	47	0·041
REPAID (TOTAL)	—	—	—	—	3,078	3·08	3,078	2·61	5,185	4·49
RESERVE OR SINKING FUND	7,700	5·92	20,500	15·0	313	0·313	1,089	0·923	2,610	2·26
DEPRECIATION FUND					4,328	4·33	5,435[l]	4·61	7,874	6·81
EXPENDED (TOTAL)	98,183	75·5	126,024	92·0	65,107	66·1	75,149	63·7	101,240	87·5
Lands and buildings	—	—	24,463	17·9	9,564	9·56	9,589	8·12	17,688	15·3
Plant	—	—	64,715[e]	47·2	28,559	28·6	31,555	26·7	39,363	34·1
Mains	—	—	35,944	26·2	27,984	28·0	34,005	28·3	44,189	38·2
Miscellaneous	—	—	901	0·658	—	—	—	—	—	—
BALANCE OF CAPITAL ACCOUNT	−20,034[a]	−15·4	−18,397[a]	−13·4	−3,366[b]	−3·37	−8,338[b]	−7·07	−19,287[b]	−16·7
REVENUE—	Total.	Per unit sold	Total.	Per unit sold	Total.	Per unit sold	Total.	Per unit sold	Total.	Per unit sold
TOTAL	£14,642	4·375d.	£17,440	4·326d.	£7,622	4·438d.	£4,805	4·493d.	£13,926	3·953d.
Revenue from supply	12,965	3·873d.	16,020	3·975d.	7,063	4·115d.	4,427	4·142d.	12,793[m]	3·630d.
„ meters, &c.	1,079	0·322d.	720	0·179d.	nil	—	nil	—	nil	—
„ public lighting	588	0·176d.	581	0·144d.	554	0·323d.	378	0·354d.	993	0·282d.
„ sale of lamps, &c.	1	—	1	—	—	—	—	—	9	0·003d.
„ miscellaneous sources	9	0·003d.	118[f]	0·029d.	—	—	—	—	131[n]	0·037d.
EXPENDITURE—										
TOTAL COSTS	£6,504	1·944d.	£8,044	1·996d.	£3,379	1·967d.	£2,081	1·946d.	£5,321[p]	1·510d.
WORKS COSTS	4,515	1·349d.	5,318	1·319d.	2,166	1·261d.	1,574	1·472d.	4,266	1·211d.
Generation of Electricity	*3,947*	*1·180d.*	*4,710*	*1·169d.*	*1,958*	*1·141d.*	*1,452*	*1·358d.*	*4,013*	*1·138d.*
Fuel (including cartage, &c.)			2,034	0·505d.	770	0·448d.	563	0·527d.	2,429	0·690d.
Oil, waste, water, stores	3,947	1·180d.	328	0·081d.	182	0·106d.	91	0·085d.	296	0·084d.
Wages at station			1,795	0·446d.	650	0·379d.	512	0·479d.	932	0·265d.
Repairs & maintenance at Station			552	0·137d.	356	0·207d.	286	0·268d.	356	0·101d.
Distribution of Electricity			*444*	*0·110d.*	*208*	*0·121d.*	*121*	*0·113d.*	*253*	*0·072d.*
Wages, &c.			217	0·054d.	—	—	—	—	—	—
Repairs, renewals of mains, &c.	568	0·170d.	227	0·056d.	208	0·121d.	121	0·113d.	253	0·072d.
Public Lighting			*164*	*0·041d.*	—	—	—	—	—	—
Attendance			164	0·041d.	—	—	—	—	—	—
Renewals					—	—	—	—	—	—
MANAGEMENT CHARGES, &c.	1,989	0·594d.	2,726	0·676d.	1,213	0·706d.	506	0·473d.	1,512	0·429d.
Royalties	—	—	—	—	—	—	—	—	—	—
Rent, rates, taxes	*391*[b]	*0·117d.*	*477*	*0·118d.*	*520*	*0·303d.*	*82*	*0·077d.*	*740*	*0·210d.*
Management	*1,598*	*0·478d.*	*2,249*	*0·558d.*	*693*	*0·403d.*	*424*	*0·397d.*	*772*	*0·219d.*
Salaries			1,341	0·333d.	336	0·196d.	191	0·179d.	345	0·098d.
Stationery, &c.	1,598	0·478d.	297	0·074d.	130	0·076d.	73	0·068d.	118	0·033d.
Establishment charges			235	0·058d.	87	0·051d.	71	0·066d.	216	0·061d.
Law charges, &c.			376[g]	0·093d.	140[c]	0·082d.	89[h]	0·033d.	93[o]	0·026d.
FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'd.
WORKING PROFIT FOR YEAR	£8,140	9·05%	£9,396	8·38%	£4,242	7·42%	£2,724	3·86%	£8,605	9·76%
Carried to Depreciation Fund	2,295[c]	2·55%	1,143[h]	1·02%	1,463	2·56%	1,108	1·57%	2,439	2·77%
Carried to Res. or Sinking Fund					905	1·58%	771	1·09%	1,336	1·52%
Net int. on loans (incl. Deb. charges)	1,476	1·64%	1,217	1·086%	1,405	2·45%	1,049	1·49%	2,343	2·66%
BALANCE FROM LAST ACCOUNT	652	0·725%	994	0·887%	—	—	—	—	−204	−0·231%
Do. AVAILABLE for DISTRIBUTION, &c	5,021	5·58%	7,154[i]	6·38%	—	—	—	—	2,284	2·59%
Deficit	—	—	—	—	*126*[d]	*0·22%*	*204*	*0·289%*	—	—
ORDINARY DIVIDEND PAID	8%	—	8%	—	—	—	—	—	—	—
% of TOTAL COSTS to GROSS REVENUE	44·4%		46·1%		44·4%		43·3%		38·2%	
Expenditure per kilowatt capacity	£5. 0s. 0d.		£5. 17s. 5d.		£3. 7s. 7d.		£1. 14s. 3d.		£4. 12s. 0d.	
REVENUE PER KILOWATT CAPACITY	£11. 5s. 2d.		£12. 14s. 7d.		£7. 12s. 5d.		£4. 1s. 5d.		£12. 1s. 0d.	
Expenditure per 8-c.p. lamp capacity	3s. 3d.		3s. 9d.		2s. 2d.		1s. 1½d.		2s. 11½d.	
REVENUE PER 8-C.P. CAPACITY	7s. 2½d.		8s. 1½d.		4s. 10½d.		2s. 7½d.		7s. 8½d.	
REVENUE PER 8-C.P. CONNECTED	5s. 5½d.		5s. 5½d.		4s. 3d.		2s. 3½d.		3s. 10½d.	
Price charged for lighting, per unit	4½d.[d]		4½d.[d]		6d. to 3d.		6d. to 3d.[g]		6d. to 3d.[g]	
„ for power, per unit	2d. to 3d.		3d.		4d. to 1½d.		3d. to 1d.[g]		3d. to 1d.[g]	
„ for public lighting	By contract		By contract		6d. to 3d.		6d. and 3d.[g]		1·95d. per unit.	

NEWCASTLE-UPON-TYNE.—REMARKS—*a* Over-expended. *b* Inclusive of insurance charge. *c* Of which £1,295 is amount of "special expenditure on dynamo reconstruction during year." *d* Less by varying discounts. *e* Includes £646 on public arc lamps. *f* Includes £107 profit on installation work, &c. *g* Inclusive of £90 to auditing, £158 law expenses and £128 insurances. *h* Includes £63 depreciation of plant and machinery, £737 reconstruction of dynamos and £343 to "reserve fund." *i* After deducting parliamentary expenses written off, £876.

ABERDEEN.—REMARKS—*a* The glow lamps are of 16 c.p. and 32 c.p. *b* Over-expended. *c* Includes £72 engineer's travelling expenses, £34 candidates' expenses and £34 insurance. *d* This deficit comes about through a charge of £595 cost of new insulators to copper strip mains, necessitated by increase of pressure and is met by the reserve fund. *e* For *period of seven months*. *f* On January 6, 1899. *g* On maximum demand system—"public lighting being computed." *h* Includes insurance £20, engineer's travelling expenses £39 and compensation for personal injury £30. *i* Includes tramways demand. *j* *Exclusive* of the equivalent of the tramways. *k* Inclusive of 131,173 units sold to tramways. *l* Inclusive of £815 received from tramways. *m* Includes £1,093 from tramways for electricity for traction. *n* For attendance on harbour lamps after deducting £169 labour and material. *o* Includes £39 for insurance, £15 auditing and £39 compensation for damages. *p* After deducting £457, amount received from tramway department for services of electrical engineer and staff in construction of Woodside line.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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EFFICIENCY OF THE CONTINUOUS-CURRENT ARC.

In Mrs. AYRTON's Paper on "The Light Emitted by the Continuous Current Arc," read before the International Electricity Congress at Paris, we have a record of an investigation of high practical importance as well as of scientific interest. Taking up a discovery of Profs. AYRTON and CARHART, published at Chicago in 1893, Mrs. AYRTON, in the present Paper, seeks the cause of the result established by them—viz., that for a given constant current, so long as it is not too small, as the arc length is increased by the separation of the carbons from contact, the light emitted rises first to a maximum, then falls to a minimum, and finally rises again to a second maximum value. It is evident that the centre of practical interest and importance lies in the first maximum point, since, if this point is sufficiently high in respect to the second maximum and also in relation with the rate of increase of power taken up in the arc with increase in its length, this first point represents the condition of maximum efficiency of light radiation. Although Mrs. AYRTON satisfied herself by experiment that there existed the first maximum and minimum points, and has thereby confirmed some of the results of Profs. AYRTON and CARHART and M. BLONDEL to the same effect, she appears to have relied on the valuable data supplied by experiments of the last-mentioned of these three investigators in arriving at the conclusion that the point of maximum efficiency of light radiation at the arc is the first and not the second maximum point. It would have been most interesting from a practical point of view had Mrs. AYRTON published the four curves connecting the ratio of the mean spherical candle power to electrical power taken up in the arc with the various lengths of arc. Mrs. AYRTON tells us that even with carbons as large as 18mm. and 14mm. and currents as low as 10 amperes the most economical arc is as short as one millimetre at least for the cored positive and solid negative carbons used by M. BLONDEL. It is now some years since Mrs. AYRTON, in her discussion of the stability of the arc, indicated that short arcs and large currents were the conditions for obtaining the highest ratio of available power at the arc to that developed in the supplying dynamo or taken off a constant-pressure service. We now learn that short arcs and large currents are also indicated when a maximum available light emission for a certain power consumption in the arc is in view—at any rate, with cored positive and solid negative carbons—and

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that there is the additional advantage of a smaller carbon consumption with the shorter arcs.

Unfortunately, in attempting to realise in actual practice the ideal conditions enunciated by Mrs. AYRTON, a certain amount of difficulty is met with as regards the steadiness of the light. The closer we fulfil the ideal conditions the closer we have to work to the unstable condition of hissing. Further, with a short arc the proportionate variation in its length with a poor feed action is much greater than in a long arc. On the other hand, given a good feed, short arcs are in themselves the steadier. In public arc lighting, perhaps, these conditions for maximum efficiency have been worked to, on the whole, as far as possible, but it is interesting to note that the bulk of private arc lighting is carried out under conditions far removed from those conducing to economy. Perhaps the chief reason for this is that the low elevation at which lamps of this class are installed necessitates the use of many lamps of small capacity in order to secure passably uniform distribution of light. Take the case of enclosed arc lamps. The reason for their very extended use may be found in their saving of carbon and attendance,—items which represent a large proportion of the total cost of the maintenance of arc lamps. While keeping in mind this characteristic of enclosed arcs, it is interesting to compare the arc conditions in this type of lamp with the conditions for efficiency set forth by Mrs. AYRTON. As compared with the one millimetre or slightly less length of arc in the ideal lamp, power is expended in the enclosed lamp on something like 12mm. length of arc. This length to some extent secures the light from being obscured by the lower carbon, yet even this advantage is discounted owing to the very blunt burning of the negative as well as the positive carbon end. Further, owing to the necessary employment of a comparatively small current—generally half that used in an open lamp of similar capacity—the ratio of the power consumed in the arc to that taken from a constant-pressure circuit is much the lowest in the case of the enclosed arc lamp.

The latter part of Mrs. AYRTON's Paper, in which an explanation is sought of the observed fall of the total light from the arc after the second maximum value of the light has been passed with increase of arc length, is of less practical importance. This investigation is, however, exceedingly interesting from the point of view of theory. Especially so is the account of the ingenious experiment of throwing a shadow of the arc itself and the resulting evidence of its refracting power. This part of Mrs. AYRTON's researches, together with her deductions from them, is more fully dealt with in a conclusion to her Paper which she has just sent us as we go to press; and we hope to publish this with our comments in a future issue.

STABILITY OF TEMPERATURE IN AN ELECTRIC CONDUCTOR.

BY H. E. WIMPERIS, B.A., WH.SC.

It is well known that the electrical resistance of most metals increases with rise of temperature, the law being nearly linear. This fact suggested to the writer that possible cases of instability of temperature might occur in the case of a conducting wire, along which a constant current flowed. Thus in Fig. 1, AB is a wire of some conducting metal and a constant current is kept flowing between A and B. Consider a small length CD of the wire, and let it be raised (by a flame, for instance) to a higher temperature than the neighbouring portions of the wire; the resistance of CD is increased and therefore the heat generated by the current at that portion will be greater, since the term (current)^2 × resistance is increased, and its temperature will tend to rise still further.

There are two phenomena that tend to oppose this rise of temperature, and they are the increased radiation from the wire and the fact that heat is conducted away through the material of the wire itself.

The latter of these two results can be made of very slight importance by suitably designing the wire. Whether or no the temperature of CD will rise or fall on the flame being removed depends upon which is greater, the increase of heat owing to increase in resistance or the decrease of heat due to increased radiation. It is obvious that similar problems may be examined in which constant voltage is maintained or in which cooling instead of heating occurs. In Fig. 2 temperature and heat change are plotted as co-ordinates; the dotted lines are curves of increase of C^2R plotted with respect to temperature, and the firm lines are curves showing the loss of heat owing to radiation for different

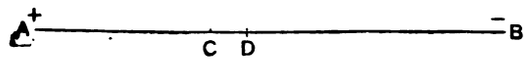

FIG. 1.

temperatures. Thus P and Q would be points of equilibrium, since at P (for example) PM would represent both heat gained from the electric current and heat lost by radiation, and these are shown equal; hence the point P is one of equilibrium. Having established the fact that P and Q are both points of equilibrium, it next becomes necessary to determine whether they are points of stable or unstable equilibrium. Consider the equilibrium at P, and let the temperature increase from OM to ON; then the heat supplied by the current increases from PM to P_2N, and the heat lost by radiation from PM to P_1N. In this case it is evident that the loss of heat is greater than the gain, and the temperature will, therefore, sink to its original value OM; the point P is a point of stable equilibrium.

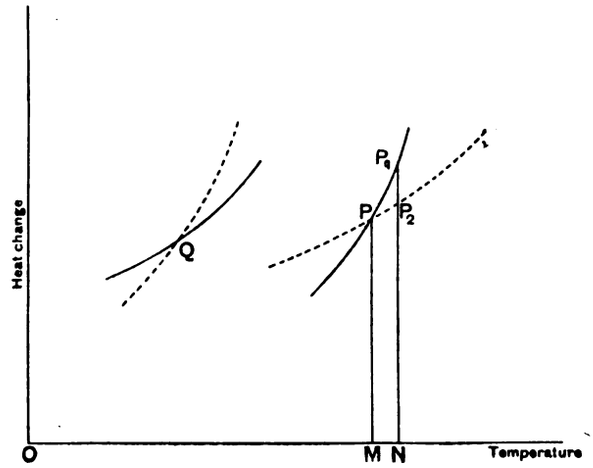

FIG. 2.

A somewhat similar investigation will show that the point Q is a point of unstable equilibrium, since if the temperature increase it tends to increase still more, and if to decrease to decrease still more. The discriminating condition between stability and instability being, which is greater, the slope of the radiation curve or the slope of the resistance curve at the point considered? Finally, it is found that instability is impossible with any metal known. Imagine a wire in equilibrium at a temperature of 200°C., and let the temperature of surrounding objects be 20°C.

The curve for this case is shown in Fig. 3. OA represents the temperature (absolute) of surrounding objects, the dotted line OCPD is the curve of resistance (with respect to temperature), O is the absolute zero of temperature, APB is the curve of heat lost by radiation, OF is the temperature (absolute) of the wire itself. The curve APB is determined from the fact that it must pass through the point A, owing to the fact that the net radiation between bodies at the same temperature (a

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curious physical fact) is zero, and it must pass through P as P is a point of equilibrium by the hypothesis of the case.

Abundant experiments have shown that the law connecting resistance of a metal with temperature is nearly linear and always passes through or near to the point of absolute zero.

These facts, taken together show that the slope of the radiation curve at P must be greater than the slope of the resistance curve at that point. Hence P is a point of stable equilibrium—it is noteworthy that with surrounding objects at the zero of temperature instability might occur. P would be a position of instability if the radiation curve were the broken one shown at AHPK, but radiation curves are always convex to the axis of temperature. The writer tried a few* experiments with an iron wire before the above form of solution occurred to him; they may be summed up thus: (1) A current was passed through an iron wire so that the wire was just not red hot, a flame was applied and taken away. Red heat spot slowly died away—without current it disappeared very rapidly. (2) Current was cut off and flame applied—flame was removed and red heat spot allowed to die out. Current was again put on after a few seconds interval and red heat spot shone out again and then died away. Current was of same amount as in Experiment 1. (8) Same current was applied and red heat spot obtained by

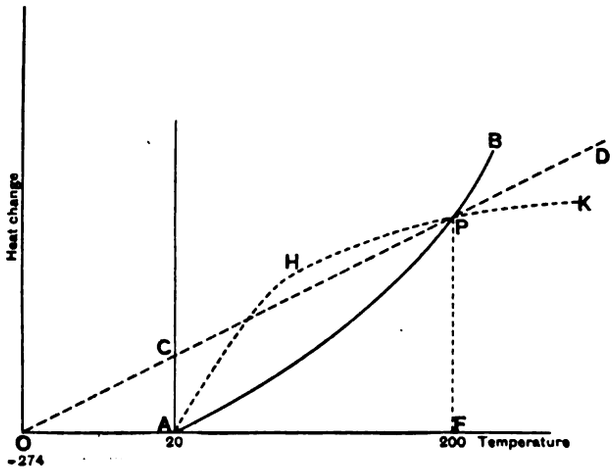

Fig. 3.

flame (flame being then removed). The writer tried to determine whether spot would go to right or left before dying out. It was difficult to determine any motion—if any it was to right. Current was then found to be flowing so as to move spot to right. In this last experiment the motion of the spot (if any really occurred) was due to the fact that owing to difference of temperature in different parts of the wire a thermo-junction effect was set up, helping the current at one end of the heat spot and retarding it at the other end.

ON THE CONSTRUCTION OF DYNAMO-ELECTRIC MACHINES.†

BY MAURICE LEBLANC.

In every dynamo the useful fields are those which pass in the same manner through both the inducing and induced circuits. The other fields, called fields of magnetic leakage, have always a detrimental action. Further, it seems legitimate to say that the best dynamo-electric machine is that in which the magnetic leakage is reduced to a minimum, and, secondly, that in order to reduce such leakage to a minimum, it is necessary to bring the inducing and the induced circuits as near together as possible. To this end it is desirable: (1) To dispose the circuits, the one in notches running in the direction of the length of the internal surface of a ring of laminated iron, the other, in similar notches, running the length of the external surface of another laminated ring concentric with the first, the two rings being separated by a very small air-gap (see Fig. 1). (2) To place the end connections on two concentric cylinders, projecting on both sides of the rings and as near together as the necessities of construction will permit (see Fig. 2). In the case of machines of the induction type in which the field is generated by alternating currents of high frequency, the necessities of the case have resulted in this type of machine being employed. I believe that there would be also the greatest advantage in employing the same design for continuous-current machines and for alternators, and that on these lines machines could be constructed which would be, from every point of view, more economical than those now in use.

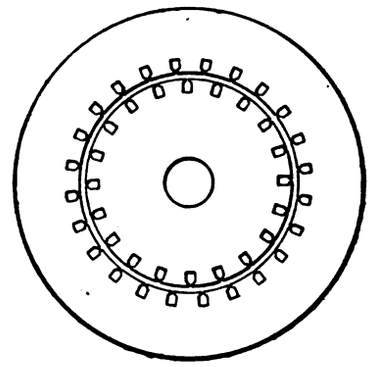

Fig. 1.

In machines of this type, however, the magnetising force developed by the currents in the induced circuits will be of the same order so far as strength is concerned, as that developed by the inducing circuits. It results then that if we wish to obtain currents at constant voltage, which is generally the case, it will be necessary to vary the

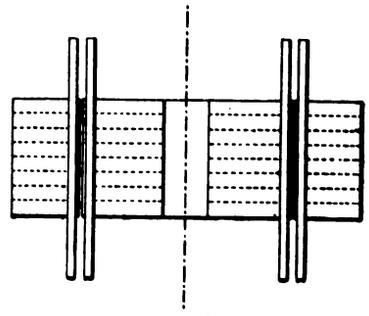

Fig. 2.

strength of the exciting current to a very considerable degree as the load on the machine varies. If this type of machine is to be utilised, as I propose, the variations in the exciting current must be obtained automatically, and by means as simple as those employed in the case of ordinary compound-wound continuous-current machines. We will now see how this result can be obtained in each case.

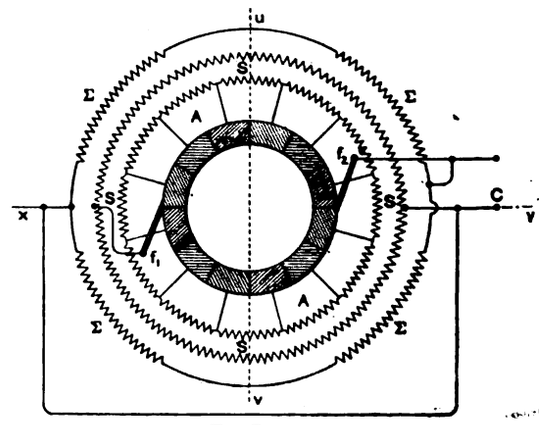

Fig. 3.

I.—Continuous-Current Machines.

The arrangement which it will be best to adopt is shown in Fig. 3. The armature is similar to that of all continuous-current machines in which the connections are placed upon the surface of a cylinder. In the notches in the fixed ring which surrounds it, there are placed: (1) A winding, SS, a reproduction of that on the armature and arranged in series with the armature winding. This winding is so

* The writer is indebted to Mr. Miles Walker, of St. John's College, for suggestion of a graphical in preference to a mathematical treatment.

† Paper read before the International Electricity Congress at Paris.

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disposed that it develops a magnetising force equal and of opposite sign to that developed by the armature. In these circumstances, the circuit of the machine comprised between the brush f and the terminal c may be considered as having no appreciable self-induction, since it cannot generate any flux other than the magnetic leakage which may occur along the air-gap between the two rings. (2) A winding, arranged as a shunt between the brush F_2 and the terminal c, and which generates a flux in the direction of the diameter vv at right angles to a line joining the brushes. The production of the useful flux is thus less costly in that no other flux is superimposed upon it, and no increase occurs in the reluctance of the magnetic circuits of the machine when the load upon it is increased, as is the case in ordinary machines. An arrangement whereby the reaction of the induced circuit of a continuous-current machine is directly annulled by a magnetising force, produced by a special winding, which is in every direction equal but of opposite sign to that developed by the armature, has already been proposed, I believe, by Messrs. Fischer-Hinnen and Ryan.

When this arrangement has been applied to machines designed in the ordinary way it is true that no great benefit has resulted; but this was natural, seeing that the machines were not adapted for the improvement. This will, however, no longer hold if we employ, as I propose, the carcase of an induction machine in the manufacture of a continuous-current machine. The absence of armature reaction would allow of the length of each pole being increased as far as desired, and of the reduction of the air-gap to the minimum required for mechanical clearance. Machines could then be constructed in which the brushes required no shifting, in which the production of the field cost practically nothing, and in which the weight of copper on the field was practically the same as that on the armature. The machines would then be very light and consequently very economical. Further, as the machines would have no appreciable armature reaction, it would be possible to vary their voltages between the most extreme limits when they were employed as generators, and similarly to vary their speeds when run as motors.

II.—Alternators.

In a continuous-current machine it is necessary for the commutation that the direction of the flux developed in the machine should be constant if one does not wish to have to shift the brushes as the load varies. This condition has no longer to be fulfilled in the case

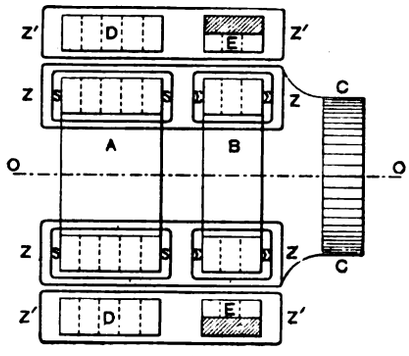

Fig. 4.

of an alternator. It will suffice, therefore, to provide a single exciting circuit, and so to alter the strength of the current in this circuit that, as the load varies, the voltage remains constant.

But as in the preceding case, the chief function of the exciting current will not be to generate the inducing flux, the strength of which the designer will arrange to be as great as possible by the reduction of the air-gap to a minimum and by keeping the iron far from saturation. The principal function will be to develop a magnetising force equal and opposite to that erected by the armature windings. The intensity of the exciting current should therefore be varied considerably with the variations of load on the machine, and the necessary variation ought to be obtained, if possible, automatically.

As a general rule one regulates the voltage of an alternator by varying the field of its exciter. We will now see if it is possible to retain this mode of regulation and to render it automatic: (1) By employing as exciter a continuous-current machine whose field is produced by alternating currents acting through a rectifier or a transformer-rectifier; and (2) by employing more than one circuit to produce the field of this exciter, as in the case of an ordinary compound-wound machine, certain of these circuits being in parallel and the others in series with the armature circuits of the alternator we wish to excite.

In order to fix our ideas, let us assume that we wish to excite a three-phase alternator, and that we employ for the purposes of excitation the special exciter with two poles shown diagrammatically in Fig. 4. Upon the same axis OO are placed the two rings A and B, and around the ring A is wound the circuit S, consisting of three bobbins situated 120deg. apart, S_1, S_2, and S_3. These bobbins are in series with the circuits P_1, P_2, and P_3 of the alternator, through the intermediary of collecting rings and brushes, as shown in Fig. 5. Round the ring B is wound a circuit comprising three bobbins 120deg. apart, Σ_1, Σ_2, and Σ_3. These bobbins are connected as shunts between the three terminals of the alternator I., II., and III., and a neutral point, M, to which are also led the ends of the bobbins S_1, S_2, and S_3. In series with each of the circuits Σ_1, Σ_2, and Σ_3, there is further placed a coil, the self-induction λ of which is adjustable (see Fig. 5).

The rings A and B, with these windings upon them are displaced, relatively to one another, by a certain angle ξ, which will be dealt with later. A continuous-current winding, Z, is then added, which encloses at the same time both rings A and B. This winding terminates in a collector CC (see Fig. 4). Two brushes, at the opposite ends of a diameter, bear upon this collector, from which is obtained the direct current for exciting the field of the alternator.

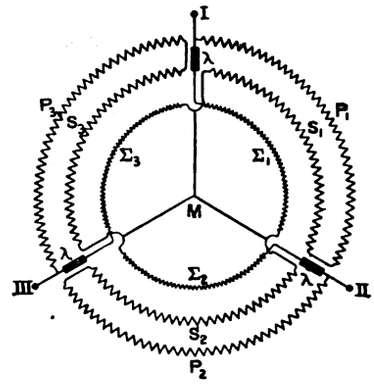

Fig. 5.

The rings A and B rotate in the interior of two iron rings D and E, which serve to complete the magnetic circuits for the fields generated by the windings on A and B. The sections of rings A and D are so proportioned that the magnetic circuit of A is always far from saturation, while the section of E, on the contrary, is such that it is magnetically saturated when the alternator produces its normal voltage. Finally, a winding Z', with the same number of turns as the circuit Z, is given to the rings D and E. This winding covers both rings simultaneously, and through it circulates the current from the collector CC, as is shown by the arrows in Fig. 6. The ends of this winding are so chosen that its magnetising force is equal and opposite to that of the winding Z.

The spindle OO is arranged to rotate in synchronism with that of the alternator, in any suitable manner; and the direction of rotation must be such that the fields produced by the windings S and Σ remain fixed in space. Under these conditions the winding Z will produce a continuous current just as though it were subjected to the action

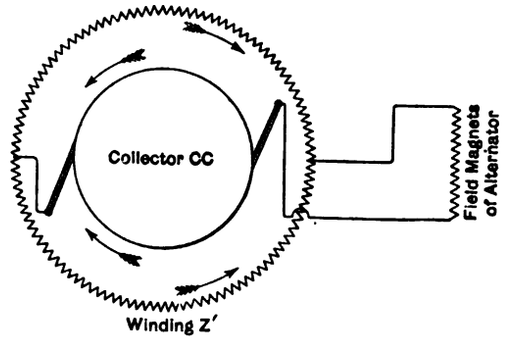

Fig. 6.

of a fixed circuit excited by a direct current. But whatever may be the strength of the current furnished by the winding Z it will produce no appreciable field, owing to its magnetising force being counterbalanced by that of the winding Z'.

I shall now proceed to show that if this exciter is properly dimensioned the alternator which it excites will give a constant voltage, no matter what the load, without the necessity for shifting the brushes of the exciter. As has been said above, if the alternator has been properly designed the resistance of those portions of its magnetic circuit which are of iron will be negligible compared with that of the air-gap, and we may consider its coefficients of self-induction as constant. And the same will hold good of each of the circuits of the winding S of the exciter.

1. *Angle of displacement of the rings A and B.*—Let us designate by r and l the resistance and the coefficient of self-induction of each

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of the circuits formed by the union in series of one of the armature circuits of the alternator and one of the windings S of the exciter. Let a be the frequency of the generated currents. According to what we have just said, the ratio $\frac{2\pi al}{r}$ will be constant.

Let $\tan\omega=\frac{2\pi al}{r}$ and $\xi=\frac{\pi}{2}-\omega$. The angle ξ thus defined is that through which it will be necessary to displace one of the rings relatively to the other, as has been said above. The ring B should be displaced relatively to A in the direction of the rotation of the rings.

2. *Proportions of the ring A and of the windings S and* Σ.—Let the armature of the alternator be short-circuited, and let the brushes of

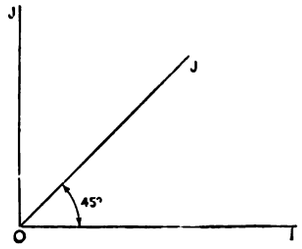

FIG. 7.

the exciter supply current to a resistance equal to that of the exciting circuit of the exciter. Let us then excite this exciter with a continuous current from an outside source. Further, let the machine rotate at its normal speed, and let the brushes be shifted until the current from the exciter brushes is a maximum. Then note the values of the current J furnished by the exciter for different values i of the exciting current. The curve connecting J and i will be a straight line (see Fig. 7). The ring A and the windings S and Z ought to be so arranged that this straight line makes an angle of 45deg. with the line Oi. The necessary adjustment will be facilitated by the introduction of a variable resistance in the field circuit of the alternator.

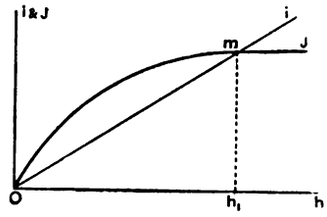

FIG. 8.

3. *Proportions of the ring B and of the winding* Σ.—Let us now open the armature circuits of our alternator, leaving the exciter circuited through the same resistance as before, and let us again rotate the alternator at its normal speed, exciting it from an outside source. The position of the brushes should be the same as in the preceding case. We then measure the strength, J, of the current, and i of the exciting current and the voltage h at the terminals of the alternator. Let the voltage be plotted as abscissæ, and the currents i and J as ordinates (see Fig. 8). Then the variations of i will be represented by a straight line, Oi, and those of J by a curve, OJ. The ring B and the winding Σ should be so designed that the curve OJ, which rises at first more rapidly than the straight line Oi, cuts it at a point in the abscissa, of which Oh_1 represents exactly the voltage h_1 that the

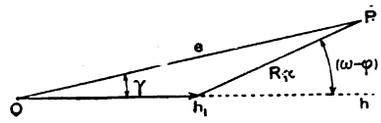

FIG. 9.

alternator should furnish. The precise adjustment will be arrived at by altering the self-induction bobbins λ in series with the windings Σ_1, Σ_2, and Σ_3.

Let $R=\sqrt{r^2+4\pi^2a^2l^2}$, and let us designate by a the strength of the current given by each of the armature circuits of the alternator at the voltage h, by ϕ the phase difference between the current and the voltage, and by e the E.M.F. which the rotation of the alternator ought to develop in the armature circuits to give the voltage h under these conditions of load.

It can easily be shown that the E.M.F. e can be determined as a function of the quantities h_1, a and ϕ, by the geometric construction represented in Fig. 9. Along a straight line Oh let us take a length Oh_1 proportional to the voltage h_1. From the point h_1 draw a straight line OP, whose length will bear the same proportion to the product Ra that Oh_1 does to the voltage h_1. Then the angle γ, between the lines OP and Oh represents the phase difference between the E.M.F. e and the voltage h_1.

We may consider the three E.M.F.s h_1, Ra, and e as developed by the rotation of three fields of strengths Oϕ, Oψ, and Oχ such that $\frac{O\phi}{h_1}=\frac{O\psi}{Ra}=\frac{O\chi}{e}$. These fields will rotate simultaneously with a speed a with respect to the armature of the alternator, which we assume to be bipolar (Fig. 10). The field Oχ will be generated by the field circuit, its rotation will depend only upon that of the alternator, while the phase of the movement of the field Oϕ, defined by the angle γ between Oχ and Oϕ will vary with the load on the alternator, and the directions Oχ and Oψ will enclose between them an angle $\beta=(\omega-\phi)$.

Let us now examine the case of the exciter, when each circuit of the armature of the alternator gives a voltage h, with a current a, the angle ϕ having a determined value. The winding Σ creates in the rings B and E a field Oϕ' (Fig. 11) which rotates with reference to it as the field Oϕ rotates with respect to the circuits of the armature of the alternator. But the ratio of fields Oϕ and Oϕ' is not constant. It varies with the voltage h according to a law which could be deduced from the curve OJ in Fig. 8. The winding S develops in the rings

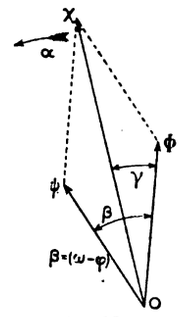

FIG. 10.

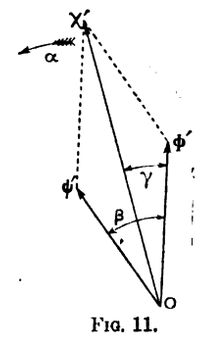

FIG. 11.

A and D a field Oψ', which is at each instant proportional to the product Ra, and the direction of which always makes an angle $\beta=(\omega-\phi)$ with the direction of the field Oϕ, owing to the displacement given to the rings A and B.

From Figs. 7 and 8 we see that,

$$\text{if } h<h_1 \text{ then } \frac{O\phi'}{O\phi}<\frac{O\psi'}{O\psi},$$

$$\text{if } h=h_1 \text{ then } \frac{O\phi'}{O\phi}=\frac{O\psi'}{O\psi},$$

$$\text{if } h>h_1 \text{ then } \frac{O\phi'}{O\phi}>\frac{O\psi'}{O\psi}.$$

When $h=h_1$, the Fig. 11 is similar to the Fig. 10, and as the direction Oϕ' is always the same as the direction Oϕ, the direction Oχ' corresponds with the direction Oχ.

The rotatory movement of the field Oχ' with respect to the rings A and B only depends upon the rotatory movement of the alternator. If the latter advances, the movement of the rings A and B is equally retarded. The direction Oχ' is thus fixed in space, and is invariable

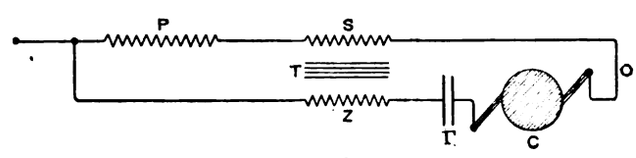

FIG. 12.

with reference to the brushes of the exciter as long as the voltage developed by the alternator is equal to h_1, and when this is the case we have

$$\frac{O\chi'}{e}=\frac{O\phi'}{h_1}=\frac{O\psi'}{Ra}.$$

But the exciter has been so proportioned that when the field Oψ' exists by itself, and has a direction at right angles to the line of contact of the brushes, its action produces a direct current capable of developing in each of the armature circuits of the alternator an E.M.F. equal to Ra; and the field Oχ' also having its direction at right angles to the line of contact of the brushes, will generate a current through the agency of the exciter capable of developing, by the agency of the field circuit of the alternator, in each armature circuit of the alternator an E.M.F. equal to e. But this is precisely the E.M.F. which should be produced if the alternator is to yield a voltage h_1 under the same conditions of load.

Now let us suppose that the voltage h is less than the voltage h_1. The E.M.F. between the brushes, and consequently the strength of the exciting current furnished by the exciter, will be proportional to

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the sum of the projections of the lengths $O\phi'$ and $O\psi'$ upon the direction Ox', considered as invariable and at right angles to the line of contact of the brushes. The angle γ, between $O\phi'$ and $O\psi'$, will always be equal to the angle γ between $O\gamma$ and $O\phi$ of Fig. 10. Similarly, the angle β between $O\phi'$ and $O\psi'$ will always be equal to the angle β between $O\phi$ and $O\psi$.

But we shall have $$\frac{O\phi' \cos\gamma + O\psi \cos(\beta-\gamma)}{Ox} > \frac{O\phi'}{O\phi}.$$

The strength of the exciting current will be greater than would be necessary to maintain a voltage h at the terminals of the alternator. The latter, therefore, will increase until it has reached the value h_1.

Similarly, if $h > h_1$ we have

$$\frac{O\phi' \cos\gamma + O\psi \cos(\beta-\gamma)}{Ox} < \frac{O\phi'}{O\phi},$$

and the voltage will decrease until it has again become equal to h_1. Thus the alternator will always give a constant voltage, no matter what its load.

I think that I have shown in what has preceded that a rigorous solution of the problem of compounding *an alternator for constant voltage*, when its coefficients of induction are constant (a condition easy of fulfilment) can be obtained if the machine is constructed on the lines of the induction type of machine now in actual use.

We may try to apply the same method of compounding to alternators of the polar type, in which the fields are always strongly saturated; and though it will not be possible to arrive at the same rigorous solution, since the induction coefficients of these machine vary with their load, nevertheless, the variations of voltage occasioned by sudden changes of load may be sufficiently limited to allow of the output of the machines being determined by the heating of the conductors and not by the fall in voltage. Take the angle ω as equal to $\pi/2$, and proportion the ring B and the windings Σ and Z, so that the machine gives the desired voltage on open circuit. Then the ring A and the winding S will be arranged so that the machine will give the same voltage at full load. It will be useless in this case to saturate the magnetic circuits of the rings B and E. In Fig. 8 the curve OJ will be represented by a straight line, and the straight line Oi by a curve similar to curve OJ. These will always meet at a point, m, the abscissæ to which will measure the voltage that the alternator is to give.

The exciter described above as an example only presents the general type. It consists of two magnetic circuits, in which are developed separate revolving fields: the one by windings in series with the alternator armature, the other by windings in parallel with it. The two fields operate simultaneously upon a winding of a direct-current machine provided with a commutator.

This arrangement seems to be essential, and ought to be followed, whatever be the type of exciter or of transformer-rectifier which may be substituted for that described above. We will endeavour to prove this. Suppose we employ an exciter or a transformer-rectifier consisting of a single magnetic circuit. Then the E.M.F. e that the rotation of the alternator should develop in each of its armature circuits, when those circuits give a voltage h and a current of strength J is $e = h + rj + l\frac{dj}{dt}$, and the exciting current should be, at each instant, proportional to the E.M.F. e. This current could be produced by means of a commutator, between the rings of which an alternating E.M.F. equal to e was generated.

In order to simplify the problem, we may remark that the product rj being always small compared to the product $l\frac{dj}{dt}$, no great error will be committed by substituting for e, $e' = h + l\frac{dj}{dt}$.

This E.M.F. may be obtained in the following manner: Let P be one of the armature circuits of the alternator that we wish to excite (Fig. 12). In the figure it is shown in series with the primary circuit of a transformer, T.

The secondary, Z, of this transformer is placed in a shunt circuit between the neutral point O and the free end of the circuit P. In this circuit is the commutator C and a condenser Γ, the capacity of which is so adjusted that the apparent coefficient of self-induction of the secondary circuit Z is counterbalanced. In these circumstances, if we designate by m the coefficient of mutual induction of the two circuits of the transformer, the voltage at the terminals of the exciter will be equal to $h + m\frac{dj}{dt}$. Take m as equal to l. But we have supposed a condenser to be employed, and this is not practicable. If we take it away the circuit containing the rectifier will remain with a coefficient of self-induction L. Let us call i the strength of the current in the secondary circuit Z, then the voltage at the terminals of the rectifier will be equal to $h + \frac{mdj}{dt} + L\frac{di}{dt}$, and this expression differs entirely from that of the E.M.F. e'. If we wish to make the effective product of $L\frac{di}{dt}$ small as compared with the product $m\frac{dj}{dt}$ it will be necessary to give to the primary circuit of the transformer, which is in series with one of the armature circuits of the alternator, an enormous coefficient of self-induction. This will tend to greatly reduce the power of the alternator. In the arrangement we have adopted the secondary circuit Z of the transformer T is replaced by a winding of a direct-current machine provided with a collector, and its action annuls the effects of self-induction. Consequently it plays the part of the condenser Γ in the case examined above. It would be possible for us to do away with the transformer T, and to employ instead, in series with the alternator, the circuits of an exciter which would be subject to the action of an inducing circuit I excited by a direct current of constant strength furnished by an outside source (see Fig. 13), but we can see at once that this method of excitation would not permit of an exact compounding unless the cos ϕ of circuit were constant. But this condition is never realised, for the

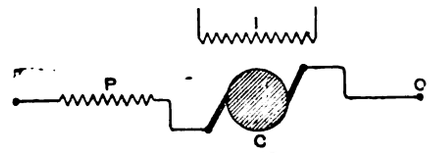

FIG. 13.

sudden variations of load occasioned by the starting of induction motors are always accompanied by a momentary, yet considerable, variation of cos ϕ.

CONCLUSION.

I believe that I have shown, in what has preceded, that there is the greatest advantage, both from the point of view of the best utilisation of material and of output, in adopting the induction type for both alternators and direct-current machines, and that it will be most profitable to excite them by means of currents, the strengths of which vary automatically with the loads on the machines, since the chief function of the field circuit will be not to create a useful field, but to give in every direction a magnetising force equal but of contrary sign to, that developed by the armature.

Further, I think I have proved that nothing is easier than to obtain such an automatic regulation of the exciting current, and the possibility of constructing machines according to the principles we have laid down has been demonstrated in practice.

At the Paris Exhibition, in the exhibit of the Société des Etablissements Postel-Vinay, there is shown a transformer-rectifier form of motor which may be regarded as a direct-current machine of the induction type. Further, in the exhibit of the Grammont firm there is a small alternator of 75kw. running at a speed of 800 revs. per min. which is also of the induction type. This machine is provided with an exciter identical with that described above. There is also a 1,000 H.P. alternator of the polar type, running at 94 revs. per min., and designed by M. Routin, in the same exhibit.* It has an exciter somewhat different to that I have described, but equivalent to it. There are also many machines similar to that exhibited by M. Postel-Vinay, which have been in service for several years, and their number is ever increasing.

The 75kw. alternator is certainly of small dimensions considering its output. It has been tested with the most satisfactory results, and by its means I have demonstrated—

1. That the excitation of machines of this description is automatic.
2. That a constant voltage can be obtained from the alternator under all conditions.
3. That the brushes of the exciter wear exceedingly well.
4. That machines of this type run perfectly in parallel with machines of other types.

As regards the large machine, it was first tested at the exhibition itself, and in these circumstances it was impossible to adjust its exciter exactly to the work it had to do. But it may be stated that the condition of its brushes is very satisfactory, and that the strength of the exciting current rises gradually with the load on the machine.

Elsewhere there are shown other methods of compounding alternators, devised by MM. Blondel and Boucherot and exhibited by MM. Sautter and Harlé and by the firm of Bréguet.

The Pollak-Virág Fast-Speed Telegraph.—According to the *Daily Chronicle* Messrs. Pollak and Virág have devised an important modification in their fast-speed telegraph. It will be remembered that in the original apparatus, the signals were received in the form of a wavy line, similar to that traced by the siphon recorder, on a slip of sensitised paper. According to our contemporary's report, the accuracy of which we, of course, do not vouch for, the inventors have devised a modification by means of which, instead of this record, messages can be actually printed on the photographic paper in ordinary round-hand Latin characters at the rate of 1,000 words per minute.

* This machine was described in *The Electrician* of Sept. 28, p. 845.—ED. *E.*

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FUEL FOR GAS MOTORS.*

BY PROF. AIMÉ WITZ.

Among the advantages of gas-motors, is the fact that they can be fed with the most diverse of gaseous fuels, from rich combustibles like acetylene to gases as poor in calorific power as blast-furnace gas. In order to burn these different substances, the proportion of gas and air must be adjusted, a perfect mixture of the two obtained, and the degree of compression and mode of firing properly arranged. With a suitable carburetter, even liquid hydrocarbons of very different density and volatility—from petroleum ethers or gasolines to petroleum burning oils—can be used. To this great adaptabiilty of the motor is due the fact of its use in town and country, in the vicinity of a coal-gas works, or other gas-making plant, either as a stationary engine or for automobile purposes, and in sizes the capacity of which vary from a few kilogramme-metres to 1,000 H.P. The 1,000 H.P. motor is to-day a practical realisation of the dreams of inventors; for it is possible to connect, in series or otherwise, two cylinders similar to that of the motor shown in the Belgian section by the John Cockerill Company of Seraing. This machine is on the Delamare-Cockerill system of monocylindric type. Its cylinder measures 1·300 metres in diameter, and its stroke is 1·400 metres. Before a commission of expert engineers it has proved itself equal to producing from 560 H.P. to 670 H.P. when burning blast-furnace gas of 985 calories per cubic metre. It absorbs about 2,120 cubic metres per hour to give 670 H.P. According to the original statement of a famous inventor, smelting is really a secondary operation of a blast furnace, which may be regarded as a gigantic gas producer yielding 150 tons of pig-iron on the one hand, and 600,000 cubic metres of gas on the other. Reckoning half this gas for heating the blast and for other purposes, there remains a suplus of gas, from a blast furnace of 150 tons, sufficient to produce 3,500 H.P. in gas motors; 1,000 H.P., and sometimes not so much, is obtained with difficulty when the gases are used to raise steam.

The gas-motor has thus taken up its place as an adjunct to the blast furnace, and produces the most satisfactory results. Similar success awaits the engineers who shall use it with gas from coke furnaces. The producers of Dowson, Gardie, Lencauchez, Duetz, Pierson, Fichet and Heurtey, Bénier, and others, have paved the way for the future success of the gas-motor. In the earlier period of producer-gas making, it was necessary to use special coals, preferably anthracite, freed from powder, non-caking, with little ash, and yielding no fusible clinker—in short, a coal of such special character that only a high price could procure. But now it has gradually become possible to use ordinary anthracite coals of moderate price, so that the cost of the producer-gas has been greatly diminished, and the possibilities of the producers greatly increased. Electric power works, pumping stations, printing presses, looms, and spinning and other mills have taken their motive power from it with most satisfactory results. A 100 H.P. motor, working 3,000 hours per annum, fed with anthracite coal costing 25fr. per tonne, furnishes 1 horse-power hour for, at any rate, 4c.,† an advantage of about ½c. over a good steam engine in which coal at 20fr. is burnt. Its first cost is much less. The producer-gas varies from 1,200 calories to 1,600 calories per cubic metre. Gas producers are very suitable for coke; but the present high price of this fuel is not likely to encourage its use. A producer has recently been put down in Messrs. Brunner, Mond, & Co.'s chemical works at Northwich, in which small and bituminous coal can be consumed; and the recovery of the bye-products has proved most satisfactory. The complete apparatus is really a miniature gas works; but the cost of the kilowatt hour is placed at about 4c. (excluding interest and depreciation of plant), with Crossley motors of 25 H.P. power, a figure which justifies the expense of a complete plant. The Riché producer, using wood, gives a comparatively rich gas of 3,000 calories, which has been found to work well in Charon motors. It is an apparatus susceptible of many different uses in districts where wood for fuel can be found, and for this reason ought to extend the usefulness of the gas motor.

The water gas of Tessie du Motay has not been much used as a fuel for gas motors. The facts that the plant must have coke, and that it acts intermittently, are, no doubt, the explanation. The Dellwik producers, which give a gas of 2,000 calories, had a measure of success in Germany; while the tendency in America is to revert to the Lowe producer, as modified by Merrifield. Few experiments on the feeding of motors with water gas have been made; yet it has been shown that the engines behave as well with water gases as with mixtures of the latter and Siemens gas, whatever may be the proportion of nitrogen.

MM. Biedermann and Harvey have suggested the supply of carbon dioxide to gas producers. The gas (CO_2) would be reduced to carbon monoxide by contact with the incandescent coke. Should this idea become practicable, it would be possible to regenerate the waste gas of the motor, and so complete the cycle of changes involved in the use of producer or water gas as fuel. The high temperature of the escaping gas would doubtless be enough to maintain the reaction; and the heat of the waste gases would thus be recovered. Unfortunately, the nitrogen would accumulate in the recovered gas (due to the air supplied to the motor); and the whole volume of waste gas could not therefore be operated upon. The outline of this process, which has been mentioned in the third volume of "Traité des Moteurs à Gaz," suggests experiments which would be perhaps more interesting than practically useful, but which would nevertheless bear upon the theory of the question.

In regard to gases obtained by destructive distillation, their calorific power varies from 3,500 for gas from dried wood, to 5,350 for coal gas, and 7,500 for cannel gas. These are average figures; but I have found coal gas—the so-called house gas—to vary from 5,000 calories to 6,000 calories.* Ordinary house gas was that first supplied to motors, for which they were designed and made, from the machines of Philippe Lebon to those of Lenoir and Otto. With gases at 10c., 15c., 20c., and 25c. and motors of 4 H.P., 10 H.P., or 30 H.P., the cost per horse-power per hour can be found from the following table:—

Horse-power of motors.	Cost per horse-power per hour, with gas costing			
	10 centimes.	15 centimes.	20 centimes.	25 centimes.
4	11 centimes	14 centimes	17 centimes	20 centimes
10	9·7 „	12·7 „	15·7 „	18·7 „
30	8·5 „	11·5 „	14·5 „	17·5 „

These figures—which are not advanced as exact, since the factors are variable—show, at any rate, that up to 10 H.P. the gas motor has nothing to fear from any other motive power, even with gas at 20c.; while for 30 H.P. the price of the gas ought not to exceed 15c.

It is true that the gas motor on the town main possesses advantages which would obtain support for it, even if the cost per unit of energy were greater. These are briefly: No other plant, no furnace or fireman, no stock of fuel, put in or out of action at once, and no expense when not actually in use. Moreover, it can be placed practically anywhere; and, if properly constructed, it is so nearly noiseless as not to raise objection from neighbours. The last point has not always been realised; but this has more often been due to the fixing of the motor and its accessories than to the machine itself.

In towns, the applications of gas-motors have not developed to the extent which might reasonably have been anticipated from the improvements of the past 10 years. Now that 1 H.P. per hour can be obtained by the consumption of 500 litres of gas of 5,350 calories per cubic metre at 0°C. and 760mm, the use of such motors ought to be profitable and economical in many industries. It is astonishing to find that the Paris Gas Co. sold only 10,013,000 cubic metres of gas in 1899 for use in motors in Paris and the suburbs. This is scarcely $\frac{1}{33}$rd of the total make—say about 3 per cent. In Germany, certain works supply 17 per cent. of their gas for motors, although the price of gas is not less than here nor the motors superior. It may therefore be hoped that the progress in this direction which has been evident in Paris in the present year owing to the exhibition, will continue, and that there will be an increasing demand for gas for use in motors. The enrichment of house gas by carburetting has been tried, but it seems as though this is of no advantage to the consumer who uses the gas as a motive power. Acetylene gas, of which premature hopes were entertained, has not given any very encouraging results, in spite of the able work of MM. Ravel, Cuinat, Franck, and many others. I am not aware of a single application in this direction. All that has been done has been to show that the gas motor can work with such a rich gas; but it still remains to make it practical. Experimental results confirming the preceding statement are in favour of the gas-motor which, as has been mentioned, can be fed with blast-furnace gas of 900 calories, or with acetylene of 14,000 calories per cubic metre. M. Lencauchez has also shown (in the analysis of a number of more or less official reports) that the thermal yield of motors varies appreciably with the richness of the gaseous fuel. The trials I have made at Seraing and Differdange confirm this statement, inasmuch as the horse power per hour could be obtained with 3 metres of gas of 980 calories, equivalent to 549 litres of gas of 5,350 calories. This number corresponds to a yield in actual work of 21·7 per cent., and in indicated work of 25 5 per cent. But I have never obtained more than 21·1 per cent. and 26 per cent.

* Paper read before the International Gas Congress at Paris.

† I reckon 5 per cent. for interest, 3 per cent. for depreciation of buildings, and 6 per cent. for that of machines and materials.

* This relates to the calorific power at constant volume (steam condensed), as determined by means of my eudiometric bomb. I obtain complete combustion, which is not always the case with poor gases in calorimeters which burn the gas at constant pressure.

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THE USE OF CONDENSERS.*

BY P. BOUCHEROT.

All the applications of condensers to industrial alternating currents may be considered as the consequence of electric resonance, and therefore of the oscillating discharge or charge. If C is the capacity of the condenser, L the coefficient of self-induction of the discharge circuit, and R the resistance of the circuit, the discharge is continuous for $R^2 > 4L/C$, that is to say that the discharge current which has at the moment of the closing of the circuit a certain value, diminishes to zero without passing through negative values. On the other hand, the discharge is oscillatory for $R^2 < 4L/C$, where the discharge current does not become zero until having passed through a series of positive and negative values. The periodic time of such a discharge is constant, that is to say, the time which elapses between two zero values of the current is the same at the beginning or at the end of the discharge. It does not depend in consequence on the actual value of the electric charge and is given by the expression

$$T = \frac{2\pi}{\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}}.$$

In the particular and exclusively theoretical case when the resistance of the circuit is zero, the periodic time becomes $T = 2\pi\sqrt{LC}$, a formula which, singularly, follows that of the periodic time of oscillation of a pendulum in a vacuum. In this case the energy stored primarily in the condenser cannot be dissipated as there is no resistance, and in consequence no RI^2, so that the discharge lasts indefinitely, that is to say, there exists for an indefinite time an alternating current in the circuit with the periodic time $T = 2\pi\sqrt{LC}$. It is evidently quite a theoretical case as one supposes that $R = 0$, which is an impossibility. But if it is not possible to make $R = 0$ it is easy to compensate constantly the loss of energy RI^2 by the introduction into the circuit of a source of current very weak compared with the energy acting in the circuit. If it is desired to make the amplitudes of the oscillations of the current independent of the time, this added E.M.F. must be of the same frequency as the alternating current due to the circuit formed by the condenser and the self-induction or the resonating circuit, *i.e.*, the periodic time of the E.M.F. must be $T = 2\pi\sqrt{LC}$. If it is, there will be resonance by analogy with the acoustical phenomena, but the circuit will only resonate for a current with a frequency corresponding to $T = 2\pi\sqrt{LC}$. For this current only, may Ohm's law be applied when taking account of the E.M.F.s of induction or capacity. Let me remark that this E.M.F. may be introduced into the circuit in any manner, and all kinds of applications are possible. I will examine the most important, and, to avoid repetition, I will say at the outset that a condenser and a self-induction are in all cases adjusted until the relation between the two is $4\pi^2LC/T^2 = 1$.

I. *Condenser in Series.*—Let us open this resonating circuit, and connect in it a source of alternating current—for instance, an alternator whose frequency is exactly $T = 2\pi\sqrt{LC}$. Under these conditions the current which will flow through the circuit will be exactly what would flow if there were only resistance—*i.e.*, if the self-induction and capacity were absent. This is what is implied when it is said that the capacity neutralises the effects of self-induction if it is properly adjusted to it. A curious detail is that if we have, for instance, 100 volts at the terminals of our circuit—*i.e.*, 100 volts produced by the alternator—we could quite well have 1,000 volts or 10,000 volts at the extremities of the induction coil or between the plates of the condenser, in consequence of the large quantity of energy which can be stored up in each of these apparatus in comparison with that furnished by the alternator during one period. The condenser can thus be employed to annul the effects of self-induction in a circuit. If, for instance, it is desired to pass through a circuit a larger current than that which the self-induction would permit with the pressure available, it is only necessary to include a suitable condenser. This property has been applied in certain simple alternate-current motors for the excitation of the field magnets, and may be applied usefully whenever one wishes to produce an alternating magnetic field without the apparent power furnished by the apparatus being much greater than the actual power expended by the Joule effect, and without being obliged to have an E.M.F. greater than that corresponding to the ohmic drop in the excitation of the circuit.

II. *Condenser in Shunt.*—Let us close our resonating circuit as it was at first, and let us connect between the two plates of the condenser a source of current. This source must have the same frequency as above. Under these conditions the current which the alternator will furnish to the condenser and that which it will supply to the self-induction and resistance may each be much greater than their sum—*i.e.*, greater than the total current furnished by the alternator in the two circuits. The latter will be strictly equal to the current which, at the pressure of the alternator, would give a power equal to the Joule effect, while each of the shunt currents will be greater in consequence of the superposition of the current of resonance. This property permits of the reduction, by means of condensers, of the magnetising currents absorbed by all the apparatus which do not produce their own magnetic fields, such as transformers, reaction coils, asynchronous motors, &c.

In the application to transformers and asynchronous motors, condensers may be shunted either to the primary or the secondary. If resonance is produced in one or other of these circuits the source of energy need not supply exciting currents. One can even produce resonance in a tertiary circuit which, in the asynchronous motor, may be wound either on the stator or rotor. These different combinations have been proposed and tried on transformers and both single-phase and polyphase asynchronous motors.

III. *Splitting up an Alternating Current.*—We now come to other applications of condensers in which the effects produced follow in a slightly less evident manner from resonance, because other currents of equal importance are superposed upon the resonance current properly so-called and complicate the phenomenon. At the head of these applications must be placed the splitting up of an alternating current into two currents differing 90deg. in phase. By connecting to a source of alternating current two shunted circuits, one containing a resistance ρ and a self-induction whose reactance is ρ, the other containing a resistance ρ and a condenser whose reactance is $-\rho$, the two shunts are the seat of alternating currents differing 90deg. in phase. So far, this arrangement has no particular interest, but if one replaces each of the resistances by one field circuit of a two-phase asynchronous motor, and at the same time modifies the reactance of the circuit so as to take account of the reactance of the motor circuits, an asynchronous motor can be driven with a simple alternating current. This application of condensers would be one of the most important; but even if an industrial condenser was to be had it would still meet with serious difficulties in its realisation, from the fact that the capacity ought to vary every instant with the load.

IV. *Constant Current Regulation.*—Condensers can also be used in combination with induction coils to obtain circuits with currents by means of constant E.M.F., and inversely. They permit, therefore, of a series distribution from any number of circuits branched on to a source of constant pressure, as, for instance, on an ordinary alternating-current supply circuit. For this it is only necessary to connect on to the constant-pressure mains a constant-current circuit and to shunt to it a condenser in series with a self-induction coil. The condenser and self-induction must be adjusted to constitute a resonator. Naturally each resonator must be connected to the constant-pressure circuit through the intermediary of a transformer, and this transformer having a self induction, the self-induction of the resonator may be eliminated and the system reduced to a transformer and a condenser. The same result may again be obtained more advantageously by the employment of a double resonator, constituted as follows: Two self-induction coils and two adjusted condensers are grouped to form a quadilateral ACBD in which the smaller apparatus are on opposite sides. Then by connecting the two opposite angles AB of the quadilateral to a source of constant E.M.F. one receives in a circuit placed between the two other points D and C a current which is constant whatever the impedance of the circuit. I will not dwell longer on these applications, but will only point out that the employment of two resonators, or more accurately of two condensers and a self-induction coil (or two self-induction coils and a condenser) permits the connection of two alternators in series, and also the realisation of an apparatus equivalent to an ordinary transformer transforming a current of constant pressure to another current of constant pressure.

V. *Excitation of Alternators.*—Just as condensers can furnish current for transformers and asynchronous motors they can also be used to excite alternators, and different systems of alternate-current generators could be devised in virtue of the following mechanism, which is, besides, the whole secret of resonance. In general, in an induction machine, an E.M.F. is the differential coefficient of a flux with respect to time, but with its sign changed. Its phase is therefore a quarter of a period behind the flux. If this E.M.F. is connected to condensers the current advances a quarter of a period on the E.M.F., and is therefore in phase with the flux, and in consequence can produce the flux. Condensers placed as a shunt to the armatures of an ordinary alternator can, by suitable arrangements in the alternator and by modifying its proportions, produce the field of this alternator.

We will cite two more systems of generators which can be excited by condensers. In the first there is no field magnet. A fixed armature and a moving armature with the same number of poles, the same number of phases, and the same number of turns, are both the seat of induced currents with the same frequency and the same pressure, in consequence of the rotation of the magnetic field, which moves in the two at a speed half that of the moving armature, and is produced by electromotive forces obtained with

* Abstract of a Paper read before the International Electricity Congress, Paris.

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the aid of condensers. In the second there are only two circuits, both fixed, and each with a coefficient of self-induction varying periodically and of the form $\lambda(1 \pm \sin 2\omega t)$, and between them a coefficient of mutual induction $-\lambda \cos 2\omega t$. But what is particularly interesting with all these generators, excited by condensers, is that by this means one can realise in these machines the same methods of excitation as with continuous current dynamos. If the condensers are placed in shunt the characteristic of the machine is the same as with a continuous-current shunt dynamo. The E.M.F. is a maximum at no load and diminishes when the machine is loaded, and the curve bends round if a certain load is exceeded. If the condensers are placed in series, the characteristic is that of a series continuous current machine, *i.e.*, the E.M.F. of the machine is zero on open circuit, but increases when the resistance of the external circuit is increased. Finally, on combining the two preceding methods of excitation one can realise a machine whose characteristic is that of a compound continuous current dynamo. Just as in these machines, the connection corresponding to a long shunt and a short shunt compound dynamo can be made, and one can also over-compound the machines.

This concludes the enumeration of the most important applications of the condenser and shows the importance this apparatus might attain in the great alternating current industry if two main reasons had not opposed its development up to the present. These two reasons are first, its price, which so far has been too high for the majority of applications, and second, the phenomena of resonance themselves which, in certain cases instead of being useful became harmful and destroy the dielectric of the condenser. Various materials have been tried for the dielectric. Among the solid bodies, glass (Jablochkoff, 1880) and mica, which seem only to have given medium results, paraffined paper, ebonite, oiled paper, paper coated with wax, and, more recently, stearate of lead and pure paraffin without support. Some liquid dielectrics have also been tried. Of all these dielectrics it seems to me that paraffined paper has been tried the most. I have not found detailed information with regard to the other substances. Paraffin has the disadvantage that its melting point is low and that it is easily inflammable, and it is to be wished that a dielectric might be found with the same insulating qualities and the same specific inductive capacity as paraffin, but less fusible and less inflammable. It seems that at present the price of condensers applied under normal conditions for ordinary frequencies of 40 ∿ to 50 ∿ per second and for pressures between 600 volts and 3,000 volts, lies between 80f. and 150f. per kilowatt, a 1kw. condenser being considered as that in which $\frac{2\pi}{T} E^2 \omega C = 1{,}000$. The price is practically proportional to the power, one condenser for 100kw. being virtually 100 condensers for 1kw. As a result, the price, which is small when compared with that of small machines costing 200f. to 500f. per kilowatt, is very large compared with the price of large machines which cost from 70f. to 80f. per kilowatt, so that up to the present the application of condensers has been confined to small powers.

But the second reason against the use of condensers up to the present in large installations is, perhaps, more important. It is the accidental production of very high pressures resulting through resonance effects, from sharp variations in the load, short circuits, failures in insulation, or in one word, from the numerous incidents which must occur in the work of a central station. It is certain that the phenomena of large increases of pressure which have been shown many times by the puncture of cables, for instance, do not occur everywhere, but only in large high-pressure installations in which there is a capacity shunted to the line. It seems therefore that even if their price does not oppose them, the adoption of condensers in large installations is dangerous both for the condensers themselves and for the whole installation. But I think that there must be a capacity at which the harmful effects pass through a maximum, and beyond which the increase in capacity has rather a beneficial effect, moderating the sharp rises in pressure. I should not be surprised if certain installations were already in the neighbourhood of this maximum, thanks to the capacity of their cables, and that in these installations the addition of condensers of large power, when their price is more reasonable, will be an advantage, not only by an improvement in the power factor but also with regard to the conditions of security.

Now it only remains to say a few words about other apparatus which can act to a certain extent as condensers. Over-excited synchronous motors employed for this object do not seem to me to be an advantageous solution, because their cost is almost as high as that of condensers, and because of the loss of energy which they occasion, the necessity of starting them, and the maintenance and attendance on them and their exciters. I think it is preferable in this case to add generating units at the central station. On the other hand, I believe that synchronous motors can be used advantageously when they actually act as motors at the same time. Electrolytic condensers (capacity of polarisation) constituted by electrodes plunged into a solution of carbonate of soda absorb much energy. Their resistance is practically equal to their reactance for a frequency of 40 ∽ per second. It is, therefore, only in quite special circumstances, such as the starting of single-phase motors, that they can be applied. One must not think of leaving them in a circuit. In short, I do not think that this apparatus can be substituted for the condenser properly so-called, and that efforts should be made to make the condenser a less costly and really industrial apparatus.

ON THE PHOSPHORESCENT GLOW IN GASES.*

BY JOHN B. B. BURKE, M.A.

When an electrodeless or ring discharge is sent through some highly rarefied gases, a phosphorescent glow is produced, which usually lasts for several seconds and in some instances as long as one or two minutes. A long series of experiments has been carried out to investigate the properties and nature of the glow, and some of the results already obtained show that the phosphorescence is due to molecules, which do not carry a change of electricity, but which nevertheless produce conductivity as they move through a gas, and at the same time are rapidly broken up or destroyed in the ionised gas.

The method of producing the electrodeless discharge was one of the two originally employed by Prof. J. J. Thomson. The inner coatings of two large Leyden jars were connected to the terminals of a powerful Wimshurst machine, and the outer coatings were connected by a coil of a few turns of wire. Whenever a spark passed between the terminals of the Wimshurst, rapid alternating currents were set up in the coil, which at pressures below 1 cm. gave rise by induction to the passage of a discharge having the appearance of a ring through the gas in a bulb placed inside the coil. At lower pressures, within certain limits, which in air lie between 0·7 mm. and 0·02 mm., the gas becomes phosphorescent, and it was this phosphorescence or afterglow that formed the subject of investigation.

The glow is easily produced in ordinary commercial oxygen, but in electrolytic oxygen it is difficult to obtain, whilst in air it is most persistent. Hydrogen does not give a glow, whether pure or with slight traces of oxygen, but oxygen appears to be a necessary element in the production of the phosphorescence, yet it is not due to oxygen alone. Thus Newall had found that the colour of the glow in oxygen is different according to the nature of foreign bodies present; thus in oxygen with carbon the glow was white, in oxygen and nitrogen yellow, and in oxygen and sulphur blue. The colour of the glow in cyanogen is white, the same as in mixtures of oxygen and carbon, and in air yellow, as in mixtures of oxygen and nitrogen.

When the ring discharge is sent through a bulb at the end of a long tube 2m. in length and 2cm. in diameter the afterglow, which starts at the bulb, travels down the tube with a velocity of about 2m. per sec., but in narrower tubes the velocity is much reduced. That the glow is not due to electrostatic effects which creep along the glass tube, is proved by the fact that when a brass tube, well earthed, is interposed between the glass tube and the bulb, the glow travels down as before, showing that the phosphorescence is a volume effect in the gas. The glow can be made to diffuse through narrow brass tubing 1mm. in diameter, but in this case the rate of diffusion is very small.

Two large bulbs were connected by a brass tube of 1mm. diameter with a tap, and well earthed, and when the ring discharge was sent through one the glow diffused slowly into the other bulb when the tap was open, but not when it was closed, showing that an actual diffusion had taken place, in the first instance, from one bulb into the other, and that the glow in the second bulb was not due to any induced effects due to the discharge in the first bulb.

The diffusion of the glow through so narrow a metal tube put to earth shows that the glow cannot consist of electrified particles. The glow in the second bulb lasts three or four times as long as that in the first, through which the discharge has passed. The only difference between the gas in the two bulbs is that that in the first has been ionised, whilst that in the second has no trace whatsoever communicated to it by the spark, since the ions are stopped, and cannot diffuse through the narrow tube. Thus the brass tube and tap act as a veritable Maxwell's demon, which lets through the phosphorescent molecules but catches the ions.

The view that the glow is rapidly destroyed by ionised gas is confirmed by the fact that when a discharge from a small induction coil is sent between two electrodes in a side tube projecting from the second bulb the glow then is rapidly destroyed.

An E.M.F. will not stop the phosphorescent particles; nevertheless the glow conducts, as can be shown when the glow reaches a pair of electrodes placed close together in one of the long glass tubes already described. This conductivity may be due to the breaking of the phosphorescent molecules by the ions already produced by the spark.

* Abstract of a Paper read before Section A at the meeting of the British Association at Bradford.

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SOME NEW ELECTRIC HEATING APPARATUS.

Messrs. O. Berend & Co. have sent us the following particulars of some new patterns of electric heating apparatus made by the "Prometheus" Co. of Bockenheim, for which company Messrs. Berend are sole agents. The electrical energy is converted to heat through resistances formed of thin films of precious metals, such as gold, platinum, &c., deposited on an insulating base of mica, enamel, or other suitable material. Resistances up to 25,000 ohms, it is said, can thereby easily be obtained. A mica strip $5\frac{1}{8}$in. × $1\frac{3}{16}$in. × 0·004in. thick, coated under the "Prometheus" patents with a film of metal is employed, with a resistance of about 120 ohms. It is estimated that a room of about 3,500 cubic ft. capacity may require some 2,000 to 2,500 large calories per hour to warm it, and, allowing a margin for wasted heat, 30 of these resistances would therefore be required at 110 volts. The weight of the mica strip is practically nil, and the terminals or connections can be kept very light; the combination therefore absorbs but little heat and practically the whole of the energy is at once available. In practice, to ensure durability, it is desirable that the temperature of the strips should not exceed 450°C.; this corresponds to 70 watts or 75 watts per strip. At 90 watts to 100 watts the strips show dull red in the dark and oxidation would then occur.

The stoves designed by the "Prometheus Co." for these strips are circular, and, of course, the number of strips employed depends on the size of the stove. The strips are mounted in two rows on a frame fitting into a circular case, the outer row, therefore, radiates heat directly, and a continual current of air passes up and is heated between the two rows. As each strip is independent and connected to the circuit in parallel, any one can be replaced or removed without altering any connections. The smallest pattern of stove contains 12 strips, weighs 5lb., and takes six to eight amperes at 110 volts; the next size contains 24 strips, weighs 10lb., and takes from two to 16 amperes at 110 volts; and the large size contains 48 strips and weighs 15lb. The two latter are fitted with a step switch enabling the stoves to be used from quarter to full power in four steps. Messrs. Berend estimate that in ordinary conditions the small size radiators will be sufficient for heating rooms of from 700 to 900 cubic feet, the medium size for rooms of 1,400 to 1,800 cubic feet, the large size for rooms of 2,500 to 2,800 cubic feet capacity.

The bases of the stoves are said to remain quite cool, and the apparatus may therefore be used anywhere. To give the stove a cheerful appearance when working, a ruby lamp is arranged behind the mica strips and shines through and between them, shedding a cheerful light throughout the room.

AUSTRALIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

Electric Power for Gold Dredging.—The first electrically-driven plant for the recovery of alluvial gold by dredging with centrifugal pumps has recently been introduced in Victoria by the Hon. J. A. Wallace, M.L.C., at Sandy Creek, near Yackandandah. The generating plant consists of a 500kw. polyphase steam-driven Stanley induction alternator situated some half mile from the barges. The power is transmitted on temporary overhead construction. Each dredging barge contains a 250 H.P. motor driving a Wallace-Hedley gravel pump by means of a 24in. Worral friction clutch and rope gearing; also a similar 150 H.P. set for the hydraulic pumps. The main gravel pumps work with 20ft. suction and 40ft. head. The small size and consequent mobility of the electrically operated barges, as compared with those containing a complete steam plant, give them a very important advantage in such work, and this method of driving will probably be largely adopted in the near future in the extensive dredging fields of Victoria and New Zealand.

Electric Pumping of Sewage.—The Sydney (N.S.W.) authorities are moving rapidly in electrical matters. The latest introduction consists of an extensive system of electrical distribution of power for pumping sewage. Hitherto the municipal authorities situated on the shores of Port Jackson have poured their sewage directly into the sea, converting the water into a condition belying the title of "the most beautiful harbour in the world." In future the sewage is to be raised by 21 electrically-operated pumping stations into a high-level system, whence it runs by gravity well out into the ocean at Bondi. The power is supplied to these stations at 500 volts from the Government generating station at Ultimo by means of cables carried partly overhead and partly underground. The arrangement will prove very useful in raising the load factor on the station as well as in solving a difficult problem in sewage disposal. Power from the same source is also to be supplied for operating the Pyrmont and Glebe Id. swing bridges.

Proposed Legislation.—In view of the approach of Federation, the Electrical Association of New South Wales is pushing forward some legislative questions of great importance to the electrical industry. The free trade colony is dreading that the non-technical federal legislators in drafting the new tariff may consider electricity as a luxury and retain the 25 per cent. duty at present in vogue in most of the colonies. In view of the importance of the industry and its dependence on outside manufacture, 10 per cent. is suggested as a limit in the federal tariff. Legislation is also called for in order to give statutory powers to undertakers of electrical supply. At present no such powers exist except in so far as created by special acts of Parliament in individual cases. The expense involved in the passing of such an act has usually proved quite prohibitive even when there is a universal demand for the light. Recent legislation has helped to remove this difficulty as far as Victoria is concerned.

Electric Traction.—Electric traction is making rapid progress in Australia. In Sydney the Government are replacing section after section of the old steam trams by the trolley wire. The opening of the latest section of some two miles to Cook's River was celebrated by the Electrical Association of New South Wales in a characteristically colonial way by a "trolley car party." The authorities do not contemplate extending the capacity of the power house at Rushcutter's Bay, the necessary plant for the whole network being installed in the central generating station at Ultimo. Private enterprise, too, is not idle. A line has been opened from Rockdale to Lady Robinson's Beach, New South Wales. The plant for working this line is a most up to date character, consisting of direct coupled Willans-Siemens generating sets running at 400 revs., Babcock and Wilcox boilers fed by electrically driven pumps and working up to 300lb. per square inch, and Chloride accumulators. The system has proved very successful. In Brisbane the tramway company are seeking powers for large extensions, and in Melbourne in spite of their ideal system of cable cars, the suburban authorities are proposing a trolley line connecting the suburbs with each other directly, the cable system being entirely a radial one. In Adelaide matters are delayed pending a decision as to the authority by whom the work is to be undertaken. Messrs. Callenders and the Westinghouse Companies have a bill before Parliament seeking powers to convert some 50 miles of the present horse lines. In the meanwhile the suburban authorities have formed a trust with the same object, and if they prove successful in getting the City Corporation to join them and in raising the necessary capital £800,000), the Government have expressed their intention of giving them the necessary powers. In this case they will probably get the firms already mentioned to undertake the equipment on a short lease. If they are not successful, the Government intend to undertake the conversion themselves, as has been done in Sydney. The main difficulty hitherto in the completion of the municipal scheme is a pledge which the City Corporation was drawn into some months back to support a fourth proposal made by an outside company promoter. This gentleman has now failed to fulfil his financial guarantees, and, the Corporation being thus freed, no great difficulty is anticipated in carrying out the municipal proposals with the financial support of the constructing companies. The improvement in the tramway service is certainly very necessary, the average speed of the present horse trams being only some 5 miles to 6 miles per hour.

Proposed Power Station for Kalgoorlie (W.A.).—Electrical development progresses very slowly in the Australian mining centres. At Kalgoorlie (W.A.) the mines hitherto have only attempted to employ electric power for lighting by means of isolated steam plants of 5kw. to 50kw. capacity. In addition, the town is supplied from a small municipal plant of 250kw.

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A syndicate has recently been formed proposing to erect a central station of 5,000 H.P. capacity, from which energy for lighting and power for mining and milling will be distributed to the surrounding mines.

Barron Falls Water-Power Scheme.—The question of the electrical utilisation of the Barron Falls (Q.) has been unfortunately postponed by the interference of a Conservative Labour Ministry who recently captured the Queensland Treasury Benches for a few weeks on a catch vote. The former Government had drawn up an agreement with the Chilligoe Railway and Mines Co. for the utilisation of 75,000 H.P. for 50 years for a total rental of £42,000. The power is to be employed by the Company for lighting, traction, and power on the Chilligoe Mines, and it is to be hoped that the proposals, which are favourable to both sides, will shortly be taken up again by a more liberal government.

CORRESPONDENCE.

COHERERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There seems to be a tendency to regard the metallic cohesion which occurs under the influence of an imperceptible spark as a *theory*, whereas it is a fact. I observed the fact 10 or 11 years ago, and published it in the *Journal* Inst.E.E. for 1890. Prof. Hughes had observed it before, so had S. A. Varley before that. I spoke of it as an apparent extension or reaching of the force of cohesion across a molecular gap under the influence of, as it were, an electrical *flux*.

Whatever it be due to, there can be no question that metals such as brass and iron, when in light contact, do cohere under the influence of electric waves, for they can be *felt* to have stuck together. So also filings mat themselves visibly together on a glass plate, and can even be got to hang as a string, one suspended from another.

Prof. Chunder Bose's observations and further investigations are interesting enough, and I am glad to call attention to them, but no amount of investigation or "correspondence" can disturb the above physical fact. There may be, and apparently are, anti-coherers which act in an opposite direction, but certainly there are coherers.—Yours, &c.,

The University, Birmingham, Oct. 6. OLIVER J. LODGE.

An Electrical Theory of Gravitation.—The *Electrical World* of New York of September 29th contains an article by Prof. Reginald A. Fessenden on "An Explanation of Gravitation." In this article Prof. Fessenden gives a sketch of his electrical theory of gravitation—a theory which is, at all events, an ingenious dovetailing of various ancient and modern hypotheses connected with gravitation and electricity. The author starts by commenting on J. J. Thomson's theorem that the addition of a charge to a body increases its inertia, owing to the electromagnetic reactions induced by the motion of the body. Then, taking the modern corpuscular theory of the atom, he affirms that the enormous charges carried by the intra-atomic corpuscles suffice to explain the very considerable inertia possessed by a piece of ordinary matter. "Inertia," he concludes, "is an electromagnetic induction effect, due to the corpuscular charge." Next, the author mentions the result of Quincke's experiments on the expansion of dielectrics submitted to electrostatic stress, and states that, in general, on introducing a dielectric into an electrostatic field the density of the ether in the region as well as the density of the matter changes. This change of density of the ether must be very great in the strong electrostatic field near an atomic corpuscle. Thus, using Newton's suggestion as to the cause of gravitation, Prof. Fessenden concludes, "gravitation is a secondary effect, the electrostatic intensity due to the corpuscular charge causing a change of density in the ether surrounding it, this latter giving the gravitational attraction." Throughout the article the author seems to assume that the corpuscles of an atom are all charged similarly.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Asylum Lighting.—The Fife Lunacy Board have authorised their consulting engineer (Prof. F. G. Baily) to obtain estimates from four or five electric lighting firms for the electric lighting of the asylum.

Ayr.—The accounts of the Electricity Department for the year ended May 31 have been issued. The total receipts (including public and private lighting) amounted to £5,244. 15s. 2d., and the expenditure to £3,479. 10s. 11d., leaving a balance of £1,765. 4s. 3d. Interest (£1,539. 12s. 8d.) and sinking fund (£930. 8s. 3d.) came to £2,461. 0s. 11d., leaving a net deficiency of £695. 16s. 8d. 499,355 units of currents were generated; 257,600 were supplied for public lighting and 168,039 to private consumers, and 12,000 units were used on the works. There are 82 arc and 117 incandescent electric lamps employed for public lighting, and the total maximum supply demanded was 256kw. The loans sanctioned amount to £50,000, and the amount borrowed to £42,977. 7s. 8d.

A report from Mr. W. A. Chamen, city electrical engineer of Glasgow, was submitted to the Ayr Council on Monday. Mr. Chamen strongly urges the Corporation to change their present system—high-tension alternating current—to low-tension continuous current. This change was recommended by the Works committee, and the Council unanimously approved the recommendation. Tenders for new plant were accepted.

Birmingham.—The work of converting the Bournbrook electric tramway route to the overhead trolley system has been commenced. The work is being carried out under the supervision of committees of the Council.

Bradford.—The accounts of the Electricity department for the half-year ended June 30 were presented at the meeting of the Corporation on Tuesday. The chairman of the Electricity committee (Mr. T. Shaw) said that the total income was £17,723. 9s. 5d., compared with £13,256. 12s. 11½d. in the corresponding period last year. The total expenditure, including interest and sinking fund, was £16,751. 1s. 3½d., against £11,523. 10s. 4d. The net profit for the half-year, therefore, was £972. 8s. 1½d., against £1,733. 2s. 7½d. The number of consumers was 1,175, against 965. The total number of units consumed was 1,419,409, against 996,807, an increase of 45 per cent., irrespective of current supplied for public lamps. The total profit since the opening of the works in Sept., 1899, after paying interest and sinking fund, amounted to £26,986. 0s. 6½d., and the total amount written off for depreciation had been £14,372. 17s., leaving £12,613. 3s. 6½d. to be appropriated as the Council might direct. The accounts were adopted without discussion.

At the same sitting Mr. E. R. Hartley moved—

That, in the opinion of this Council, it is desirable that the Corporation should have control of the supply of coal required by the Corporation for use in their various undertakings, and that it be an instruction to the town clerk to insert in the bill to be promoted in the next session of Parliament a clause empowering the Corporation to become the owners of and to work a colliery or collieries, with power to borrow the necessary moneys required.

Mr. Hartley contended that, in the interests of the city, some such step was necessary. He had taken the increase in the price of coal at 5s. per ton, although others had put it at 7s. 6d., and on that basis he estimated that the extra cost of coal required by the Corporation this year would be equal to 10d in the £ on the rates. The consumption of coal in the whole of the city was 1½ million tons per year, which meant that the city would pay for its coal an increase in price of £375,000. The total rates of the city were £400,000 per year, so that the increase in the price of coal was equal to doubling the rates. He proposed that the Corporation should have the means to provide for its own coal supply, and not be dependent on a monopoly. Ald. Wood, who seconded, said the Manchester Corporation had taken the matter up, and he thought no harm could be done by trying to secure a mine. Mr. Land pointed out that the Corporation had to have contracts with something like 20 collieries in order to make certain of a proper supply of coal. Eventually the resolution was carried by a large majority.

At a special meeting of the Tramways committee on Wednesday it was decided to recommend the City Council to enter into an agreement with the Shipley Council for working the proposed tramways to Shipley. It was also decided to apply for powers to construct several additional lines connecting with the existing tramways.

Brighton.—In the bill which the Corporation have decided to promote next session power is to be sought to enable the Corporation to purchase and hire out to consumers or wiring contractors electric motors, cooking, heating and ventilating apparatus. Feeder No. 11 is to be extended to the south side of Grand Junction-parade at an estimated cost of £2,500.

Bristol.—The Electrical committee have decided to make an alteration in the charge for electricity for motive power and heating.

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In future the minimum charge of £1. 5s. per quarter per kilowatt supplied will be abolished, except in cases where the consumer has an alternative source of supply, and the charge will be 1½d. per unit only, irrespective of quantity used, subject to discounts, and with no charge for motor hire. Motive power customers will be required to enter into a special agreement, providing, amongst other things, that if the electricity supplied under the agreement is used for lighting, either directly or indirectly, the Corporation shall annul the agreement without notice to the consumer, and thereupon the latter shall pay for the electricity supplied to him according to the then existing rate for electricity for lighting. Extensions of the lighting mains have been authorised.

The Dock committee reported to the Council on Tuesday that they had been requested by the Petroleum Company to furnish a supply of electric current, and, being in a position to give a supply from their new works at Avonmouth, recommended they be empowered to make the necessary arrangements. Ald. Pearson, chairman of the Electrical committee, questioned the advisability of two committees supplying electricity, possibly in competition with each other. Some time ago the Electrical committee were asked if they were prepared to supply electric current at Avonmouth, and declined, not realising the large demand that was likely to arise. Had they been informed the demand would have been so large, it would have been worth while considering whether the supply could not be economically given from the central station. It was, he feared, too late for his committee to intervene now. The report was agreed to, and the company will be supplied with current by the Dock committee.

Burnley.—The Corporation intend to reconstruct the tramways in this district, and notice to this effect has been given to the various authorities into whose districts the system extends.

Bury.—Messrs. Lacey, Clirehugh and Sillar have been appointed consulting electric tramway engineers to the Council.

Bury St. Edmunds.—Sanction to a loan of £800 for public electric lighting has been obtained, "but no part of the loan may be applied in providing incandescent lamps."

Cable Communication with China.—The cable which was laid been Chefoo and Tientsin for the German Government was opened for the transmission of messages on Thursday last, and Kiao-Chau thus becomes connected up with the international cable system of the Eastern Extension and Great Northern Companies.

Canterbury.—The consulting engineer (Mr. Robert Hammond) has been requested to report as to further extensions of the electricity generating plant necessary and the probable cost. An order has been placed with the Western Electric Co. for an extension of their cable contract.

Cardiff.—At a meeting of the Electrical committee last week the electrical engineer (Mr. N. Appelbee) reported that the consumption of electric energy had increased to considerably above the maximum of last winter. Provision had been made for a 50 per cent. extra consumption on last year's maximum, and when that was reached, as was anticipated, they would have machinery standing by to provide half as much energy again.

Owing to the increase in the price of coal, the Cardiff Gas and Coke Co. have given notice to terminate their existing agreement for the public lighting on March 25. The town clerk is reporting on the matter, and with a view to increasing the demand for electric current it has been decided to issue circulars pointing out the great advantages of electric light.

Chester.—The Council will promote a bill to reconstruct existing and construct new tramways. The undertaking of the local tramway company has been acquired for £18,000. Power to adopt electric traction will also be sought.

City of London.—At the meeting of the Common Council yesterday (Thursday) the Streets committee presented a scheme for the testing of all electricity meters within the City under the direction of the electrical inspector at the expense of the City of London and the Charing Cross and Strand Electricity Supply companies, each company to contribute, in addition to other expenses, £200 per annum to the Corporation in respect of the electrical inspector's salary. Under these circumstances it was proposed to increase the inspector's salary from £350 to £500 per annum. Under the scheme the Corporation will be relieved of all expenses in connection with the appointment, at present amounting to £350 per annum.

Coburg (Victoria).—The borough engineer (Mr. Pullar) is preparing a report on the question of erecting electricity works.

Colne.—The Technical Schools are to be lighted electrically. The electrical engineer (Mr. A. G. Cooper) recently sent out circulars to ascertain the amount of support likely to be accorded to the proposed electric lighting scheme, and up to the present favourable replies have been received for nearly 3,000 8 c p. lights.

Colwyn Bay.—Owing to the increasing demand for electric current, the engineer (Mr. Jones) has been instructed to prepare plans and specifications for additional plant.

Consett.—The Council have resolved to adopt public electric lighting, and refuse destructor works are to be erected in conjunction with the electricity undertaking. Terms have been come to with the Northern Counties Electrical Supply Co. for obtaining a provisional electric lighting order.

Darlington.—The Light Railway order granted to the Imperial Tramways Co. has now been issued, and the Town Council are dissatisfied with its terms. Objections will be lodged against its confirmation by the Board of Trade.

The Electric Light committee will supply electric current about Christmas.

Derby.—Application has been made to the Local Government Board for sanction to borrow £35,000, the estimated expenditure on electric lighting account during the next two years. The chairman of the Electric Lighting committee (Mr. Butterworth) announced on Wednesday that the revenue from the sale of electric current increased last year by £1,593, or 16½ per cent. Expenditure increased by £1,267, principally owing to the high price of coal. Establishment charges had, however, been reduced, and the committee had been able to pay interest on capital, which now amounted to £105,000, to pay off £2,507 of borrowed capital, and the profit balance was £113. New plant, which would cost £8,650, was urgently required, and extensions of mains would absorb £7,500, whilst a new chimney would also have to be built. The equivalent number of 8 c.p. lamps connected had increased during eight months of the current year by 9,000, compared with an increase of 7,800 during the whole of last year.

Devonport.—The Council have instructed Mr. C. Chadwell to prepare plans for the construction of the St. Budeaux electric tramways, but owing to the pressure of other work, application is to be made to the Board of Trade for an extension of time to construct the lines. The Council have offered to lease the lines to the Devonport and District Tramway Co. for a term of years, at a rental of £50 per mile, with the addition of such sum as is required to pay interest and sinking fund on the cost of construction, and one-third of the sum required for interest and sinking fund on the cost of rebuilding Camel's Head Bridge. The company are also to pay the Corporation's costs in obtaining powers for the St. Budeaux lines, and are to take electric current from the Corporation's mains.

Dudley.—An inquiry was held on Friday into the application of the Council to borrow £10,000 for electric lighting. The consulting engineer (Mr. R. P. Wilson) said the loan was required for the "free" wiring of premises. The Corporation were going to charge 6d. per unit for the first two hours per day, and 1½d. per unit after. Dudley would be the first place in England where so low a price as 1½d. per unit had been charged. At present they were only supplying current for the tramways, the charge being 2d. per unit for the first 150,000 units, and one-tenth of a penny less for every additional 50,000 up to 400,000 units. The tramway to Stourbridge had been at work a year, during which period the consumption had been 196,000 units, and they anticipated a demand of 270,000 units for lighting. There was no opposition.

Dudley-Cradley Electric Tramway.—Owing to the non-arrival of the Board of Trade certificate, traffic on the new Dudley-Cradley Heath electric tramway has been suspended.

Eccles.—The Council have decided to promote a bill for, *inter alia*, powers to double and alter the existing tramways, to construct new lines, and to adopt electric traction.

Electricity in Mining.—At a meeting of the Mines Drainage Commissioners at Dudley the chairman (Mr. J. B. Cochrane) regretted he could not speak more encouragingly of the Tipton mining district. They looked to shortly having electric pumps at work, and to mine-owners opening out their mines. When these advances were made, there would come a good time for South Staffordshire mining.

At a meeting of Rezende (Ltd.) on Wednesday the chairman (Mr. N. Brown) said the Umtali Falls (Rhodesia) were near their mine, and from the outset it had been the directors intention to use the power there available, but owing to conflicting claims they did not feel it safe to order the necessary machinery, but on the day that matters were put on a proper business footing with the Chartered Company they immediately proceeded to order the water power and electrical plant, the specification and tenders for which had long before been obtained in anticipation. They had the right to half the power of the Falls, and the plant, which was now in course of shipment, was calculated to deliver about 150 H.P. effective at the mine. Until the plant was erected and started they could not bring their additional 10 head of stamps into use. Two Pelton water wheels would drive a two-phase electric generator, which would produce current at 2,500 volts. This current would be conveyed about 1½ miles to the mine, where it would be utilised in driving the motors, working the mill, rock breakers, cyanide works pump, mine pump, hoisting gear, rock drills and other machinery, besides supplying electric light. Until this installation was complete they were dependent on wood and oil fuel. The plant ordered had now been practically all shipped, and some of the material was actually in Umtali.

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"**Engineering Magazine.**"—The October issue contains articles on "Electric Power Distribution in Great Britain," "The Commercial Organisation of the Machine Shop," "Centralisation of Steam Condensing Plant," and "The 1,000 miles Automobile Trials."

Fatality.—On Saturday last the first fatal accident on the Central London Railway occurred. A conductor on one of the trains named Field had occasion to take exception to a passenger smoking in a non-smoking carriage, and, in order to discover whether the smoking was still going on, very incautiously opened the gates which divide the carriages, put his head out into the tunnel to look through the side window, and in doing so his head seems to have caught a projecting lamp, and he was rendered insensible. His body then fell on to the permanent way receiving numerous injuries which proved fatal. A verdict of accidental death was returned at the inquest held on Wednesday. Field's action was in direct contravention of the railway company's regulations, which prohibit the opening of a gate whilst the train is in a tunnel. In future the ends of the carriages are to be fitted with glass panels, and the probability of any such accident occurring will be reduced to a minimum.

Fifteen Years' Inland Telegraph Messages —The number of messages forwarded from telegraph offices of the United Kingdom for the year ended March 31, 1886, was 39,146,283. In 1890 this number had increased to 62,368,034, in 1895 to 71,589,064, and in 1900 to 90,415,123, the annual increase having been continuous throughout.

Finchley.—The Council have declined to join the local authorities of Enfield, Edmonton, Wood Green, and Southgate in the suggested joint electricity supply scheme for these districts. The Council are willing to take a supply of electricity in bulk on suitable terms when available.

Folkestone.—The Council have decided to apply for parliamentary powers to construct electric tramways at an estimated cost of about £93,000. It is proposed to adopt the conduit system in the centre of the town and the overhead system in the outskirts.

Glossop.—The Urban Electric Supply Co., which recently acquired the provisional electric lighting order from the Council, has entered into a supplementary contract in regard to the construction of electric tramways in the town.

Harrogate.—Sanction to borrow an additional £10,000 for electric lighting extensions has been obtained by the Council.

Hastings.—Extensions of the electric lighting mains, estimated to cost £1,149, have been sanctioned by the Council, and application has been made for sanction to borrow this amount.

Heckmondwike.—Sanction to a loan of £14,343 for electric lighting has been approved by the Council.

Hexham.—A special meeting of the Council has been called to consider the electric lighting question.

Irvine.—A proposal "that steps be taken to ascertain the capabilities of the Burgh's coalfields for the generation of electric current" has been remitted to a committee of the whole Council.

Islington (London).—Arc lamps are to be erected from Hornsey-road, along Benwell-road, to Drayton-park, at a cost of £1,450.

Light Railway.—The Sheerness and District Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by 27th inst.

Lincoln.—The Corporation are advertising for tenders for a dry-back, marine-type boiler and a high-speed engine coupled to a continuous-current dynamo, a motor and centrifugal pump, and accessories. Tenders have to be in by Nov. 15.

On the recommendation of the Electricity Works committee it has been decided to grant the city electrical engineer (Mr. C. S. Vesey Brown) a gratuity of 100gs. for his services in connection with the Corporation (Tramways) Act (1900).

At the last meeting the chairman of the committee (Ald. Harrison) said the increase in the amount of current supplied during the last quarter was 40 per cent. over the corresponding quarter of last year.

Liverpool.—The School Board have decided to wire the Hightown Truant School for the electric light at a cost of £749.

London County Council.—At Tuesday's meeting it was agreed to loan Battersea £20,000 for electric lighting; £3,187 to Islington for electricity meters; and £5,147 to Battersea for arc lamps and standards.

On the recommendation of the Building Act committee, approval was given to plans for the extension of the Hampstead electricity generating station, and for the construction of a generating station for the Bermondsey Vestry.

The Highways committee, in their report, point out that for the first time the result of the Council's working of its own tramways in South London could be noted, the result being in every way satisfactory. Traffic receipts had exceeded by £8,000 those of the most successful year of the London Tramways Co., whose undertaking the Council had purchased. The system of ½d. fares had been largely extended, the service generally improved, and a 60-hour week established for the employés, and, in spite of the expenditure incurred in connection with these matters, the budget for the present year showed that £42,000 was available for relief of the rates.

Long-Distance Telephony.—H.M. Consul-General at Christiania, Norway, has forwarded to the Foreign Office a despatch reporting that telephonic communication has been established between Christiania, Göttenburg, Malmö and Copenhagen. The rates for conversations between these Danish and Norwegian cities are as under: First zone on Danish and Norwegian exchanges east of Porsgrund and south of Lillehammer, 2 kroner, and 50 ore extra for each zone beyond the first in each country, for every ordinary conversation of three minutes' duration. Express and prepaid conversations are charged thrice these rates. 20 ore extra is charged for sending a messenger or a summons to a particular individual.

Lowestoft.—The Council have decided to promote a bill for powers to construct electric tramways. This decision has been come to owing to the refusal of the Board of Trade to insert in the Royal Plain-Kessingland Light Railway order granted to the National Electric Traction Co. the terms of an agreement between the Council and the company entered into in May last. In dealing with this question at the last meeting of the Council the mayor stated that a great deal of negotiation had taken place between the Council and the promoters ending in an agreement which the Council considered vital in the interests of the Corporation, and as the Board of Trade had not seen their way to incorporate the terms of that agreement in the order the Council had no other course but to give the company notice to determine that agreement, which would leave the Council at liberty. Of course, if the Council constructed the tramways on their own account, they might expect opposition from the company, who, through no fault of their own, lost the benefit of their order. Therefore, he thought the clause of the resolution in regard to the leasing to the company of the tramways in the borough was very fair and honourable, and if carried was likely to terminate in benefit to both parties.

Lytham.—At the Council meeting last week, in answer to a question from Councillor Mellor in regard to electric lighting (the provisional order being about to expire), the chairman (Mr. E. R. Lightwood) explained that they had been so staggered with the estimate placed before them by their consulting engineer that they considered they had better let the matter drop for the present.

Manchester Post Office Fire.—It is gratifying to learn that, notwithstanding the friction existing between the National Telephone Co. and the Post Office, the former tendered very acceptable assistance to the Manchester postal authorities on the occasion of the big fire which occurred at the postal telegraph office a few days back. For this good service the Postmaster-General has officially expressed his appreciation. By the aid of the company the work of maintaining and restoring telephonic and telegraphic communication between Manchester and the rest of the world was materially facilitated.

Matlock Bath.—The Northern Counties Electricity Supply Co. have submitted terms to the Council for the erection of electricity works.

Middlesbrough.—A meeting of the Electric Lighting committee was held last week to consider the positions of the 40 arc lamps which it is proposed to erect in the principal thoroughfares. The consulting engineer (Mr. Hammond) submitted plans. The 40 arcs are to displace 147 existing gas lamps. Twenty of these arcs are to be switched off at midnight, and the total estimated cost is £800 per annum, against the present cost for gas by the 147 lamps of £782.

Moffat (N.B.).—A committee consisting of Messrs. Brown, Easton and Stevens has been appointed by the Burgh Commissioners to consult Mr. W. J. G. Forman in regard to a scheme for the erection of electricity works in the district. In a preliminary report Mr. Forman puts the estimated cost at about £2,500, and proposes to utilise water power in the generation of current.

Molesey (Surrey).—The Council has obtained a report from Mr. A. T. Snell on the proposals of Edmundson's Electricity Corporation in regard to establishing electricity works. Mr. Snell is of opinion that the offer of the company is a fair one, except in one provision, the effect of which would be to prevent the Council from putting down their own plant within 21 years. The advantages to the Council, if the offer were accepted, Mr. Snell summarises as under: (1) No immediate outlay of capital, and no immediate responsibility; (2) the maximum price for street lighting, 2½d. per unit, is lower than the Council could themselves generate current for some years to come, having regard to the relatively few street lamps (about 200) and the probable small demand for private supply during the first few years; (3) the maximum price for private lighting, 7d., 4d., and 2d. (on the maximum demand system) is fair to commence with, and will probably work out on an average to about 6d. per unit, which is cheaper than gas at 4s., light for light. The revenue earned by the company from the district would probably be insufficient to pay a dividend on the capital for some years, and as 11 districts were proposed to be supplied, half of which, in Mr. Snell's judgment, offered more remunerative fields than East and West Molesey, it was possible that this district might suffer for some time from an inefficient or defective supply, due to want of

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plant at the power station. Granting the choice of company supply, Mr. Snell suggested a number of conditions for inclusion in any agreement between the Council and the company. After discussion the Council decided to apply for a provisional order as suggested.

Municipal Telephony.—The Eastbourne Town Council have decided to apply for a licence to establish a municipal telephone exchange.

Nelson.—The Council have notified the Burnley Tramways Co. of their intention to purchase so much of the company's undertaking as lies within the borough.

Northampton.—It has been decided by the Council to apply for parliamentary powers to construct and work electric tramways in this district.

Oldham.—The Electric Lighting committee recommend that application be made for sanction to borrow £157,000 for the erection and equipment of a new electricity station at Greenhill for the purpose of supplying electric current for lighting, power and traction. At last week's Council meeting the chairman of the committee (Ald. Harrop) said the old station was started in a state of fear for the purpose of keeping companies out of the town, and not for the love of the work. Consequently, the present site was very cramped, and was a great inconvenience and expense. Seeing the success of the work, the committee thought it best to start in an adequate way, and they would provide for the next 20 years by the new works and system of working now proposed. The price for current was now one of the lowest in the country, being 3·41d. per unit for lighting and 3·39d. for other purposes. The total of the various estimates for the electric extensions amounted to £156,510. The recommendation was agreed to.

Paisley.—At Tuesday's meeting of the Council a statement was presented dealing with the financial condition of the electricity department. The capital expenditure to date is £94,832. 15s. 1d., after allowing £500 for contingencies, or £14,832. 15s. 1d. in excess of present borrowing powers. No allowance has, however, been made to cover the cost of laying additional mains and connections. Mr. J. Balderston Whyte, C.A., who presented the report, stated that three engines supplied to the station by Messrs. S. Z. de Ferranti (Ltd.) are to be removed, and two engines are to be supplied of equal capacity without further expense to the Corporation.

Pietermaritzburg (South Africa).—The Municipal Council have resolved to construct a system of electric tramways. The work will be carried out under the superintendence of the borough electrical engineer. The gauge of the track is to be 4ft. 8½in., and the pattern of car chosen is the 8-wheeled double-deck. Electric current will be supplied by the electric light department.

Pleasley (Notts.).—An offer of the Shirebrook Colliery Co. to light the district by 32 c.p. incandescent electric lamps, at £2 per lamp per annum is to be considered at the next meeting of the Parish Council.

Poplar.—The official opening of the electricity station built by the Poplar District Board of Works took place on Monday last. Poplar is one of those districts which has held a provisional order for many years, and would probably not have made use of it even now had not a company applied for powers in the same district. The order dates from 1893. The works have been designed by Mr. A. Blackman, who remains as resident engineer. Mr. Blackman who was formerly Corporation electrical engineer at Aberdeen, a "Kennedy" station, has adopted the pressure of 230 volts on the three-wire system. This is somewhat surprising, as, so far, the load on the station is chiefly for public lighting, and the area of the district amounts to 5 square miles. For the street lighting there are 165 10-ampere and 7·5-ampere arcs and 200 16 c.p. incandescents. The mains are B.I.W. lead-covered cable laid in ducts of U-section, with spigot and socket joints and brick covers. The equipment of the works themselves includes four Babcock-Wilcox boilers, with an aggregate horse-power of 1,200, and four Belliss triple expansion engines driving four-pole 150kw. Mather and Platt machines. Both condensing and feed-water is obtained from a canal, and the pumps of the surface condenser are driven off the crank shaft of the engines. The battery is made up of 200 15-plate Hart cells, with a capacity of 600 ampere-hours and for a maximum discharge current of 160 amperes. The "Wright" system of charging is employed, with rates also on the "Wright" system for power supply, and a system of "free" wiring has been adopted in order to encourage private consumers.

Redcar.—The Council have already decided to embark in municipal electricity supply, and they are now recommended to obtain powers for the construction of electric tramways between Redcar and Saltburn. Should the Council decline to take this step a company will proceed to obtain powers.

Rochdale.—Electric current was supplied to some of the shops in the principal thoroughfares on Wednesday evening. There are at present 35 customers, and the Town Hall, Technical School, Central Board School and the new Board School at Hamer Bottoms are being wired. The supply pressure is 220 volts, and the charge is 6d. per unit for lighting and 3d. for power.

Ryde (I.W.).—Sanction to a loan of £30,000 for 25 years has been obtained by the Council.

Sheffield.—In our issue of Sept. 7 we gave an abstract of the report of the city electrical engineer (Mr. S. E. Fedden) on the position of the electricity undertaking and of the steps to be taken to meet the anticipated increased demand for current for power. Mr. Fedden recommended that certain modifications of the existing system should be effected, and reported that to carry out his proposal, the following additional expenditure would be necessary for 1901: Additions and alterations in boiler house, £3,500; 2,000kw. of new plant complete, £23,000; additional feeders, £5,000; contingencies, £1,995; total, £41,895. This extension would fill up the present station, and Mr. Fedden therefore recommended that the erection of a larger station should be taken in hand without delay. The Council's consulting engineer (Mr. Robert Hammond), who was instructed to consider this report, now announces that he is in complete agreement with Mr. Fedden, and considers that hitherto municipal electricity works have been started on far too small a scale. He is in entire accord with Mr. Fedden as to the advisability of putting the works in a position to supply electric energy at a low rate for motive power. Mr. Hammond states that, as consulting engineer to many of the towns affected by the bills promoted during the past session of Parliament he had the advantage of hearing the whole of the evidence tendered by the promoters, and of gathering the feeling of the House of Commons Committee on these and similar schemes, and he was glad to say that the Committee fully affirmed the principle of "peaceable possession for good behaviour." The Committee laid down the precedent that "where a local authority was able and willing within a reasonable time and on reasonable terms to afford a supply of electrical energy for power purposes it should not be competed with by a company." While not sharing the opinion of the promoters of the power bills that electrical energy will be adopted by large steam users in preference to steam, Mr. Hammond was decidedly of opinion that there was a very large field for the substitution of electrical energy for steam in a host of small industries, and that opinion had recently been confirmed by a visit which he had made to the principal cities on the Continent. That visit afforded him an opportunity of considering the relative merits of polyphase and continuous-current motors, and excellent work was being done by the use of the former. In those circumstances Mr. Fedden did well to consider whether the central area should be supplied by continuous currents or whether certain modifications could be made in the existing system in order to avoid the heavy capital outlay entailed by conversion. With the data before him last year, it certainly seemed to Mr. Hammond desirable to consider carefully the advantages attaching to a partial conversion of the system to continuous-current supply. He had on the present occasion had fuller data laid before him, and he had also had the advantage of a lengthy conference with Mr. Fedden, with the result that he was able to state his complete conformity with Mr. Fedden's proposed plans. Mr. Hammond states that the introduction into Sheffield of the sub-station system, which had been found satisfactory in Leeds, would largely diminish the losses in distribution. He was also in agreement as to the desirability of reducing the periodicity of the present system from 100 to 50. As the earliest possible delivery was highly important he advised the Council to endeavour to secure one or, if possible, two of the sets at present in use at the Paris Exhibition. With regard to the estimated expenditure of £41,895, he understood that the figures were based upon actual quotations, and, roughly checking them, they appeared to him to be well within the mark. To those figures, however, must be added the cost of substituting the sub-station for the house-to house transformer system, and also those incidental to the changed periodicity as far as the tranformers were concerned. He would suggest, also, that in applying to the Local Government Board provision should be made for a capital outlay on motors, in order to put the Corporation in a position to let these machines out on hire, a plan which had met with great success at Bradford. Finally, he agreed that the carrying out of Mr. Fedden's scheme would put their present works on a footing to give the best possible results as a whole. Mr. Hammond's report was considered at the last meeting of the Electric Light committee, but nothing was decided in regard to it. It was reported that the deputation appointed at the last meeting had concluded that it was unnecessary to make the proposed visit to Paris, and that Mr. Fedden had gone alone to the Exhibition, and also to Nuremburg and Frankfort.

South Shields.—In a report to the Electric Lighting committee the borough electrical engineer (Mr. J. A. Jeckell) states that as the distributing mains are now laid in a large number of streets, it is advisable to light all the streets as an additional source of income, and he suggests that if the Town Improvement committee would light all the streets electrically where low-tension mains are laid the price of current might be reduced to the following: 2·16 c.p. lamps, 1s. per week; 2·25 c.p. lamps, 1s. 6d. per week; 3·32 c.p. lamps, 2s. per week. The price for arc lamps to be reduced to £20 per annum when 100 or more are taken. The committee resolved that

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these prices be adopted on the Town Improvement committee agreeing to light electrically all the streets where low-tension mains are laid.

Stafford.—An inquiry will shortly be held into the application of the Council to borrow £10,000 for electric lighting extensions.

Stirling.—The County Hall is to be wired for the electric light at a cost of £160.

Stirling and Bridge of Allan Tramways.—In a report just issued by the directors of the Stirling and Bridge of Allan Tramways Co. (Ltd.), it is stated that a provisional agreement has been entered into with the British Electric Traction Co., and in consequence negotiations are proceeding with the local authority in regard to extensions and the adoption of electric traction.

Stratford-on-Avon.—As the Council have decided to apply for a provisional order, the application of the United Electric Light and Tration Co. is to be opposed.

Sunbury.—The Twickenham and Teddington Electric Supply Co.'s application for a provisional order is not to be opposed by the District Council.

Swindon.—Application for sanction to a loan of £31,000 for electric lighting is to be made.

Warwick.—The British Electric Traction Co. notify that they will apply for a provisional electric lighting order.

Waterloo (Liverpool).—A proposal by a syndicate to construct a pier, together with an electric tramway about three-quarters of a mile in length, is under the consideration of the Health committee of the Council.

Watford.—Messrs. Preece and Cardew have been appointed consulting engineers to examine and report upon the existing electricity works. In a preliminary report by Major Cardew, the Council were recommended to obtain an additional Babcock-Wilcox boiler, a feed water-heater and softener, as proposed by their electrical engineer (Mr. Colebrook), at an estimated cost of £1,700. This recommendation has been approved, and a tender from Messrs. Babcock and Wilcox has been accepted.

West Bromwich.—As announced in our last issue the Electric Lighting committee have decided, on the recommendation of their consulting engineer (Mr. Robert C. Quin), to fix the charge for electric current for lighting purposes at 6d. per unit until an equivalent of 100 hours' maximum demand has been reached in each quarter, and 2d. per unit after. Current for power is to be supplied at 3d. per unit until an equivalent of 78 hours' maximum demand has been reached in each quarter, and 1d. per unit after. The "free" wiring system is to be adopted, the cost of wiring to be spread over 10 years. The following table show the estimated cost of wiring, and the annual purchase payments:—

Number of lights.	Estimated cost of wiring.	Estimated annual payments.
5	£4 1 10	£0 8 2
8	6 10 11	0 13 1
10	8 3 7	0 16 4
14	11 9 1	1 2 11
20	16 7 4	1 12 9
35	28 12 6	2 17 3
40	32 14 7	3 5 6
48	39 5 6	3 18 7

Consumers who pay the whole of the annual payments within the first year will be allowed 10 per cent. discount; during the second year 7½ per cent.; during the third year 5½ per cent.; during the fourth year 2½ per cent.; after the fourth year no discount. The committee further recommended that contracts be entered into for the supply of materials for wiring houses, and for the labour necessary for carrying out the work. It has also been resolved to hire out motors, but the conditions are still under consideration. An animated discussion arose on the report, which was eventually adopted. Application has been made for sanction to borrow £10,000. Owing to the large demand for current for power the station buildings are to be extended.

West Yorks.—A scheme for the erection of electricity works for supplying current for lighting and power in the districts of Slaithwaite, Linthwaite, Marsden, and Holmfirth is being prepared by Mr. A. H. Gibbings. A conference of representatives from the districts interested was held last week at Huddersfield, when Mr. Gibbings submitted particulars. It is probable that parliamentary powers will be applied for.

Whitby.—At a recent meeting of the Council contracts were let for the supply of electricity generating plant, and it was decided to advertise for tenders for a loan of £9,000 to defray the cost.

Worksop.—Sanction to a loan of £15,570 for electric lighting has been received by the Council, the period of the loan being 25 years.

Electro-Harmonic Concert.—Members and their friends are reminded that the first (smoking) concert takes place this (Friday) evening at 8 o'clock, at the old haunt, St. James' Hall Restaurant, Regent-street, London, W. Mr. J. Wilson Swan, F.R.S., will preside.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

TENDERS INVITED.

Cardiff County Borough invites tenders for slow-speed vertical engines, slow-speed converters, and boilers and economisers, &c. Specifications can be obtained from the tramways engineer (Mr. Arthur Ellis), Old Post Office-buildings, Cardiff, and tenders must be sent to Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 23rd inst. An advertisement gives further particulars.

Bradford Corporation invite tenders for a 30-ton electric travelling crane for their Valley-road electricity works. An advertisement gives further particulars, and specifications may be obtained from the city electrical engineer (Mr. R. A. Chattock). Tenders to town clerk (Mr. Frederick Stevens), Town Hall, Bradford, before 25th inst.

Belfast Gas and Electric Light committee invite tenders for steam pipes, pumps, &c., condensing plant, boilers, mechanical stokers and superheaters, coal and ash-conveying plant and switchboard extensions. An advertisement gives further particulars, and specifications may be obtained from the city electrical engineer (Mr. Victor A. H. M'Cowen). Tenders to town clerk (Sir Samuel Black) by noon Nov. 23.

The directors of the *Acme Wood Flooring Co. (Ltd.)* require tenders for the electric lighting of their mill premises at Victoria Park, London, N.E. Specification, &c., may be obtained at the offices of the consulting engineers, Messrs. Taylor and Field, 14, Victoria-street, Westminster, S.W. An advertisement gives further particulars.

The Directors of the *Great Western Railway Co.* invite tenders for telegraph and other stores for twelve months from Dec. 1st next. Samples and patterns may be seen at Swindon from 9th to 18th inst., and specifications may be obtained at office of stores superintendent. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, W., by 22nd inst.

The *Secretary of State for India* invites tenders for (1) a complete electrical installation for supplying power to a factory from a waterfall 3 miles distant, and (2) a complete hydraulic installation to develop about 500 H.P. Tenders to India Office, Whitehall, S.W., by 2 p.m. Oct. 16.

Bermondsey (London) Vestry invite tenders for steam, feed exhaust, and drain pipes, feed pumps, water storage tank and sundry ironwork, and also for steam dynamos, battery charging motor, booster, and balancer. Tenders to vestry clerk by Oct. 15.

The *Postmaster-General* is inviting tenders until 22nd inst. for red fir telegraph poles and for creosoting. Forms of tenders from Mr. Chas. E. Stuart, controller of stores, General Post Office, London.

London County Council require tenders for 12 months' supply of engineers' goods and electrical stores. Tenders to clerk, County Hall, Spring-gardens, S.W., by 29th inst.

Whitechapel (London) Electrical committee require tenders for a hand-driven overhead travelling crane for their electricity station. Tenders to chairman must be delivered by noon 23rd inst.

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Sunderland Corporation invite tenders for 24 car bodies, trucks, and electrical equipment. Tenders to chairman Tramways committee by noon Oct. 15.

Maidstone Corporation invite tenders for surface condenser and feed pumps. Tenders to town clerk before 10 a.m. Oct. 16.

The Streets committee of *City of London* Corporation are again inviting tenders for a mechanically-driven dust cart. Tenders to town clerk (Sir J. B. Monckton) before Nov. 10.

Aberdeen Town Council invite offers for 25 electrical tramcars, and for equipments for six horse cars about to be converted. Tenders before noon of Oct. 17.

Aberdeen Council require tenders for materials and construction of works in connection with the permanent way of their new electric tramways. Tenders to burgh surveyor by 18th inst.

Glasgow Corporation require steel straight track and curved rails and fish-plates. Tenders by 23rd inst.

Dundee Gas Commission require tenders for three steel water tanks for their electricity works. Tenders to clerk by noon Oct. 15.

French Post and Telegraph authorities invite tenders until 18th inst. for 850,000 porcelain insulators. Tenders to le Sous-Secretariat d'Etat des Postes et des Télégraphes, 103, rue de Grenelle, Paris.

TENDERS RECEIVED AND ACCEPTED.

The War Office have accepted the tender of Messrs. Pritchetts and Gold for supplying and fixing storage batteries and stands for each of the three Spithead forts. There will be 33 cells at the Spitbank fort and 44 at both Horses and Noman's Land forts, and in all cases the boxes will be of teak lead-lined.

The contract for steam dynamos, balancers and boosters for the new Worksop electricity works has been awarded to Messrs. Witting Bros. (Ltd.), 49, Cannon-street, E.C. The generating sets consist of Messrs. Witting's standard multipolar machines direct-coupled to Messrs. E. Scott and Mountain's high-speed engines.

Tunbridge Wells Council have accepted the tender of Mr. J. Jenkins for the erection of a brick chimney shaft at the electric lighting station for £3,835. 2s. 4d.

Heckmondwike Council have accepted the tender of Mr. G. F. Cooke for arc lamps and posts in place of Messrs. Veritys, who declined to accept the contract owing to an error in tendering. As Messrs. P. C. Middleton & Co. (Ltd.), who had obtained the contract for generating plant, have gone into liquidation, the consulting engineer (Mr. W. C. C. Hawtayne) has been instructed to communicate with the next three lowest tenderers.

Stafford Council have accepted the tender of the Electric Construction Co. for re-winding the armatures and field coils of the dynamos at the electricity works at £322; and in consequence of the insulation of the feeder and distributing cables having been found to be defective, the necessary work for re-insulating and re-laying the cables on Callender's solid system is to be carried out at an estimated cost of from £2,300 to £2,500.

Wigan Corporation have accepted the following tenders for the supply of electric tramway plant:—

Estler Bros., steel poles and section pillars.
Robt. W. Blackwell & Co., flexible bonds and castings.
Bergtheil and Wilson Young, overhead construction material.
Naylor Bros., bracket arms.

The contract for trolley wire has not yet been let.

Ayr Corporation have placed an order with Messrs. Siemens Bros. & Co. for three sets of continuous-current generating plant at £5,862 for lighting, and with Messrs. D. Bruce Peebles & Co. for two traction generators, each of 200kw., at £4,380 for the tramways.

Glasgow Tramways committee have arranged with Messrs. Macartney, M'Elroy & Co. to proceed at once with the erection of the overhead work for the tramway extensions in Alexandra-parade, Cumbernauld-road, Keppochhill-road, and Great Western-road, and with the Lorraine Steel Co. to proceed with their contract for the special track work.

The contract for the wiring and fitting of the Horton Asylum, Epsom, for the electric light has been let to Messrs. F. Troy & Co.

Stockport Town Council have accepted the tender of Messrs. Dick, Kerr & Co. for 20 top-seat cars at £675 each.

The London County Council have entered into a three years' contract with Mr. F. J. Coleby for the maintenance of the electric bells at the chief fire station, at £315 per annum.

Watford Council have accepted the tender of Messrs. Babcock and Wilcox for a water-tube boiler at £930.

APPOINTMENTS VACANT AND FILLED.

Motherwell Corporation invite applications for the position of burgh electrical engineer. An advertisement gives further particulars, and applications must be sent to the town clerk (Mr. James Burns) by 20th inst.

Bray (Ireland) Council notify in an advertisement that they will, at their meeting on 22nd inst., elect an electrical engineer to take charge of their electricity works. Applications to clerk (Mr. P. MacDonnell), Town Hall, Bray.

A mechanical engineering assistant is required for the office of a municipal engineer of a large town in the Midlands. Candidates must have had experience in electric tramway construction and steam practice. Applications by 26th inst. See advertisement.

Leyton District Council require a shift engineer for their electricity department. An advertisement gives further particulars, and applications must be sent to the engineer and manager (Mr. F. Harman Lewis), Cathall-road, Leytonstone, by 20th inst.

A first-class mechanical engineer, a shift engineer, a sub-station assistant, and a time and store keeper are required for a continuous-current electric lighting station near London. See advertisement.

A laboratory assistant in electrical engineering is required for the Municipal Technical School, Manchester. Applications to director (Mr. J. H. Reynolds). See advertisement.

A switchboard attendant is required for a London low-tension supply station. See advertisement.

West Bromwich Corporation require a borough electrical engineer. Commencing salary, £250 per annum. Applications to Mr. Alfred Caddick, Town Hall, West Bromwich, by 17th inst.

Belfast Corporation require a principal for their proposed technical institution. Salary £600 per annum. Applications by 22nd inst.

A head master is required for the Walthamstow Technical Institute. Applications to clerk to District Council by 26th inst.

Mr. C. S. Davidson, of Leyton electricity works, has been appointed clerk of works to superintend the laying of electric lighting mains, &c., at Barnes.

Mr. J. Erskine Murray, D.Sc., F.R.S.E., of the Marconi Wireless Telegraph Co., and formerly of the Heriot Watt College, Edinburgh, has been appointed lecturer and demonstrator in physics at University College, Nottingham.

Mr. G. A. Bruce has been appointed resident electrical engineer to the borough of Lowestoft at a salary of £200 per annum.

Mr. Gardiner has been appointed manager of the telephone department of the Tunbridge Wells Town Council at £156 per annum.

Mr. Bolam has been appointed assistant engineer at the Bristol electricity works, vice Mr. Dowson, resigned.

Mr. J. R. P. Lunn, of Huddersfield, has been appointed borough electrical engineer at Darlington.

Mr. H. W. Clayden, clerk of works under the consulting engineer (Mr. Robert Hammond), has been appointed resident electrical engineer at the Middlesbrough electricity works.

Mr. C. C. Atchinson, at present clerk of works, has been appointed resident electrical engineer at the Rochdale electricity works at a salary of £200 per annum.

BUSINESS NOTICES.

We have received a communication from Messrs. Polland & Co., 5, St. Nicholas-buildings, Newcastle-on-Tyne, intimating that arrangements have been completed for the disposition of the business to the Union Cable Co., Ltd., 23, College Hill, Cannon-street, London, E.C., as from Aug. 24 last. Debts due to Messrs. Polland & Co. will be received by the Union Cable Co., and debts due by Messrs. Polland & Co. will be discharged from 23, College Hill, Cannon-street, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Wm. Haines, electrician, &c., 261, Bury New-road, Whitefield, Lancs., has been adjudicated bankrupt.

In the bankruptcy of T. W. Greaves and W. G. Randall (lately trading as T. W. Greaves & Co.), electrical engineers, &c., 130, East India Dock-road, London, E., and Greenwich, the first meeting of creditors will take place on 18th inst., and the public examination on Nov. 15, at Bankruptcy Buildings, W.C.

An amended notice in the *London Gazette* states that the first and final dividend payable in the bankruptcy of B. Symmons, electrical engineer, Brighton, is 2s. 5½d. and not 2s. 8½d. as previously announced.

Official notice is given that the liquidator (Mr. J. D. S. Bogle, 91 and 93, Palmerston-buildings, E.C.) in the liquidation of the London Metallurgical Co. (Ltd.) has been released.

The Land and Water Electric Power Syndicate (Ltd.) is to be wound up voluntarily. Mr. S. B. Saunders, Bush-lane House, London, E.C., and Mr. J. B. Childe, Bradford and London, are joint liquidators, with Messrs. Hutton, Firth and Ingham as a committee to assist the liquidators.

The Aluminium Co. (Ltd.) is being wound up voluntarily, and Mr. P. S. Court, 13, Abchurch-lane, London, E.C., is liquidator.

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Plant for Sale.—A 1,200 H.P. three-phase generator, at present in operation at the Paris Exhibition, is offered for sale. An advertisement gives further particulars, and offers must be addressed to "L. T." 815, c/o Haasenstein and Vogler, Berlin, W. 8.

Oldham Electric Light committee invite tenders for two 40kw. shunt-wound dynamos and a spare armature, which will be for disposal in December next. An advertisement gives further particulars, and offers must be sent to the superintendent (Mr. Arthur Andrew), Gas and Water Offices, Oldham.

Telegraph Stores Sale.—The Postmaster-General invites tenders for the purchase of old stores, including about 40 tons of gutta percha, 90 tons of copper wire, plates, &c., indiarubber covered copper wire, tools, &c. Tenders by 10 a.m. 18th inst.

Parsons' Turbo Generators and Alternators.—A new pocket list of the various units of Parsons' turbo-generators and alternators supplied during the past five years or now on order is issued by Messrs. C. A. Parsons & Co., and can be obtained on application. An illustration is given of the 1,000kw. turbo-alternator supplied to the municipal authorities of Elberfeld, Germany. Altogether about 150 units of this type of plant have been supplied for lighting, power and traction. The largest customer in the list for this type of plant is the Metropolitan Electric Supply Co., who have 20 machines installed, the Newcastle and District Electric Lighting Co. being a good second with 11 machines, Blackpool Corporation following with eight.

Brush Traction Trucks.—The Brush Electrical Engineering Co. inform us that plant has been put down at the Falcon Works, Loughborough, for the manufacture of traction trucks, this being the first attempt made in this country to manufacture these trucks. Three standards have been adopted which are calculated to cover the general needs of electric traction. These standards comprise the four-wheel single type, the four-wheel bogie type and the maximum traction type. The special shop which has been equipped for this purpose at Loughborough has been placed under the control of Mr. E. Cook, an engineer who has had large experience in this branch of manufacture in the States.

"Johnson and Phillips" Cables.—Messrs. Johnson and Phillips's Electric Cable Works are issuing a list of standard sizes of conductors for electric supply mains in hanging card form, and copies of this card can be obtained by the trade free on application.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 3 to Oct. 9, with the ports of destination :—

Africa.—Alexandria, £413; Cape Town, £311; Durban, £2,422; Port Elizabeth, £385 (including £366 telegraph material); Port Said, £20. *Argentina*—Buenos Ayres, £226 (telegraph material). *Australasia*—Brisbane, £30; Fremantle, £66; Hokitika, £11; Lyttleton, £286; Melbourne, £3,210 (telegraph material); Perth, £244; Sydney, £990 (including £139 telegraph material); Wellington, £329. *Belgium*—Ostend, £581. *Brazil*—Rio Janeiro, £47. *Ceylon*—Colombo, £321. *China*—Shanghai, £169. *Denmark*—Copenhagen, £74 (including £44 telegraph wire). *Germany*—Hamburg, £200 (telegraph material). *Gibraltar*, £351 (including £18 telegraph apparatus). *Holland*—Amsterdam, £110; Rotterdam, £250. *Hong Kong*, £488 (including £368 telegraph material). *India*—Bombay, £40; Calcutta, £1,676. *Straits Settlements*—Singapore, £44 (including £30 telegraph material). *Sweden*—Stockholm, £260 (telegraph material). *West Indies*—Jamaica, £112. Total £13,656 against £20,925 in the corresponding week last year (Oct. 4 to Oct. 10).

Fifteen Years' Exports and Imports.—From the recently-issued "Statistical Abstract" for the United Kingdom for the years 1885 to 1899 we find that the *exports* of telegraphic wire and apparatus, electric lighting apparatus and parts thereof, and the *imports* of general electrical goods, were as under :—

Exports.—*Telegraphic Wire and Apparatus.*

1885	£770,054	1890	£1,602,305	1895	£782,375
1886	932,667	1891	1,434,020	1896	857,174
1887	817,385	1892	909,917	1897	997,802
1888	521,055	1893	1,052,887	1893	985,283
1889	1,038,540	1894	1,336,614	1899	1,406,734

Electric Lighting Apparatus and Parts thereof (except Steam Engines).

1885	No record	1890	£281,248	1895	£335,929
1886	88,679	1891	239,194	1896	382,438
1887	99,905	1892	174,641	1897	448,732
1888	166,409	1893	215,366	1898	514,632
1889	211,049	1894	246,354	1899	510,758

Imports.—*General Electrical Goods.*

1885 to 1896. No separate record kept.

1897	£242,185	1898	£367,572	1899	£613,593

Imports of Electrical Goods into the United Kingdom.—The value of the electrical goods and apparatus imported into this country during September was £97,107 against £148,317 in the preceding month. The total for the nine months ended Sept. 30 was £794,699.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

August 9, 1900.

14,288. J. SZCZEPANIK and L. KLEINBERG. London. Improvements in electromagnetic apparatus for jacquards.

14,289. A. W. B. PEARSON. London. Improvements in electric switches.*

August 10, 1900.

14,337. A. BRÜGGEMANN and DEUTSCHE WAFFEN UND MUNITIONS FABRIKEN London. An electric releasing apparatus for pneumatic pressure brakes.

14,347. T. ROBINSON. Liverpool. Hygienic appliance for sound transmitter mouthpieces. (Date applied for under Patents, &c., Act, 1883, sec. 103, Jan. 30, 1900, being date of application in United States.)*

14,354. THE EDISON ORE MILLING SYNDICATE (LTD.). London. Improvement in magnetic separating apparatus. (T. A. Edison, United States.)

14,355. THE EDISON ORE MILLING SYNDICATE (LTD.). London. Improvements in magnetic separating apparatus. (T. A. Edison, United States.)

14,357. K. DE KANDÓ. London. Improvements in electrical contact apparatus.*

14,368. C. DE KANDÓ. London. Improvements in liquid rheostats operated by means of compressed air.*

August 11, 1900.

14,373. H. O. FARRELL. Manchester. Improvements in and connected with electrical fuse boards.

14,383. E. W. LEWIS. Coventry. Improvements in or relating to electrical ignition devices for explosion motors having two or more cylinders.

14,384. W. CARTER and J. BOWRET. Bristol. Improvements relating to rail points and overhead switches in electric tramways.

14,409. J. HARRIS. London. Improvements in electric meters.*

14,420. J. G. LORRAIN. London. Improvements in combined electric meters and demand indicators. (A. Wright, at present on the High Seas.)

14,422. A. H. ADAMS. London. Improvements in switches and apparatus for use in starting and controlling electric motors.

August 13, 1900.

14,449. E. E. BARTLETT. Liverpool. Improvements relating to double-pole, three-way, and similar electrical switches.

14,450. E. E. BARTLETT. Liverpool. Improvements relating to electrical controlling and regulating switches.

14,463. P. SCHOOP. London. Improvements in apparatus for electrolysis.

14,488. R. HADDAN. London. A method of electrically reversing the direction of elevators driven by electricity. (A. Stigler, Italy.)

August 14, 1900.

14,506. A. G. BROOKES. London. Improvements in and relating to dynamo-electric machinery. (C. L. Cotton, United States.)*

14,550. H. H. LAKE. London. Improvements relating to the insulation of electric conductors. (N. Tesla, United States.)*

14,552. H. TUGBY. London. Improvements in conduits for electric conductors, water, or the like.

14,537. J. J. BATE. Liverpool. Improvements in or relating to conduits for electric conductors.

14,558. G. F. R. BLOCHMANN. London. Improvements relating to the transmission and receiving of telegraphic signals.

14,568. R. HADDAN. London. Improvements in toll-collecting machines for telephones. (The American Toll Telephone Co., United States.)

14,582. R. CHAVARRIA-CONTARDO. London. Improvements in and connected with electric furnaces.*

August 15, 1900.

14,608. S. H. HOLDEN and CHAMBERLAIN AND HOOKHAM (LTD.). Improvements in electricity meters.

14,633. P. LAPERTOT, G. VILLARD and L. PIGNAUD. Liverpool. An improved system of electric lighting and apparatus or devices therefor.

August 16, 1900.

14,688. H. E. MOUL. London. Improvements in or connected with incandescent electric lamps.

14,691. S. W. MAQUAY and T. G. CHAMBERS. London. Improvements connected with electric primary batteries for traction purposes.

14,704. C. G. G. BRAUNERHJELM. London. Improvement in transmitters for electrical waves or the like appartus. (Date applied for under Patents, &c., Act, 1883, sec. 103, Jan. 26, 1900, being date of application in Sweden.)

14,712. G. E. GOURAND and H. L. SHORT. London. Improvements in apparatus for recording, reproducing and transmitting sounds.

14,715. W. E. EVANS. London. Improvements in and relating to thermo-electric apparatus. (La Société Ginestes et Cie, France.)

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August 17, 1900.

14,743. H. F. Clayton. Huddersfield. Improvements in electric cutouts and the like.*

14,759. E. H. Tyler and A. G. Hansard. London. Improvements in electric traction.

August 20, 1900.

14,868. W. A. Phillips and C. E. Kent. London. Improvements relating to the insulation of electrical conductors.

14,877. J. Denuel and M. Junka. London. An improved dynamo-electric machine and regulator therefor.

14,893. L. B. Atkinson. London. Improvements in electrical measuring instruments.

14,895. F. R. Simms. London. Improvements in electric ignition plugs for internal combustion engines.

August 21, 1900.

14,906. J. Milnes. Liverpool. Improvements in or connected with sectional conductor street or road electric railways.

14,915. T. Watson. Sheffield. A new automatic life-saving guard for electric cars, motor cars, &c.

14,924. H. Rose, J. Halifax and C. H. Antrobus. London. Improvements in electric accumulators.

14,930. J. T. Knowles, of the firm of D. Young & Co. London. Improvements in galvanising apparatus. (The New Process Coating Co., United States.)*

14,943. M. I. Baird. London. Improvements in switchboards for telephone stations.*

August 22, 1900.

14,971. J. Swinburne. London. Incandescent electric lamps.

14,972. D. G. Graham. Glasgow. A new or improved arrangement for automatically lubricating the spindles of dynamos.

15,001. A. Honig. London. Improvements in electric measuring instruments.

15,019. R. H. Gould. London. Improvements relating to the recovery of tin, and the simultaneous generation of electric energy.

15,021. V. Alexandroff. London. Improvements in the manufacture of carbon electrodes for arc lamps.

August 23, 1900.

15,073. H. R. Boissier. London. Improvements in electroplating apparatus.*

15,095. The Reason Manufacturing Co. (Ltd.). London. Improvements in electrical demand indicators. (A. Wright, High Seas.)

August 24, 1900.

15,123. Nettlefolds Limited and W. E. Symons. London. A new or improved electrical arc lamp.

August 25, 1900.

15,148. T. Greensmith and M. B. Wild. Manchester. A new or improved electrical hauling apparatus.

15,167. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (W. J. Davis, jun., United States.)*

15,168. The British Thomson-Houston Co. (Ltd.). London. Improvements in commutators for electric machines. (J. T. H. Dempster, United States.)*

15,169. The British Thomson-Houston Co. (Ltd.). London. Improvements in rectifying alternating electric currents. (E. Thomson, United States.)*

15,175. A. G. Bloxam. London. Improved apparatus for igniting by electricity combustible mixtures in internal combustion motors and the like. (A. Schoeller, Germany.)

15,193. R. J. Reynolds. London. A new or improved method for adjusting electrodes.

August 27, 1900.

15,225. H. Bremer. Germany. Improvements in electric arc lamps.*

15,226. J. A. Prestwich. London. Improvements in kinematographic apparatus.

15,227. H. S. Elworthy. London. Improvements in or relating to machinery for the production of electrical energy.

15,246. E. Sander. London. Improvements in the manufacture of electrically conducting bodies.

August 28, 1900.

15,265. G. A. Clark. Glasgow. An improved joint-box for electric cables.

15,285. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (A. D. Lunt, United States.)*

15,313. P. B. L. Lombard-Gerin. Liverpool. Improvements in automotor trolleys for electric current.*

15,332. W. L. Wise. London. Improvements in apparatus for stopping, starting, and reversing electric motors. (The Skodawerke Actien-Gesellschaft, Austria.)

15,334. A. H. Adams. London. Improvements relating to switches and apparatus for use in starting, controlling, and reversing electric motors.

August 29, 1900.

15,363. G. Cooke. Sheffield. Improvements relating to the electro-deposition of metals upon articles of china, earthenware, and the like.

15,378. The British Thomson-Houston Co (Ltd.). London. Improvements in means for generating alternating electric currents. (A. D. Lunt, United States.)*

15,379. The British Thomson-Houston Co. (Ltd.). London. Improvements in regulating dynamo-electric machines. (C. P. Steinmetz, United States.)*

15,380. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz and W. Le Roy Emmet, United States.)*

15,381. The British Thomson-Houston Co. (Ltd.). London. Improvements in thermal electric cutouts. (W. Le Roy Emmet, United States.)*

15,382. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. M. Green and J. G. Callan, United States.)*

15,404. W. P. Thompson. Liverpool. Improvements in incandescent electric lighting devices. (The Voltohm Elecktrizitäts Gesellschaft, A. G., Germany.)

15,419. R. Haddan. London. Improvements relating to the supply of current to electric vehicles by inductive means. (E. Sussmann-Kellborn, Germany.)

August 30, 1900.

15,457. E. Sander. London. Improvements relating to the production of electrical conducting bodies specially applicable for use in electric incandescent lamps.

15,470. A. J. Boult. London. Process of forming metallic electro plates. (E. Andreas, Germany.)

15,473. A. J. Boult. London. Process for the forming of electrodes. (E. Andreas, Germany.)

15,475. F. E. Beeton. London. Improvements in and in connection with the distribution of electrical supply.

August 31, 1900.

15,479. F. E. Beeton. Dover. Improvements in electric arc lights.

15,480. W. Routledge. London. Improvement in or relating to overhead systems for the transmission of electrical energy.

September 1, 1900.

15,591. A. J. Boult. London. Improvements in automatic interruptors for electric circuits. (F. Katzenstein, Switzerland.)

September 3, 1900.

15,605. E. P. Grove. Bromley. Improvements in and relating to automatic frogs for the overhead equipment of electric tramways.

15,642. L. J. P. Hollub and H. Mignal. London. Improvements relating to electric incandescent lamps.*

September 4, 1900.

15,701. J. Matthews and W. Davies. Birmingham. Improvements in electrolytical apparatus.

15,710. H. H. Lake. London. Improvements relating to electric storage-batteries. (W. R. Bowker, United States.)*

15,713. R. Hacking. London. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like.

15,717. Léon Dion. London. Improvements relating to electric railways working on the closed conduit system.*

15,718. H. H. Lake. London. Improvements relating to the preparation of conducting material chiefly designed for the manufacture of brushes for dynamo-electric machines. (J. B. Fay, United States.)

15,721. H. T. Cedergren and G. M. T. Pietz. London. Improvements relating to telephone systems.*

15,725. C. B. King, jun., E. R. Smith and J. J. Rathbone. London. Improved means and appliances connected with electric arc lamps.

15,730. E. Tatham. London. An improved material or composition suitable for use as an electrical cement and insulator.

15,746. G. C. Fricker. London. Improvements in arc lamps.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

16,569. Katz. Accumulator electrodes.

16,926. Darwin, Griffiths and Whetham. Electric measuring and indicating apparatus.

17,159. Hookham. Electricity meters.

17,504. Goddin. Means and apparatus for recording the deflections of pointers, magnetic needles, coils, and the like, and the fluctuations of electric currents, and for utilising such deflections or fluctuations to actuate or control various other mechanisms or apparatus.

17,593. Morgan. Transmission dynamometers or torque indicators.

18,365. Aitken. Central battery telephone exchange systems.

18,643. Frederick Foss (Executors of the late Frederick Hall Snyder). Amalgamation and coating of metals or alloys of metals with metals or alloys of metals by the aid of electricity, and apparatus therefor.

19,120. Imhoff, Raschen and United Alkali Co. (Ltd.). Means to be employed in the electrolytic manufacture of chlorates.

19,261. British Thomson-Houston Co. (Ltd.) and Holden. Means for electrically re-winding clock or similar mechanism.

19,440. Gehre. Apparatus for periodically producing electric current by means of irregular motive power.

19,445. Blondell, Weissmann and Wydts. Electric lighting systems.

19,856. Clark (Courtney). Magnetic separators.

19,941. Pick. Electric tramcars with overhead collectors.

20,084. Cervera-Baviera. Method of and means for transmitting and receiving electric waves for the production of signals and for imparting motion to machines or apparatus.

20,145. Sevenoakes. Combination electric light fittings.

20,316. Sykes. Troughs for electric cables.

20,480. Curwen. Electric arc lamps.

20,544. Bowman. Electric bell.

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1900.

246. HEADLEY. Automatic electric switches or cutouts.
2,929. CHAPMAN and BATT. Electrolysers.
5,755. JUNG, BRECHER and KITTEL. Manufacture of electrical insulating material.
6,479. RIBBE. Electric accumulator plate.
7,106. MURPHY. Electric railways on a surface-contact system.
8,829. SKOPES and HERD. Safety lock with electrical door-opening device.
8,866. NEWTON (Carleton). Electric signalling apparatus.
8,880. EICHWEDE. Means for recording the number and duration of telephonic conversations.
8,945. BOULT (Hatch). Electric motors particularly applicable for propelling boats.
9,110. PAUL (Paul). Contact-pieces for transmitting the current from the fixed base to the revolving or swinging top of electric search-light projectors.
9,413. GIBBS. Electric motor suspension on electrically-propelled vehicles, such as tramcars and the like.
9,768. MCTIGHE. Manufacture of electric railway rail bonds, and other electric couplings or terminals.
9,836. LARKIN. Conduits of electric railways.
9,873. HEWITT, LINDSTROM AND HEWITT. Electric motors, batteries, and connections thereof for propelling automobiles and like vehicles.
9,879. KRAYN. Electric incandescent lamps.
10 181. GRIFFING. Means for electrically generating steam.
10,318. FELL (Wiegand). Electric storage batteries and conducting plates therefor.
10,357. HYNES and RANDALL. Electrical apparatus for surgical and other purposes.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC RAILWAYS CO. (LTD.)—This company was registered on Oct. 1, with a capital of £75,000 in £1 shares, to apply for and obtain parliamentary powers, concessions or other rights for the construction of railways, tramways, electrical and other works, electric light installations, &c., and to carry on the business of electrical and mechanical engineers, railway and general contractors, electricians, suppliers of electricity, &c.

CROMPTON & CO. (LTD.)—The annual return to Aug. 12 gives the capital as £162,000, in 54,000 shares of £3 each, all of which have been taken up, and £3 per share has been called up on 52,000 shares.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29 $\frac{5}{16}$d. per oz. (Oct. 11). Consols (2$\frac{3}{4}$ per cent.) 98$\frac{5}{8}$ - 98$\frac{7}{8}$ for money, 98$\frac{1}{2}$—98$\frac{5}{8}$ for account; 2$\frac{1}{2}$ per cent. 96$\frac{1}{4}$—96$\frac{3}{4}$ (Oct. 11). Stocks and Shares Continuation Days, Oct. 24 and Nov. 11; Ticket Day, Oct. 25; Pay Days, Oct. 12 and 26; Mining Share Carry-over Days, Oct. 23 and Nov. 10.

AKKUMULATORENFABRIK AKTIENGESELLSCHAFT BERLIN—HAGEN.—A dividend of 10 per cent. has been declared for 1899-1900, the same as last year.

BRITISH MOTOR TRACTION CO. (LTD.)—At the statutory meeting held last week the chairman (Col. Harris) announced that the reconstruction of the company had been effected. It is stated that numerous actions are pending against alleged infringers of the company's patents.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors recommend a dividend of 5 per cent. per annum on the ordinary shares (tax free) for the half-year ended June 30.

DIRECT UNITED STATES CABLE CO. (LTD.)—An interim dividend of 3s. per share, tax free (being at the rate of 3 per cent. per annum for the quarter ended Sept. 30), has been declared payable 26th inst.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS (LTD.)—The ordinary general meeting of this company was held last week, when the directors reported that the profit shown for the period was £3,914. 4s 11d., and they recommended that this amount be carried forward. All the share capital had been fully subscribed and paid up. Notwithstanding the great pressure in the building and engineering trades, the work of completing the necessary buildings and the installation of the machinery was carried out with a minimum of delay. The works are now in full operation and in a most efficient state. In starting the new industry at Preston great difficulty arose in securing and educating the necessary labour, but the directors are able to announce that there is now a full complement of skilled men, and they look forward with confidence to the result of the working of the current year. Large orders have been received for cars at remunerative rates, and it is hoped that the output of 600 cars per annum mentioned in the prospectus will be exceeded.

GENERAL ELECTRIC CO. (1900) (LTD.)—As announced in our last issue, the prospectus will be issued early next week of a new company, with the above title, formed to take over the General Electric Co. (Ltd.), registered in 1889. The share capital of the new concern is £800,000 in 40,000 5 per cent. cumulative preference and 40,000 ordinary shares, each of £10. There will also be an authorised issue of £200,000 in 4 per cent. first mortgage debenture stock, bringing the authorised capital up to £1,000,000. Subscriptions will be invited for £150,000 debenture stock and £180,000 preference shares, (total £330,000) at par, the venders taking in part payment of the purchase price £50,000 in debenture stock, £70,000 in preference shares, and £250,000 in ordinary shares at par, £130,000, the remainder of the purchase money, being taken in cash. The new company takes over the old company as from March 31, 1900, and the price fixed by the vendors for the business as a going concern is £676,139. 0s. 7d., less debts and liabilities on March 31, 1900, and profits for the year to that date (which are reserved to the vendors), £176,139. 0s. 7d., making the net purchase money £500,000. A certificate of the profits of the old company for the last three years is given by Messrs. Edwin Guthrie & Co., C.A., as under:—

To March 31,	1898	£51,546	10	7
Ditto	1899	57,034	0	0
Ditto	1900	76,804	12	5

or an average of £61,795. 2s. 3d. per annum for the period covered. The nominal capital of the old company was £200,000, of which £177,000 was called up. Of this latter sum £152,000 represents calls received, and £25,000 is considered as paid.

The prospectus states that the present issue will provide £132,841 for extensions of the works and further working capital. The works, offices, and businesses taken over by the new company are set out in the prospectus as follows:—

67, 69, 71, 88, and 92, Queen Victoria-street, 30, Cannon-street, and 56, Upper Thames-street, London, E.C.; 120, Union-street, Borough, S.E.; Victoria Bridge, Manchester, and Peel Works, Adelphi, Salford; 56, Barwick-street, and Ileene Works, Sherlock-street, Birmingham; 71, Waterloo-street, Glasgow; 16, St. Andrew-street, Dublin; and 13, Westgate-road, Newcastle-on-Tyne.

No mention is made in the prospectus of the business of the Incandescent Electric Lamp Co. (Ltd.), with which the General Electric Co. has been so closely identified.

No new blood is introduced on the directorate of the new company, the management remaining in the hands of the old directors, Messrs. G. Byng, M. Byng, H. Hirst, and A. Eckstein. Mr. G. Byng, who has been connected with the company and its predecessors in business since 1880, and who has acted as managing director since the incorporation of the old company in 1889, becomes chairman of the new concern.

The subscription list opens on Tuesday, Oct. 16, and closes at or about 4 p.m. on Wednesday. It is a remarkable sign of the vitality of the electrical industry that a new company with a capital of £1,000,000 sterling can be introduced to the public on such short notice. This is the more surprising, seeing that the prospectus announces that none of the capital has been underwritten; but it may be claimed in this particular instance that the company is old-established and well known.

MUNICIPAL LOAN.—The Reigate municipal issue of £55,000 3 per cent. redeemable stock for electricity works and other improvements has proved a failure. It is said that only eight tenders were received for £6,900.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—At an extraordinary meeting, held last week, the circular which was abstracted in our last issue was discussed. The chairman (Ald. T. G. Gibson) pointed out that the sites selected for the two generating stations were advantageously situated, and in addition to the lighting of the new districts for which they had parliamentary powers the directors were considering the question of constructing electric tramways between Newcastle and North Shields. A private syndicate had been formed which would make application to Parliament for the necessary powers. The various resolutions proposed by the directors were approved.

NEW ST. HELENS AND DISTRICT TRAMWAYS CO. (LTD.)—The first annual meeting was held at Liverpool on Monday. The chairman (Sir John A. Willox, M.P.) moved the adoption of the report, which appeared in our last issue, and said that some time ago the Corporation of St. Helens obtained parliamentary powers to construct electric tramways in the borough and the adjacent districts. They granted a lease of the whole system to their company for 21 years. The Corporation undertook to lay down the rails and the electrical equipment and to supply the motive power, and the company the rolling stock and the staff for working the lines. The rent began to accrue from the date of the lease, but while the rental was thus accruing the electric tramways were not ready for use. At the outset the company was, therefore, at some disadvantage financially. It was seven months after the company came into existence before their first electric section—that between St. Helens and Prescot—was opened. Since then other sections had been opened, and the work was being pressed forward vigorously. At June 30 only about one-half of the tramway system had been completed, but since then other sections had been finished and opened, and they were not without hope that in a comparatively short time fully 20 miles of tramway would be completed. The directors made no complaint against the Corporation of lack of energy in pushing forward the work, as they all knew that there was a great demand for electrical plant and apparatus, and that contractors were unable to finish their work within the stipulated time. The delays at St. Helens might no doubt have arisen from unavoidable causes, and they must endure them with patience, but the result, all the same, had been rather hard on the company. They had been paying rent, providing rolling stock, and incurring all the charges of administration, and had not been able to recoup themselves by receipts from traffic. However, the directors had provided for an ample equipment of cars, and as each section of lines was passed by the Board of Trade the service in that section was commenced the very next day. The cars were roomy, handsome, and well appointed, and had given entire satisfaction to the travelling public, and the service had been maintained on all the routes with regularity. The Corporation's supply of power had been adequate and uninterrupted, and the efficiency of the company's service was undoubtedly largely due to that fact. The receipts on the sections of line now working were large

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and progressive. The relations between the Corporation and the company were harmonious, and all they now wanted was to get their lines into operation; when that was realised he thought the shareholders would have reason to be satisfied with the result. The report was adopted.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—An interim dividend of 2½ per cent. (5 per cent. per annum) on the paid-up capital of the company (tax free) has been declared.

REUTER'S TELEGRAM CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum (free of tax) for the half-year to June 30 has been declared, payable 13th inst.

SOCIETE ELECTRICITE ET HYDRAULIQUE (CHARLEROI, BELGIUM).—The report of the directors of this company states that the British business, which is entrusted to Messrs. Witting Bros., 49, Cannon-street, London, E.C., has made great progress during the last 12 months. As a matter of fact, the order books of the latter firm show sales for upwards of 17,000 H.P. of machinery during the period mentioned.

STOCK EXCHANGE NOTICES.—The 17th inst. has been appointed a special settling day for £150,000 3½ per cent. debenture stock of the *St. James' and Pall Mall Electric Light Co. (Ltd.)*, and the stock, together with £348,777 4 per cent. debenture stock of the *Western Telegraph Co. (Ltd.)* has been ordered to be quoted in the official list. The committee has also been asked to allow 10,000 ordinary £5 fully-paid shares (Nos. 1 to 10,000) of the *Folkestone Electricity Supply Co. (Ltd.)* to be quoted in the official list. This is a renewed application.

WESTERN UNION TELEGRAPH CO.—The total earnings for the year ended June 30 were $6,165,000 net, the gross increase being $804,258 and the net increase $296,631.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways	Oct. 6	4,570	+ 250	13	59,717	+ 2,644
Blackpool Corporation ..	„ 4	673	+ 241	27	25,146	+ 6,489
Blackpool and Fleetwood	„ 6	407	− 15	14	18,070	+ 112
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 7	547	+ 173	27	14,037	+ 3,035
Brisbane Trams	Aug. 22	1,841	+ 479	7	13,059	+ 2,665
*Bristol Trams & Carriage	Oct. 6	3,305	+ 362	14	49,576	+ 458
*Buenos Ayres & Belgrano	Sept. 9	3,095	+ 316	10	22,241	− 274
Central London Railway	Oct. 6	5,103	− 105	10	47,510	...
City & South London Ry.	„ 7	1,616	+ 597	14	21,237	+ 8,033
Cork Elec. Trams	„ 4	458	+ 67	40	16,625	+ 1,385
Dover Corporation	„ 6	224	+ 22	27	6,589	+ 359
Dublin & Lucan Rly.	Sept. 29	92	+ 20	14	1,590	+ 299
	Oct. 6	98	+ 21			
Dublin United	„ 5	3,651	+ 657	14	54,087	+ 7243
Dublin Southern Dist....	„ 5	836	+ 116	14	15,536	
*Glasgow Corporation ...	„ 6	9,141	+ 212	...	...	...
Hull Corporation	„ 6	1,276	+ 655	14	18,510	+ 10,155
*Liverpool Corporation...	Sept. 29	8,920	+ 2,873	39	305,057	+ 37,636
Liverpool Overhead Rly.	Oct. 7	1,592	+ 130	14	24,272	+ 1,193
*Sheffield Tramways	„ 7	2,691	+ 640	40	88,794	+ 31,330

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 3.		Price Wednesday, Oct. 10.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 10. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.			
100,000	1	...	Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)					...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	12⅛	13⅛	12⅛	13⅛	3 14 1	...	10⅜	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red.)	100	103	101	104	4 6 7	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord....	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¼	6⅝	6	6⅛	...	...	6¼	6⅜
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp. ...	9	10	9	10	4 12 6	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3	„ „	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½	7⅛	6½	7⅛	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110	113	110	113	4 0 11	June and December...	111½	110
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) ..	100	110	100	110	4 10 11	April and October.....	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8½	9½	8½	9½	4 4 3	February and August	9	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12⅜	13⅜	12⅜	13⅜	4 9 0	January and July.....	13½	13⅜
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124	129	124	129	3 18 2	June and December ...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9½	8½	9½	6 6 4	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11	13	11	12	5 0 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107	110	107	110	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½	7	6½	7	4 2 7	January and July.....	...	...
110,000	3	...	London Electric Supply Ordinary	1¼	2¼	1⅜	2⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½	5½	4½	5½	5 9 1	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100	102	100	102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord.	13	14	13	14	3 18 7	April and October.....	13⅛	13¼
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage ...	111	114	111	114	3 18 11	June and December ...	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97	100	97	100	3 10 7	...	93½	93
6,452	10	6/0	Notting Hill Electric Ordinary	14⅜	15⅜	14⅜	15⅜	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5⅛	6⅛	5⅛	6⅛	3 16 11	„	6¼	...
300,000	1	1/6	Rand Electric	1 5/16	1 7/16	1 5/16	1 7/16	10 18 2	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb....	75	85	75	85	5 18 0	January and July.....	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165	185	165	185	4 6 6	April and October.....	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures ..	103	105	103	106	4 4 11	„ „	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	15⅝	15⅝
20,000	5	3/6	Do. 7 per Cent. Preference	8	9	8	9	3 17 8	„ „	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2	2½	2	2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85	95	85	95	4 4 3	—	...	...
65,000	5	...	South London Electric Supply Ordinary.....	3	4	3	4	...	...	5⅛	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12	13	12	13	5 0 0	March and September	13⅝	12½
29,437	5	...	Do. Do.....	11	12	11	12	...	...	13⅝	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.								
15,000	10	4/0	Blackpool and Fleetwood Tramways.....	14	16	14	16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	101	103	101	103	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	21⅞	22⅛	22½	23⅛	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10⅜	10⅝	10⅜	10⅝	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	120	118	120	3 6 1	February and August	...	...
13,600	10	5/0	British Columbia Electric Railway 5% Pref.	10	10⅛	10	10⅛	4 15 3	May and November .	10⅛	...
45,000	10	11/0	British Elec. Trac. Ord.	14	15	13⅛	14⅛	6 17 11	...	14⅛	...
50,000	10	6/0	Do. 6% Cum. Pref.	12	13	12	13	4 12 4	February and August	12⅝	12⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	120	123	120	123	4 1 4	...	121¼	121⅛
£150,000	Stock	52/3	Do. Do. (issued Feb. 5, 1900)	120	123	120	123	4 1 4	...	...	...
40,000	5	3 0	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅜	5	4⅜	5	6 0 0	...	...	...
27,500	5	...	Do. "B"	3⅜	4⅛	3⅜	4⅛	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 14 8	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) ...	96	99	96	99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10	10¼	10¼	10⅜	2 15 10	June and December ...	10⅜	10⅜
£855,000	Stock	1½%	City and South London Railway Con. Ordinary ...	58	61	58	61	2 5 2	February and August	61	58⅜
37,500	10	1/5 7/8	Do. (Nos. 22,501 to 60,000)	5	6	5	6	2 9 4	„ „	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)...	133	143	138	143	3 9 11	„ „	...	...
£200,000	Stock	5%	Do. (1896)	130	135	130	135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120	125	120	125	3 4 5	May and November ...	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	20½	21½	20½	21½	3 12 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½	15	14½	15	3 18 8	„ „	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July.....	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref. ...	9¾	10¼	9¾	10¼	4 17 7	May and November ..	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary.....	8⅝	9	8⅝	9	4 8 11	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	„ „	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	104	106	104	106	3 16 0	January and July.....	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'k'g 5% Mor. Debs. (1903)	...		104	105	4 15 6	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	...		103	105	4 6 4	...	...	...
24,000	5	...	New General Traction Ordinary	3¼	3¾	3¼	3¾	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½	5	4½	5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.....	18	19	17	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½	10⅞	10½	10⅞	4 14 1	„ „	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅜	12⅜	11⅜	12⅜	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9½	10½	4 15 3	February and August	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	104	107	104	107	...	...	...	...
940,000	Stock	3%	Waterloo and City Ordinary	92	95	94	97	3 2 2	June and December...	96	93½

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 3.	Price Wednesday, Oct. 10.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 10	
						£ s. d.		Highest	Lowest
			TELEGRAPHS.						
£96,200	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	...	...	...	June and December	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£822,720	Stock	15/0	Anglo-American	59 62	58 61	6 0 8	Feb., May, Aug., Nov.	59	...
£3,088,640	Stock	30/0	Do. Preferred	109½ 110½	109 110	5 10 1	,, ,,	110½	109½
£3,088,640	Stock	27/0	Do. Deferred	11 11½	10¾ 11¼	12 0 0	,, ,,	11 7/16	10⅝
$13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	100 102	100 102	3 18 5	,, ,,	102	101¾
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	,, ,,	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	100¾ 104¾	100¾ 104¾	4 6 7	January and July	...	...
60,710	20	5/0	Direct United States Cable	10¾ 11¼	10¾ 11¼	6 4 5	Jan., Apr., July, Oct.	11	10 11/32
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December	...	...
£4,000,000	Stock	6/0	Eastern Ordinary	149 154	149 154	4 11 6	Jan., Apr., July, Oct.	150¾	149½
£1,826,888	Stock	17/6	Do. 3½ per Cent. Preference Stock	99 102	99 102	3 9 0	,, ,,	101	99½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	114 119	114 119	3 8 1	May and November	114	...
250,000	10	2/6	Eastern Extension	15 15½	15 15½	4 10 4	Jan., Apr., July, Oct.	15⅜	11⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 118	113 118	3 8 6	February and August	...	..
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	99 102	3 18 6	February and August	100	99½
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)	100% 103%	100% 103%	3 17 8	May and November	...	...
180,227	10	4/6	Globe Telegraph and Trust	10¾ 11¼	10¾ 11¼	4 13 4	Jan., Apr., July, Oct.	11⅛	11 1/16
180,042	10	3/0	Do. 6 per Cent. Preference	15 15⅝	15 15⅝	3 17 5	,, ,,	15⅝	15
150,000	10	5/0	Great Northern of Copenhagen	31 35	31 35	3 11 5	January and July	...	...
£84,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)	98 101	98 101	4 9 1	June and December	...	...
17,000	25	37/6	Indo-European	49 53	49 53	4 14 4	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	103 106	103 106	5 13 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126 131	126 131	4 13 5	,, ,,	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	98 101	4 19 0	March and September	101	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 13 4	January and July	...	...
88,321	10	1/0	West India and Panama	¾ 1	¾ 1	...	May and November	1⅛	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	,, ,,	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 6	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	105 108	105 108	4 13 6	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15½	14½ 15½	4 11 10	Mar., June, Oct., Dec.	15	14 13/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December	...	...
£314,777	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	...	100 103	3 18 5	...	...	...
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	5 14 4	August	...	...
224,850	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	½ 1	½ 1	5 0 0	,,	...	...
590,000	5	3/0	National	4⅜ 4⅝	4½ 4⅝	6 6 4	February and August	4 1/16	4½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13 15	13 15	4 0 0	,, ,,	17/8	13½
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	13 15	13 15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½ 5⅝	5 5½	4 15 3	,, ,,	5½	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 101	97 101	3 10 8	June and December	...	...
171,504	1	0/8	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October	...	...
58,000	5	4/6	United River Plate	4¾ 5¼	4¾ 5¼	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	104 107	4 13 6	,, ,,	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	⅞ 1⅛	⅞ 1⅛	4 8 11	...	...	...
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾ ⅞	¾ ⅞	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	¼ ½	¼ ½	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	¾ 1	¾ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5¾ 6¼	5¾ 6¼	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4¾ 5¼	4¾ 5¼	...	...	...	...
90,060	2	1/2⅜	Brush Electrical Engineering	1¾ 2	1¾ 2	6 0 0	September	1 1/16	...
15,731	2	...	Do. £1 paid	...	...	...	...	...	...
90,000	2	1/2⅜	Do. 5 per Cent. Pref. Non-Cum.	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2 5/16	...
15,731	2	...	Do. £1 paid	...	...	...	...	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	106 111	106 111	4 0 11	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	102 104	102 104	4 7 2	January and July	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	12½ 13½	12½ 13⅝	5 11 1	,, ,,	13 5/16	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 5½	5 5½	4 10 11	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	6 8 0	...	1/8	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	6 10 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	5 6 8	...	...	...
54,000	3	2/6	Crompton and Co. (Nos. 1 to 32,098)	3¾ 4½	3¾ 4½	5 5 10	January and July	3 15/16	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 102	99 102	4 18 0	,, ,,	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	1¾ 2¼	1¾ 2¼	8 0 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	90 92	90 92	4 7 5	June and December	...	...
£100,000	Stock	2/11⅝	Do. 5% 2nd Deb. Standing Prov. Certs (all pd)	94 100	96 100	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4½ 5	4½ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	100 103	100 103	4 8 0	...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 6 8	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2¾ 3¼	2¾ 3¼	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 105	102 105	3 16 2	January and July	...	...
30,000	5	4/0	Henley's Telegraph Works Ordinary	12½ 13½	12½ 13½	5 11 1	February and August	13¼	12¾
30,000	5	2/3	Do. 4½ per Cent. Preference	5 5⅛	5 5⅛	4 1 10	,, ,,	5⅜	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	108 112	108 112	4 0 4	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20 21	3 11 5	,, ,,	20½	20 1/16
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 18 5	March and September	100	...
37,350	12	12/0	Telegraph Construction and Maintenance	34 38	34 38	4 14 8	March and July	38	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 5½	5 5½	4 10 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary	10½ 11½	10½ 11½	5 4 4	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	6½ 7½	6½ 7½	4 2 9	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,170. [No. 26. Vol. XLV.] FRIDAY, OCTOBER 19, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 80c., or 70pf.

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NOTES.

ON another page we give the conclusion of Mrs. AYRTON'S Paper on "The Light Emitted by the Continuous-Current Arc." The explanation arrived at, that the arc column selectively absorbs the more illuminating rays of the light from the crater seems unavoidable, and is one which will probably meet with ready acceptance by all who have studied the subject. To explain the increase of this absorption with increased arc length obviously requires either that the thickness of the absorbing medium, or that its absorbing power increases with increase of arc length. We hardly think there is yet sufficient reason to choose the latter explanation in preference to the former. Mrs. AYRTON considers that in long arcs there occurs a condensation of carbon vapour to mist, and that the solid particles of this mist selectively absorb the visually brighter rays while reflecting the violet. However, without going into the mechanism by which the absorption is effected, it would seem better—provisionally at all events—to explain the increased absorption merely by the probable increase in the thickness of the vapour through which the light from the crater has to pass in long arcs. M. BLONDEL'S measurements of the light radiation of the arc were, we believe, made with his lumenmeter, which measures the total flux in one operation. Polar diagrams of the light radiation with short and long arcs at constant current would probably be fruitful of indications as to the cause of the greater absorption of the light emitted with long arcs. It would be a laborious task to produce them, but perhaps Mrs. AYRTON, whose steady and patient research in this special subject has been already fruitful of such good results, will be tempted to conclude her present investigation in this manner.

IT will be remembered that when the City of London Electric Lighting Co. applied to the London County Council for sanction to an alteration in its standard supply voltage, under the Southwark Electric Lighting Order, from 100 volts to 200 volts, the Council only consented to this modification under conditions which were prohibitive to a dividend-earning company. After changing the wiring in consumers' premises at their own cost, the company were further to allow its consumers a reduction of 15 per cent. in the price charged for electrical energy; they were to undertake to impose no extra charge to consumers who objected to being changed-over to the higher pressure, and finally were to guarantee the house wiring for a year. The company wisely availed itself of its right to appeal to the Board of Trade against this action of the London County Council, and it will be seen in our report of the Council's proceedings in another column that only one of the London County Council's conditions has been allowed, viz., that justly specifying that the company should bear the cost of any necessary re-wiring of the premises of a changed-over consumer.

ANOTHER important matter which has been pending for some time is an appeal from the decision in the case of a police court prosecution brought by the London County Council against the London Electric Supply Corporation for not maintaining a constant supply of electrical energy. The summonses taken out against the company in May had been dismissed by the magistrate, but he had stated a case for a superior Court. On the assurance of the company that it was highly improbable any similar failure of supply would occur in the future, the Council has now decided to abandon further proceedings. On previous occasions the magistrates have always held that undertakers failing to supply were absolved from the penalties in the Board of Trade regulations if the failure had occurred through accident or unforeseen emergency, and it is probable that, if the Council had made the appeal, this view of the

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matter would have been upheld. It would, however, have been advantageous to the electric supply industry to have obtained an opinion on the case in the Court of Appeal.

THE article on American cable manufacture, reprinted in another column of this issue, will be read with interest by both cable makers and cable users in this country. Of course, the general principles of cable manufacture must be the same all the world over, but on important points of detail it appears that American practice differs from British. For instance, if Mr. MAVER is correct in stating that conductors are not usually stranded unless of a greater diameter than a quarter of an inch, American users of cable must be satisfied with considerably less flexibility than is considered necessary in this country. The insulation of paper-covered conductors is now rendered more flexible than formerly by not laying on the strip so tightly, a necessity recognised, we believe, by British cable makers some years ago, but on the other hand, it would seem that the Americans have not yet imitated some manufacturers here in substituting layers of tape ("half lap") in the same direction for the "reverse lap" universally in vogue at one time. Seamless rubber insulation has also been tried and found wanting by our manufacturers, the reason assigned being usually that the modified sausage-machine employed for covering wire in this manner demands an inferior and more plastic india-rubber compound than that which can be laid on by the longitudinal, or by the taping process. Even with rubber cables of the latter class, deterioration has usually been traced to the properties of the material itself rather than to an opening of the seam.

WE publish this week a description of the most recent form which the POLLAK-VIRÁG system of high-speed telegraphy has taken. Our readers may remember that just over a year ago we published an account of this system as then developed, and gave some of the results which the inventors had obtained with their apparatus under favourable conditions. Speed of transmission up to 100,000 words per hour were obtained, while the average rate proved to be between 1,800 and 1,500 words per minute. By an ingenious addition to the original form of their apparatus the inventors have now made it capable of recording its messages in ordinary handwriting. In doing this, speed has been lost, but even yet a rate of transmission of about 1,000 words per minute is said to have been attained. This performance involves the writing of about 80 complete characters per second. The permanent recording of so great a number in so short a time has been rendered possible by the great advance made in recent years in the preparation of sensitive papers; indeed, the success on a practical scale of this new high-speed system depends largely on the reliability of that material. When employed on ordinary lines under the conditions of daily practice one may expect a considerable reduction in the speeds mentioned, but be that as it may, Messrs. POLLAK and VIRÁG are to be congratulated on a most important invention in the art of telegraphic signalling.

AFTER much discussion, in August last the Marylebone Vestry, anxious to emulate the example of the neighbouring parishes of Hampstead, Islington and St. Pancras, authorised a sub-committee to conclude negotiations with the Metropolitan Electric Supply Co. for the purchase of the portion of that company's undertaking within the parish of Marylebone, at an estimated cost of between £900,000 and £1,000,000. It appears from the report of the proceedings of the Vestry (reprinted in another part of this issue) that this resolution, although passed on August 2nd with only one dissentient, needed confirmation by a subsequent vote, and this vote, taken on Tuesday last, negatived the former resolution. The Marylebone Vestry will, therefore, not bequeath to the Borough Council succeeding it next month an electric light undertaking that had cost nearly a million pounds.

ELSEWHERE in this issue will be found an abstract of an important Paper by Dr. BARNES, of the McGill University. This Paper describes the methods and discusses the results of a long series of refined experiments undertaken primarily with the object of finding the value of the mechanical equivalent of heat in terms of the international electrical units. A new method of calorimetry was employed by Dr. BARNES—a method whose reliability seems adequately certified by the results of these exhaustive experiments, and bids fair to become a classical method for the calorimetry of liquids. GRIFFITHS, in his Paper on his determination of the mechanical equivalent (*Proc.* Roy. Soc., 1893) showed that the accuracy of modern electrical standards is comparable with the degree of accuracy to be hoped for in the determination of J; so that this connection between the electrical and the fundamental mechanical units might serve as a check on the more direct methods of establishing the values of electrical quantities in absolute units, if the direct mechanical methods of determining J involve errors of experiment not larger than those inevitable to the electrical methods. Since the epoch of ROWLAND'S masterly researches on the value of the mechanical equivalent the direct mechanical methods of determining J have attained a high degree of accuracy, and, in consequence, the determination of the value of J in electrical units may be made a step towards reducing those units to absolute measure.

DR. BARNES, in his Paper, takes, implicitly, this view of the case, for he uses the value of J found by the direct mechanical method by REYNOLDS and MOORBY to correct the value he had assumed for the E.M.F. of his Clark cells. The moral seems to be that when we are dealing with potential differences whose exact values we must know to within a small fraction of 1 per cent. we must not rely too confidently on even the most carefully constructed cell. This is not surprising; for, when we consider how in many other circumstances, and with regard to others of the electrical qualities of a substance, the minutest trace of impurity in the substance gives rise to comparatively large variations in the specific value of the electrical quality considered, the marvel is that the values of the E.M.F.s of different Clark cells agree so perfectly even as they are known to do.

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Institution of Junior Engineers.—Sir Lowthian Bell, Bart. F.R.S., has been elected president of this Institution, in succession to the Hon. C. A. Parsons, F.R.S.

Electrical Engineers (R.E.) Volunteers.—Among the casualties at Vlakfontein on Oct. 10 we notice Lieut. J. H. Stubbs of the Electrical Engineers (R.E.) Volunteers, wounded.

University College, Liverpool.—A bequest of £1,000 has been made by Mr. Holbrook Gaskell towards the building and equipment of a new physics laboratory in connection with this institution.

Röntgen Society.—The first meeting after the recess will be held on Thursday, Nov. 1, at 20, Hanover-square, at 8 o'clock, when the President, Dr. J. B. Macintyre, will deliver his address.

Fuel for Gas Motors.—It should have been stated that the excellent translation of Prof. Witz's Paper on this subject, published in our last issue, was reprinted from our esteemed contemporary the *Journal of Gas Lighting*.

The Lighting of Ladysmith.—We referred to the fact, a month ago, that the Ladysmith Town Council was considering the question of the public lighting of the town. According to the *British and South African Export Gazette* the Council has now decided on electric light and is inviting tenders.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Tangier—Tarifa	Jan. 3, 1900
Ceara—Maranham	Feb. 20, 1900
Pará—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Zanzibar—Mombasa	Sept. 20, 1900
Pararmaribo—Cayenne	Oct. 6, 1900

Hackney Vestry Electric Supply Station.—The ceremony of laying the foundation stone of the Hackney Vestry electric supply station took place yesterday afternoon. The works, designed by the Vestry's consulting engineer, Mr. Robert Hammond, are to be on the three-wire system, with a declared pressure of 240 volts on each side. There will be four engines, two Willans and two Belliss, driving eight Lundell dynamos, with a total capacity of 1,800kw., the engines running non-condensing. A large proportion of the capital expenditure has been allocated to mains, which will include 36 miles of conductors. These will be B.I.W. lead-covered triple concentric cable laid "solid" in earthenware troughs.

Obituary.—We regret to announce the death of M. Adolph Cochery, one of the four honorary members of the Institution of Electrical Engineers. M. Cochery, who reached the advanced age of 88, was a member of the French Senate, and was at one time Minister of Posts and Telegraphs, having been industriously engaged in political work since 1848, when he was appointed principal private secretary to M. Crémieux, Minister of Justice at the time of the Revolution. He was also a conspicuous figure in the negotiations for the conclusion of the Peace of 1871. During his term of office he was responsible for many improvements in the French postal, telegraph, and telephone services. He was honorary member of the Instidtution of Electrical Engineers since 1881.——We regret to announce the sudden death on October 1st of Mr. J. E. Hudson, president of the American Bell Telephone Co. John Elbridge Hudson was born at Lynn, Mass., in 1839. He graduated at Harvard College, and in 1880 became general counsel to the American Bell Telephone Co. Five years later he was appointed general manager to the company, in 1887 he was made vice-president, and since 1889 he filled the position of president.

Telephony with Belgium.—An announcement has been made in the daily press purporting to have been inspired by the Assistant Engineer-in-Chief to the Post Office, to the effect that a telephone cable has been laid between England and Belgium, that it has been tested and found satisfactory, and that telephonic communication will shortly be opened between the two countries. We are authorised to state that there is no foundation whatever for this report. The question of telephonic communication between the two countries has, it is true, been discussed by the authorities, but nothing definite has been decided upon, although from a technical point of view there is very little doubt that successful telephony could be maintained across the North Sea. A telegraph cable of the ordinary four-core post office pattern was recently laid between Benacre (near Lowestoft) and Zandvoort (Holland), but it has not been proposed to use it for telephony, even if this would be feasible. It is not improbable that telephonic communication might be established shortly between England and Brussels, but if so, it will be viâ one of the Channel telephone cables—Calais and Lille.

Charing Cross and Hampstead Railway.—That much-talked-of scheme, the Charing Cross, Euston and Hampstead Electric Railway, has definitely been taken over by a syndicate of which Mr. Yerkes, the American financier, is the head. It is expected that work in connection with it will be started in February next, and that its construction will take at least two years. It is proposed to place the power station at Highgate-road, and to divide the northern part of the railway into two lines, one from High-street, Hampstead, to run down Haverstock Hill, and the other from a station adjoining the Midland Company's Kentish Town station. These two lines will unite at High-street, Camden Town, and run to Euston station, thence under Tottenham Court-road to a junction with the Central London Railway at Oxford-street, and from there across to Charing Cross. The Sprague multiple unit system will probably be employed, in which each car is a motor car, and the whole train can be controlled from the platform of any car. A 2½-minute service during part of the day and an all-night service are contemplated, and it is expected that the complete journey from Hampstead to Charing Cross will take only 20min.

The Metropolitan Electric Supply Co.—We learn that a large contract for motor-generators has just been placed with Messrs. Witting Bros. by the Metropolitan Electric Supply Co. As is generally known, the Metropolitan Company are gradually converting their old single-phase system into a continuous-current system, two-phase current being supplied from the new generating station at Willesden to the various sub-stations in the company's area, where at present it is merely distributed as alternating current after transformation to a lower pressure, but motor-generators producing continuous current are now to be added. The present contract is for the equipment of the new Manchester-square sub-station. It comprises six polyphase synchronous motor-generators of 500kw., each machine consisting of a 900 B.H.P. motor directly-coupled to a multipolar continuous-current generator of 500kw. In addition to the six large sets, there will be three auxiliary motor-generators of 70kw. to 80kw. for starting and exciting the large machines, and for helping with the day load. The two-phase current received from Willesden, at 10,000 volts per phase, is first transformed down to 1,000 volts per phase for the motor generators. The sub-station equipment will be of a highly interesting nature, as special arrangements are necessary in such cases to ensure the perfect parallel working of the large synchronous motors at all loads, the problem of feeding such large synchronous motors, placed at the end of a long transmission line, possessing both inductance and capacity, being by no means an easy one, when the power is supplied from a steam-driven station, as is the case in question. We are informed that Messrs. Witting Bros., who are the agents for the Charleroi firm, "Electricité et Hydraulique," have taken the present contract under heavy penalties and stringent guarantees.

The Tesla Patents.—A decision, considered to be of some importance on the other side of the Atlantic, has been given in the United States Circuit Court of Connecticut with regard to the three Tesla patents, Nos. 381,963, 382,280 and 382,279 of May 1, 1888. The following were the claims at issue in the three patents:—

Patent No. 381,968.

1. The combination, with a motor containing separate or independent circuits on the armature or field magnet, or both, of an alternating-current

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generator containing induced circuits connected independently to corresponding circuits in the motor, whereby a rotation of the generator produces a progressive shifting of the poles of the motor, as herein described.

3. The combination, with a motor having an annular or ring-shaped field magnet and a cylindrical or equivalent armature, and independent coils on the field magnet or armature, or both, of an alternating-current generator having correspondingly independent coils, and circuits including the generator coils and corresponding motor coils in such manner that the rotation of the generator causes a progressive shifting of the poles of the motor in the manner set forth.

Patent No. 382,280.

The method herein described of electrically transmitting power, which consists in producing a continuously-progressive shifting of the polarities of either or both elements (the armature or field magnets or magnets) of a motor by developing alternating currents in independent circuits, including the magnetising coils of either or both elements, as herein set forth,

Patent No. 382,279.

1. The combination, with a motor containing independent inducing or energising circuits and closed induced circuits, of an alternating-current generator having induced or generating circuits corresponding to and connected with the energising circuits of the motor, as set forth.

2. An electro-magnetic motor having its field magnets wound with independent coils and its armature with independent closed coils, in combination with a source of alternating currents connected to the field coils, and capable of progressively shifting the poles of the field magnet, as set forth.

3. A motor constructed with an annular field magnet wound with independent coils and a cylindrical or disc armature wound with closed coils, in combination with a source of alternating currents connected with the field-magnet coils, and acting to progressively shift or rotate the poles of the field as herein set forth.

The action was brought by the Westinghouse Electric and Manufacturing Co., the owners of the Tesla patents, against the New England Granite Co., and the judge declared that the patents were valid, and had been infringed.

Effective Length of the Air-Gap with Toothed Armatures.—In the *Industrie Electrique* of September 10th M. C. F. Guilbert points out that the usual method of estimating the effective width of the air-gap in dynamos with toothed armatures is liable to error. Dynamo designers usually calculate the magnetic flux through the air-gap in machines with toothed armatures by taking the section of the air-gap as the mean between the total polar surface and the surface offered by the teeth; but this, M. Guilbert says, takes too low a value for the effective length of air-gap, which introduces an appreciable error when designing apparatus with unsaturated iron, such as alternating-current motors. By a simple application of the integral calculus, M. Guilbert arrives at the following more accurate expression for the reciprocal of the magnetic resistance of the air-gap:—

$$\frac{1}{R} = \frac{2L}{\log_e \frac{l}{l_1}} \log_e \left[\frac{l - l_1}{2\delta} + \sqrt{1 + \left(\frac{l - l_1}{2\delta}\right)^2} \right];$$

or for the effective length of the air-gap,

$$\delta' = \frac{l}{2} \frac{\log_e \frac{l}{l_1}}{\log_e \left[\frac{l - l_1}{2\delta} + \sqrt{1 + \left(\frac{l - l_1}{2\delta}\right)^2} \right]}.$$

In these formulæ, L is width of the machine, l_1 and l the widths of an armature tooth and the corresponding arc of the pole-piece, and δ the actual distance between the polar surface and the exterior of the armature core. For the case of machines in which both the polar surface and the armature are slotted the following formula is given:—

$$\delta' = \frac{l}{2} \frac{\log \frac{l}{l_1}}{\log \left[\frac{l - l_1}{\delta} + \sqrt{1 + \left(\frac{l' - l_1}{\delta}\right)^2} \right]} + \frac{l'}{2} \frac{\log \frac{l'}{l'_1}}{\log \left[\frac{l' - l_1'}{\delta} + \sqrt{1 + \left(\frac{l - l'_1}{\delta}\right)^2} \right]}.$$

l and l' are here the circumference of the armature divided by the number of teeth in the stator and rotor respectively, while l_1 and l'_1 are the actual widths of the teeth of the stator and rotor respectively.

Action of Sunlight on Lead Peroxide.—Herr Schoop has recently stated that electrolytic peroxide of lead is reduced by direct sunlight, and supported the assertion by the following experiment. He coated a sheet of soft lead with a paste made of peroxide of lead and sulphuric acid, left it to dry in the air, and then cut it into three portions, one of which he exposed to direct sunlight, another to diffused daylight, while the third was put in a dark place. After the lapse of some hours he found that the colour of the two samples exposed to light had altered considerably, the hue of that which had been exposed to direct sunlight having turned to a foxey red, and this change of colour Herr Schoop attributed to a change in the chemical composition of the lead peroxide. In the opinion of Dr. Peters, expressed in No. 16 of the *Centralblatt für Accumulatoren und Elementenkunde* this change of colour cannot be taken as a proof of change in chemical composition, for in the course of experiments on the formation of Planté plates he tested the correctness of Herr Schoop's assertion. Dr. Peters took two lead plates which had received an electrolytic coating of peroxide, washed them in running water whilst protecting them as far as possible from the action of light, and dried them in the dark. One of these plates, *a*, was left in the dark, whilst the other, *b*, was exposed for two to three days to daylight, 36 hours to 40 hours of which was direct sunlight. The hue of the plates became lighter, although not to the same degree as noticed by Herr Schoop, and this change of colour depends on the thickness of the peroxide layer, which was probably thinner in Herr Schoop's experiments than in those conducted by Dr. Peters. At the expiration of the time named the amount of lead peroxide on the plates was determined by a titration method, to be described later, and it was found from the result of several analyses of the two plates that plate *a* which had been kept in the dark contained a lower percentage of peroxide than plate *b* which had been exposed to the light, which seems to show that sunlight has no chemical action on lead peroxide, and that any lightening in hue of the peroxide plate which takes place is due to some physical cause, or to an alteration in the molecular groupings rather than to any change in chemical composition. With reference to these experiments on the effect of direct sunlight on lead peroxide, it will be remembered by many of our readers that Mr. R. E. Crompton in 1890 called attention to the fact that secondary batteries which were exposed to strong light had not the same capacity as those which were not thus exposed, and that those negative plates which were most exposed to sunlight or to the action of the arc light gave off hydrogen most rapidly, so that it would appear that light has some action on the electrolyte even if it does not affect electrolytic peroxide when dry.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, October 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. First General Meeting of the Session. Paper to be read and discussed: "Observations on an Improved Glass Revealer for Studying Condensation in Steam Engine Cylinders, and Rendering the Effects Visible," by Bryan Donkin.

FRIDAY, October 26th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "Exhibition of Experiments Illustrating Certain Phenomena of Vision," by Dr. Shelford Bidwell, F.R.S. (2) "On the Concentration at the Electrode in a Solution, with Special Reference to the Liberation of Hydrogen by the Electrolysis of a Mixture of Copper Sulphate and Sulphuric Acid," by Dr. J. S. Sand. (3) "Electromotive Force and Osmotic Pressure," by Dr. R. A. Lehfeldt.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Annual General Meeting at the Westminster Palace Hotel.

SATURDAY, October 27th.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the London Hydraulic Power Co.'s station, Millbank-street, Westminster.

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THE NEW MUNICIPAL POWER STATIONS IN LIVERPOOL.

The Corporation of Liverpool decided in 1898, on the advice of Mr. A. Bromley Holmes, the city electrical engineer, to meet the rapidly-increasing demand for electrical energy for lighting and for tramways by the erection of two large power stations. The sites selected for these stations were properties owned by the Corporation, and situated at Pumpfields, in Vauxhall-road, and Lister Drive, in West Derby. They are about 2½ miles apart, and a line joining them passes approximately through the centre of Liverpool. The Pumpfields station is adjacent to the Leeds and Liverpool canal, which furnishes a supply of condensing water and facilities for the delivery of fuel, and the Lister Drive station has a siding from the London and North Western Railway. As there is no natural supply of water for condensing at the latter station, a cooling tower is in course of erection.

The two new stations, which are almost identical in size and equipment, are now complete. Mr. Holmes has been responsible for their design, while the buildings have been constructed from the designs of Mr. Thos. Shelmerdine, the Corporation surveyor, by Messrs. Morrison & Sons, contractors, Liverpool. The works are now in daily operation.

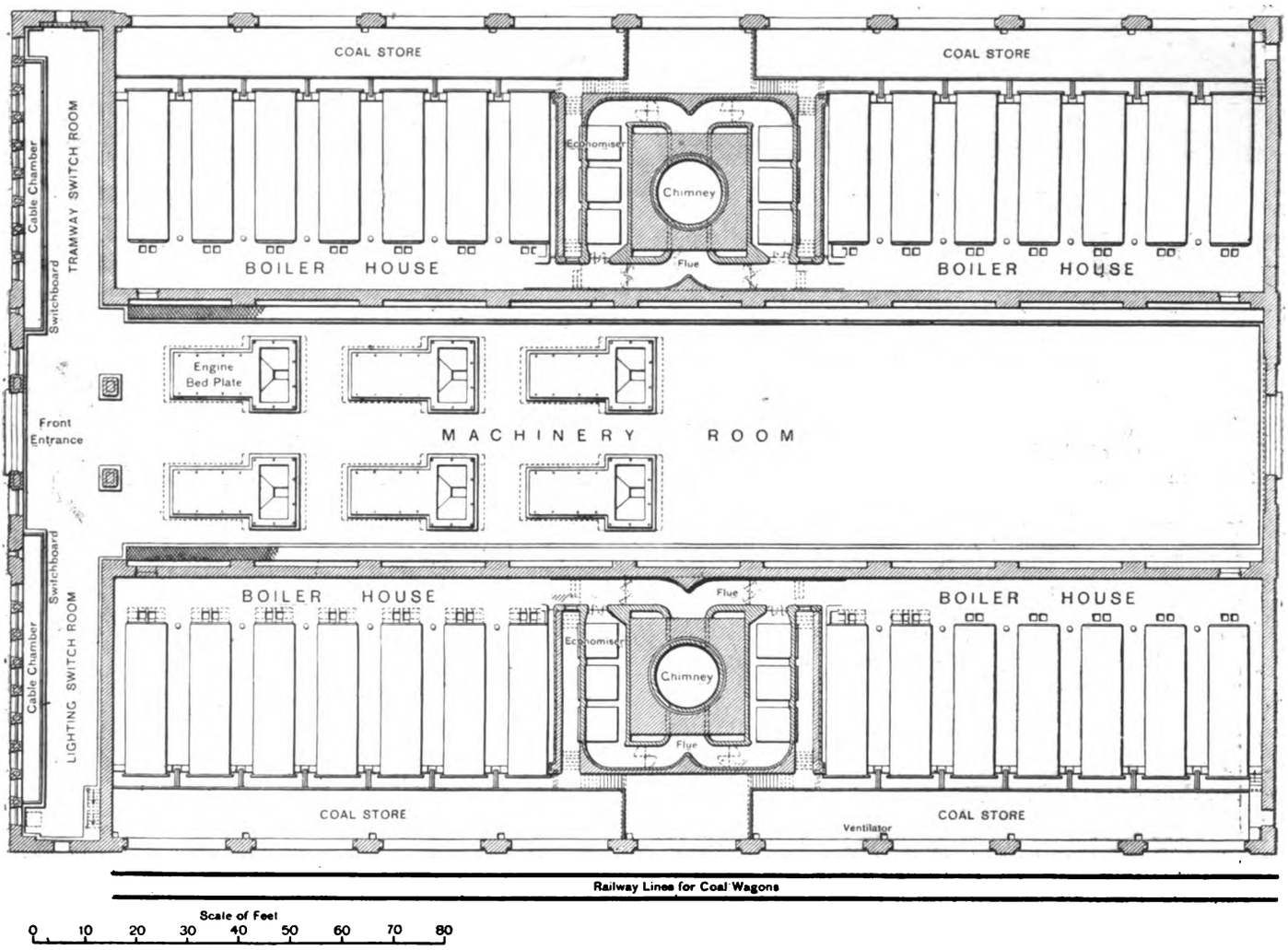
In each station the plant is divided into four independent sections consisting of seven boilers and economiser and three steam dynamos and accessories. The engine rooms are 247ft. long and 50ft. wide, with a boiler house 53ft. wide on each side.

We are indebted to Mr. A. Bromley Holmes, the city electrical engineer, for the greater part of the following description of the plant, and for the photographs from which our illustrations are made.

Pressure of Supply.—The distribution of electrical energy for the tramways is at 500 volts pressure with an earth return, and the distribution for lighting and power is on the three-wire system of 460 volts between the outer conductors, the middle wire being earthed at the station.

Engines.—Willans' single-acting, three-crank, triple-expansion, running at a speed of 230 revs. per min., with an output of 1,200 I.H.P. on continuous load and 1,500 I.H.P. for short periods. Main dimensions: Cylinder diameters 15in., 20½in., and 34⅝in.; stroke 16⅞in.; diameter of crank shaft 11in. The bearings are lined with white metal. The engines are fitted with a high-speed sensitive governor and speed regulating gear, and also with automatic expansion gear; the armature of the dynamo forms the flywheel.

Dynamos.—Siemens' multipolar machines with an output of 1,420 amperes at 550 volts. The field magnets are shunt-wound, and are mounted on a steel ring made in halves and strongly bolted together, carrying 10 inwardly-projecting steel poles. The armature winding consists of copper bars individually insulated and securely fixed in slots formed in the armature core, which is built up of a number of segments of sheet steel, supported on a cast-steel spider, and held together by bolts passing through steel end plates. It is provided with ventilating ducts. Each slot contains four



GROUND PLAN OF THE LIVERPOOL CORPORATION GENERATING STATION AT LISTER DRIVE.

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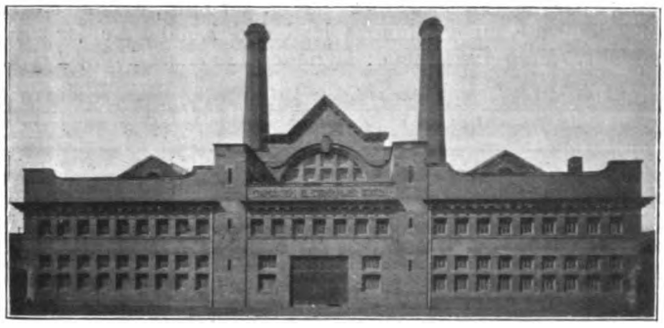
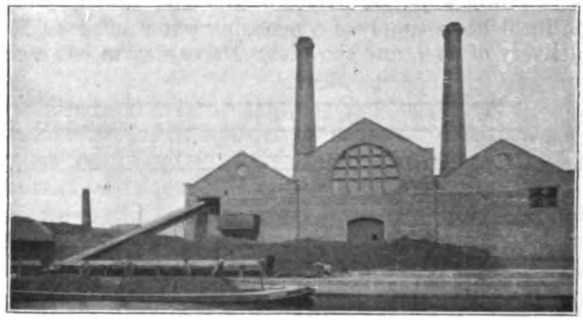
insulated solid bars of copper. The winding is of the drum type, and the bars are so connected as to form a multiple-circuit single-winding. The connections are arranged on what is known as the barrel system, which provides good mechanical support and at the same time reduces to a minimum the probability of breakdown of insulation.

The commutator is 57in. in diameter and consists of 560 segments of hard copper insulated by mica. It is so arranged as to permit of removal of sections without the necessity of taking the whole commutator to pieces, and is long enough to allow of axial adjustment of the brushes to equalise the wear.

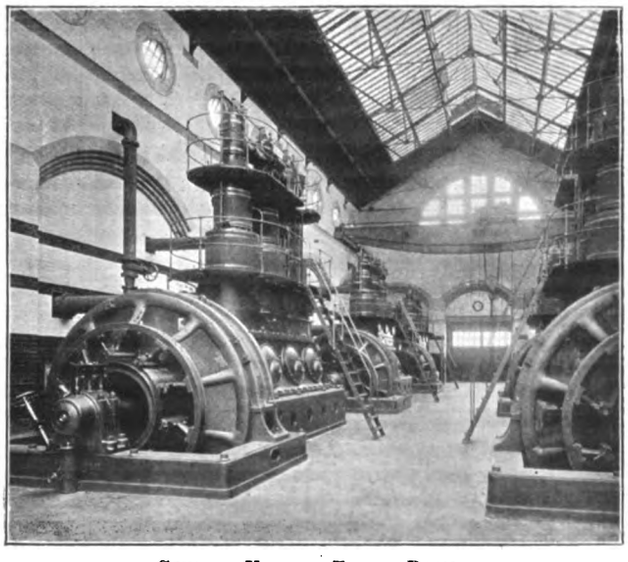
The brushes are of carbon. They are carried by spindles projecting from the rocking gear in the usual way, there being 16 brushes to each spindle. The brushes are carried by aluminium holders and held with a uniform pressure upon the commutator by means of steel springs. Flexible copper strips are used to form the connection between the brush holders and the gun-metal bar to which the cable connections are made. The spindles, referred to above, are fixed by insulated bolts to horizontal projections from a cast-iron ring forming part of the rocking gear, and this ring can be rotated for adjustment of the brushes in the usual manner by means of a worm wheel.



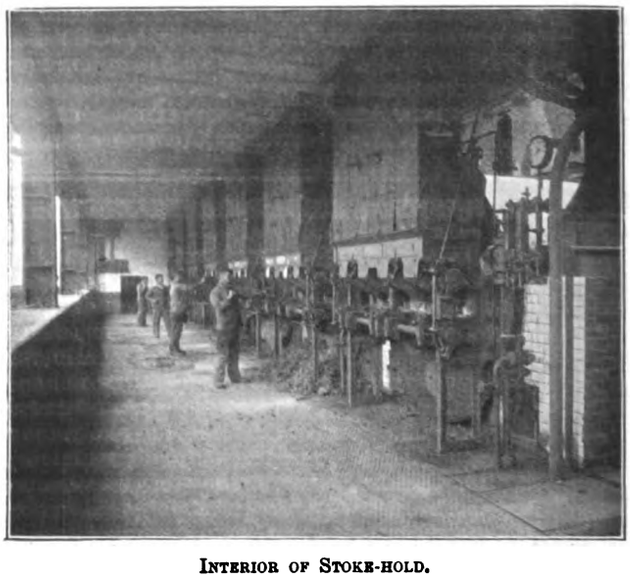
FRONT VIEW OF STATION.



BACK VIEW OF PUMPFIELDS STATION SHOWING COAL CONVEYER.



GENERAL VIEW OF ENGINE ROOM.



INTERIOR OF STOKE-HOLD.

Condensers.—At the Pumpfields station the condensers are of the Körting ejector pattern. There is a separate condenser for each engine, and they are supplied with water from an overhead tank, into which it is pumped from the canal adjoining the works. The condensers pass each 55,000 gals. of water per hour. The condensing water is raised from the canal by Allen's steam-driven centrifugal pumps to overhead tanks. Each pumping engine consists of a centrifugal pump coupled directly to a high-speed enclosed engine, each pump being capable of delivering 4,000 gallons of water per minute against a head of 50ft. The pumps are of the "Conqueror" centrifugal type having casings and discs of cast-iron. The suction and discharge branches are 16in. in diameter and the discs each 8ft. 6in. in diameter. Each pump is designed to pass the required quantity of water when running at a speed of 365 revolutions per minute. The engines are of the two-crank double-acting, high-speed enclosed compound type and are fitted with a system of forced lubrication. The cylinders are 11in. and 19in. diameter respectively, the stroke being 8in. in each case. The cranks are arranged opposite one another, and the oil is supplied to the working parts by means of a valveless oil pump from one of the eccentrics. These engines are of the same design as Messrs. Allen's standard two-crank electric lighting engines.

The water flows from the condensers, by gravity, in pipes along Vauxhall-road to a branch of the canal adjacent to Leeds-street, between which point and the station a large cooling area is provided.

At Lister Drive the condensing plant is being supplied by the Klein Engineering Co. It consists of a counter-current jet condenser and steam-driven air and circulating pumps, and the condensing water is cooled by means of two Klein chimney coolers. The condenser is fitted with an automatic exhaust relief and oil separator. The exhaust steam from each set of the three engines is carried in one main trunk to the condensing plant. The position of the oil separator is at a height which allows for the oil running out automatically by means of a barometric tube. This arrangement keeps the oily matter out of the condensing water and allows the latter to be used for boiler feed. The condensing vessel is fixed outside the engine house, and is so arranged that the steam is admitted at the end where the hot water is taken away, the air being drawn off at that end where the cold water enters, that being of course the coldest point. The air is taken away by means of a separate air pump coupled to a water circulating pump, which latter not only takes away the water from the condenser, but also lifts it to the cooler.

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The pumps are of vertical type, and with compound steam cylinders, the air pump being on the Edwards principle. By this arrangement the ground space required is very little, the space occupied by them being about 14ft. by 9ft.

In the piping arrangement provision is made which renders it impossible for any condensing water to enter the steam cylinders of the main engines. The exhaust steam main trunk is carried to a height of some 34ft. above the injection water level before entering the condenser, and should any condensation occur in this piping before arriving at the barometric height provision is made for clearing it or drawing off such water through the air-pump. There is also provision made between the condenser and cooler for tapping the water (where its temperature is the highest) for feeding purposes. The coolers work entirely by natural draught, the draught being increased by means of a casing with which the cooling stacks are surrounded.

Boilers.—The boilers at Pumpfields have been supplied by Messrs. Tetlow Bros., and at Lister Drive, by Galloways Limited. They are of the Lancashire type, 30ft. long and 8ft. diameter; flues 3ft. 2in. diameter, each fitted with five Galloway tubes. Shell plates are of steel $\frac{7}{8}$in. thick. The circular seams are double-rivetted with lapped joints, and the longitudinal seams are butt jointed with straps inside and outside which are treble-rivetted. The flue plates are $\frac{1}{2}$in. thick. Each boiler is fitted with 8in. parallel slide steam stop valve, a safely valve for high steam and low water, and a duplex safety valve and the other usual fittings. Each boiler is also fitted with Vicars' mechanical stoker.

Economiser.—Each section of seven boilers is provided with a Green's economiser and vertical direct-acting steam feed pump in addition to the injector with which each boiler is fitted. The economisers in both of the works contain 720 pipes, arranged in six groups of 120 tubes each, the sections being ten pipes wide. They are constructed for 160lbs. pressure and fitted with patent internal lids. In each economiser there is a heating surface of about 7,200 sq. ft.

Coal Supply.—At Pumpfields the coal is delivered from a canal barge or from a cart on to a horizontal canvas belt conveyor, which delivers the fuel on to an inclined belt conveyor which elevates it into a large storage chamber situated over the mechanical stokers. An ample storage area for fuel is also provided on the space between the station and the canal. At Lister Drive a railway siding runs on each side of the station, from which the fuel is delivered into a wrought-iron storage chamber over the mechanical stokers.

Ashes.—The ashes are raised from the stokeholds by elevators on to a platform, from which they are delivered into the railway trucks or carts for removal.

Accumulators.—Each station is provided with an accumulator chamber, with accommodation for four batteries of 240 cells each, each battery being capable of giving a discharge of 200 amperes for one hour, or 80 amperes for four hours. The accumulators are used to equalise the load for the tramway service, and to assist in balancing the load on the two sides of the three-wire supply for the lighting service.

Switchboards.—At each station there are two switchboards, one for the lighting service and one for the tramways. The dynamos on one side of the station are connected to the tramway switchboard, and on the other side of the station to the lighting switchboard. The two switchboards are so connected that any set of plant may be used either for the lighting or for the tramway service. By this means it is possible to work the plant in the station in such a way that each set may run the same number of hours annually.

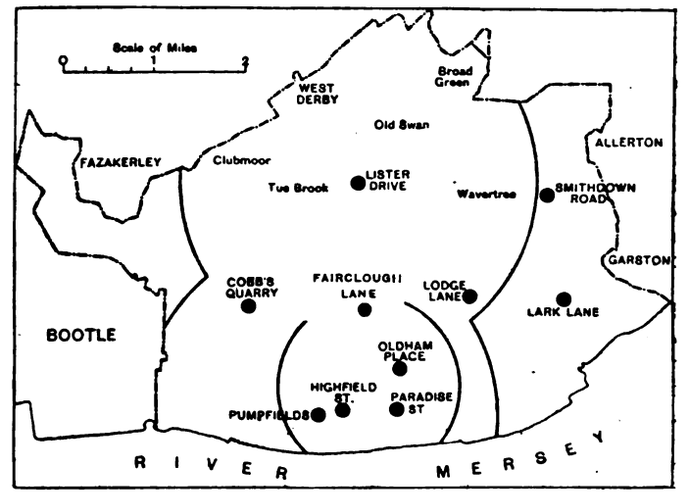
Balancers.—At each station balancers are provided for equalising the load on the three-wire mains, and motor generators are employed when charging the accumulators.

Motors.—The coal elevators, ashes elevators, mechanical stokers and economisers are driven by electric motors varying from 2 H.P. to 12 H.P.

At the present time there are the equivalent of 182,000 lamps of 16 c.p. connected to the supply mains of the Corporation, and more than 150 electric cars are in daily service on the tramways. The number of units supplied during the half-year ending June 30, 1900, was:—

For tramways	2,197,937
For lighting and power	2,243,225
Total	4,441,162

In addition to the two large stations described above, electrical energy is distributed in the central portion of the city from the Oldham-place, Highfield-street and Paradise-street stations, each having a capacity of about 3,000 H.P. Small supplementary plant is in operation at the Smithdown-road and Cobbs Quarry refuse destructors of the Corporation. Sub-stations for the distribution of electrical energy have been constructed at Fairclough-lane and Lodge-lane in connection with the new power stations. Finally, the residential district of Sefton Park and Princes Park derives its supply from the Lark-lane station, which with the three town stations referred to above were purchased by the Corporation from the Liverpool Electric Supply Co. (Ltd.) in the year 1893. Our map



SKETCH MAP OF LIVERPOOL, SHOWING POSITION OF STATIONS AND SUB-STATIONS.

shows the situation of the various stations and sub-stations. The dotted line indicates the city boundary, the two large circles are drawn at a radius of 2 miles from the Pumpfields and Lister Drive stations respectively, and the smaller circle (1 mile radius) indicates the central area of the city where the excess winter demand chiefly comes from.

ROCHDALE CORPORATION ELECTRICITY WORKS.

Although Rochdale is one of the most important towns in Lancashire, with a population of 75,000, the question of electric lighting did not assume practical importance until early in 1897, when it was referred to the Gas committee, under the chairmanship of Alderman Petrie. The committee immediately proceeded to visit various electricity works in the neighbourhood, and subsequently decided to appoint Mr. E. M. Lacey to advise, in conjunction with Mr. T. Banbury Ball, the gas engineer to the Corporation. The preliminary scheme was prepared and submitted to the committee in August, 1897, and this having received the approval of the Corporation, instructions were forthwith given to prepare the plans and specifications of buildings, plant, and mains. The necessary borrowing powers having been obtained, the contracts for the plant and buildings were placed as follows:—

Siemens Bros. & Co. (steam dynamos, balancers, &c.)	£4,640	0	0
Oldham Boiler Co. (boilers)	1,160	0	0
Green & Sons (economisers)	327	0	0
Mirrlees, Watson and Yaryan Co. (condensing plant)	885	0	0
E. Danks & Co. (pumps, feed, steam, and exhaust pipes, tanks, &c.)	1,440	0	0
Carrick and Ritchie (travelling crane)	198	0	0
Cowans Ltd. (switchboard)	848	0	0
Pritchett and Gold (accumulators)	1,152	0	0
W. T. Glover & Co. (cables)	4,978	16	10
Chamberlain and Hookham (meters)	463	15	0
W. A. Peters & Sons (buildings)	11,200	0	0
Total contracts	£27,292	11	10

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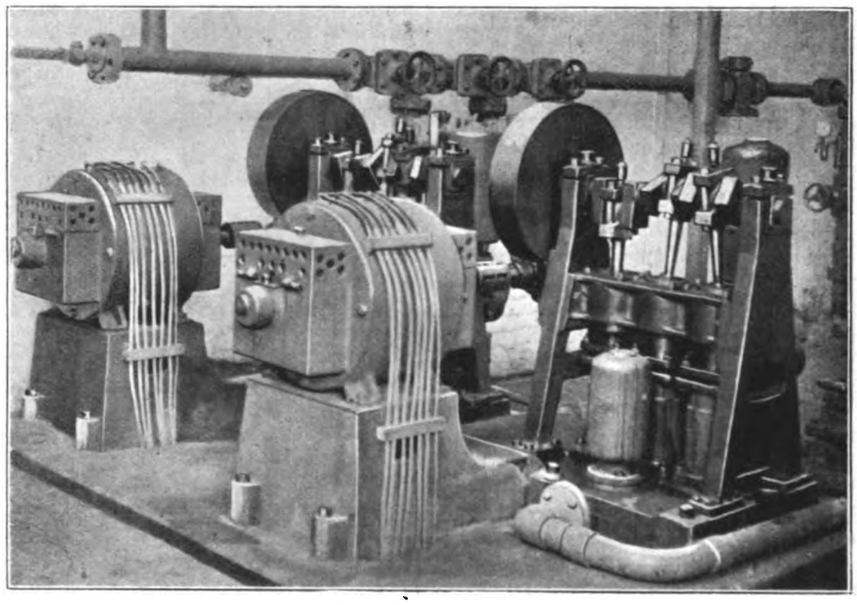
The system adopted by the Corporation is a three-wire system with balancing machine and accumulators, the supply to consumers being at a pressure of 220 volts or 2 × 220 volts. A suitable site was found adjacent to the Corporation gas works, situated alongside a river from which water can be taken for condensing purposes. The buildings, which have been designed by Mr. T. Banbury Ball, comprise a handsome suite of offices facing Dane-street, engine house, boiler house and accumulator house and a chimney 150ft. high by 6ft. 6in. diameter.

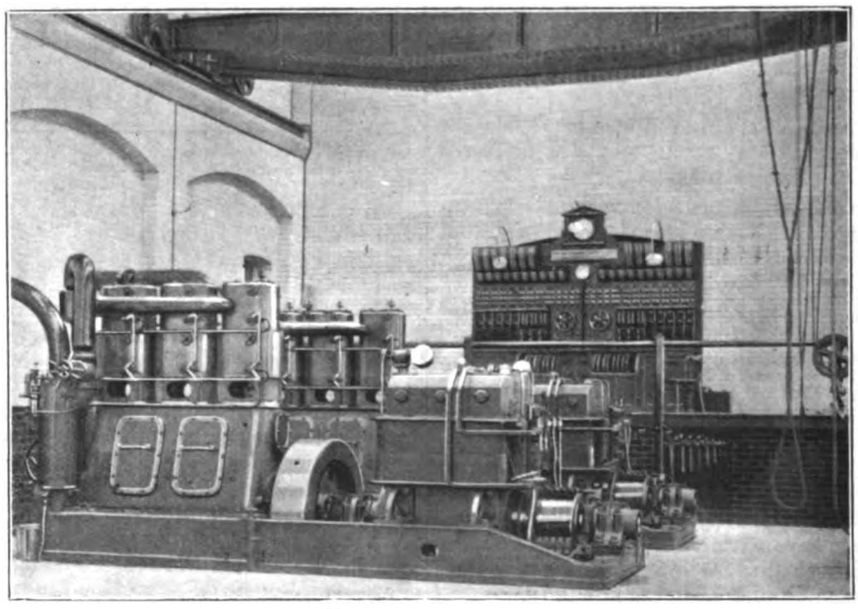
The boilers are of the Lancashire type, 30ft. in length and 8ft. in diameter, constructed for a working pressure of 150lb. Automatic stokers driven by a Lundell motor have been fitted to these. The boiler fittings are by Messrs. Hopkinson & Co. The economiser consists of 256 tubes. Its scrapers are driven by a Lundell motor, directly coupled through worm gearing to the scraper shaft.



Motor-Driven Pumps.

Messrs. F. Pearn & Co. are the makers of the feed pumps, which are of three-throw type geared to electric motors by means of worm-gearing working in an enclosed oil bath. Each pump is capable of delivering 2,000 gallons of water per hour against a steam pressure of 140lb. per square inch.

The motors are enclosed, each having two commutators for series parallel running, and were constructed by Messrs. Wilson Hartnell. The feed pipes are 3in. cast-iron, arranged to feed either through the economiser or direct to the boilers. The branch feed pipes to the boilers are in duplicate. A cast-iron tank, having a capacity of 3,000 gallons, has been provided for town water, and another cast-iron tank to hold 2,500 gallons for the hot-well.



View in Engine Room.

The steam pipes are of lapwelded steel, and the branch pipes to the engines of solid-drawn copper. All joints are made with corrugated brass rings. The steam pipes are lagged throughout with Leroy's lagging, and painted two coats. The exhaust pipes are of best quality cast-iron. Messrs. E. Danks & Co. were the contractors for the whole of the pipework, pumps, &c.

An electrically-driven surface condenser was supplied by Messrs. Mirrlees, Watson and Yaryan. This condenser is capable of dealing with 12,000lb. of steam per hour, and of maintaining a vacuum of at least 25in. on the exhaust pipes. On test a vacuum of 26in. was obtained. The air pumps are driven through spur gearing by an electric motor, constructed by Messrs. D. Bruce Peebles & Co. The circulating pump is driven directly by its motor, which is also of this firm's manufacture. Both motors are of the enclosed type.

The engine room has been provided with a 10-ton travelling crane by Messrs. Carrick & Ritchie. The span is approximately 33ft. and the lift 20ft.

The generating plant consists of two three-crank Belliss tandem compound engines, self-lubricating, and arranged to work either condensing or non-condensing. Each of these engines is directly connected to a two-pole Siemens dynamo. These dynamos have each an output of 180 kw. as shunt machines, but a series coil has been added in order that the machines may be used either as simple shunt machines for the ordinary town supply or as compound machines for the tramway supply.

The switch-gear is of the edgewise type. It was constructed by Cowans Limited to the designs and specifications of the consulting engineers, Messrs. Lacey, Clirehugh and Sillar. The board is built up of strong black marble sections, and consists of accumulator, feeder, and dynamo panels, the feeder and dynamo panels being so constructed as to be interchangeable. All switch-gear and connections are on the face of the board, with the exception of the voltmeter wires, and all metal work has been so fixed that it may be removed, refixed, or replaced without the necessity of touching the back of the board. The board is provided with four dynamo panels and two booster panels, three omnibus bars and 24 vertical bars. The general design of the board is such that the switch gear and instruments of each dynamo or feeder are in one line of parts. The instruments were constructed by Messrs. James White. The overall dimension of the board is only 9ft. by 9ft. 6in. high.

The accumulators consist of 252 cells, capable of giving a discharge of 60 amperes for a period of 10 hours, or 250 amperes for a period of one hour. These cells have been supplied by Messrs. Pritchett & Gold.

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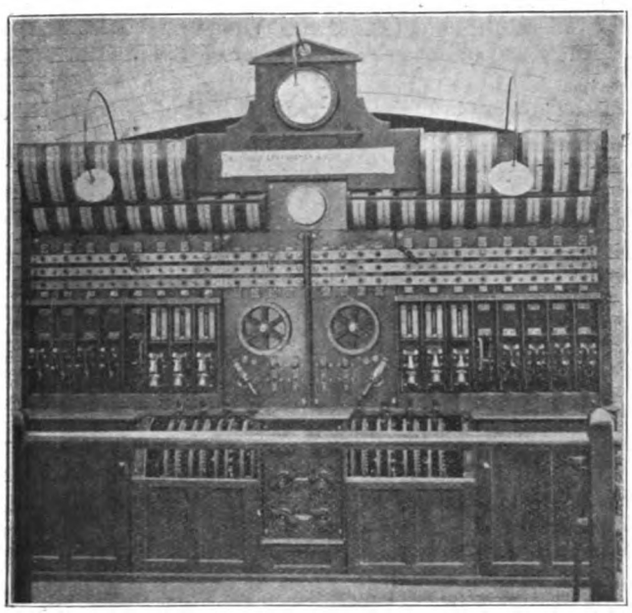
Cables have been laid in all the principal streets. These cables are insulated with fibrous material substantially cased in lead, and the distributor cables are further protected by



SWITCHBOARD.

two laps of iron sheathing, and are laid directly in the ground. The contractors for the cable work were Messrs. W. T. Glover & Co.

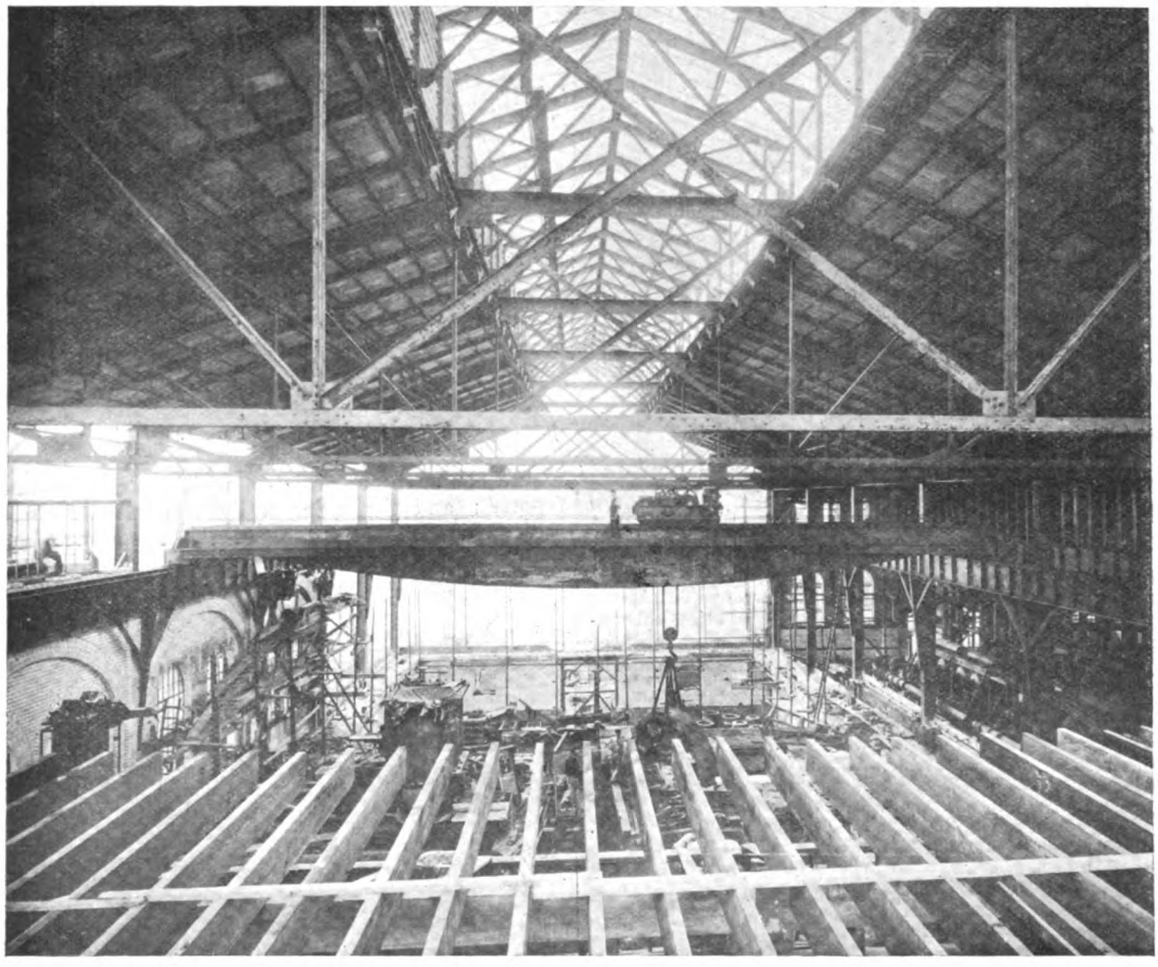
On the taking over of the works by the Corporation in September last, Mr. Atchison was appointed borough electrical engineer. Current is already being supplied in some parts of the town. During the last few months a fair number of applications for current have been received, and, having regard to the demand for traction which will arise on completion of the Corporation tramways, the committee will very soon find it necessary to take into consideration the question of extensions.

We are indebted to Messrs. Lacey, Clirehugh and Sillar for the above particulars, and for the photographs from which our illustrations have been made.

THE BRITISH THOMSON-HOUSTON CO.'S ELECTRIC CRANES.

The British Thomson-Houston Co. has just issued an interesting pamphlet on electrically-operated cranes. An illustration on the front page shows an artistic conception of "travelling cranes" flying rather low in the midst of typical Japanese flora. The apparatus described in the article, however, may be considered to be electrically driven without the assumption of Prof. J. C. Bose's electrical hypothesis of vital functions.

The company prefer three-motor cranes, one for each motion, and fit these with series-wound motors. As the speed of such a motor decreases in proportion to the increase of load, it is practically self-regulating, allowing the maximum load to be lifted at a definite speed, and all lighter loads at a proportionately greater speed. This has the further advantage that empty tackle can be lowered at a maximum speed which conduces to the efficiency and rapidity of the service. Shunt and compound-wound motors maintaining practically a constant speed at all loads are only employed for single motor equipments.



OVERHEAD TRAVELLING CRANE AT THE DUBLIN UNITED TRAMWAYS CO.'S POWER STATION.

Some time previous to the completion of the works, Mr. C. C. Atchison was appointed clerk of the works, and he has superintended the erection of the whole of the plant.

The type of enclosed motor chosen ("C.E." up to 5 B.H.P. and "G.E." for larger sizes) will stand an overload of 100 per cent. for a short time without injurious heating. The motors are rated on the

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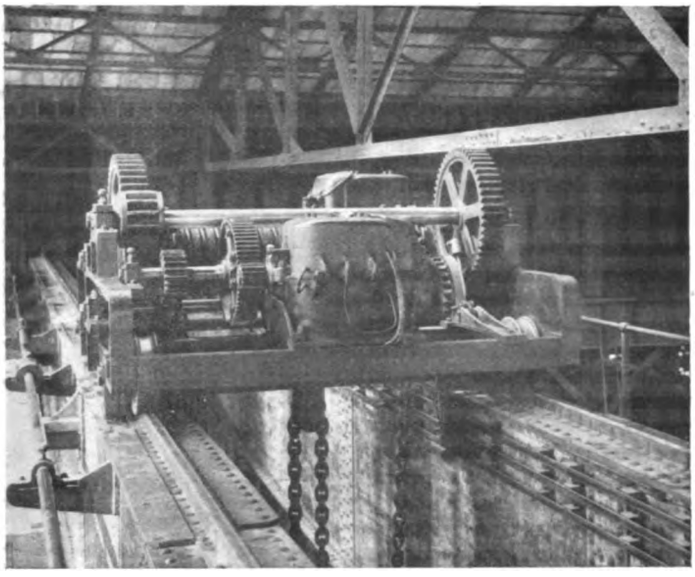
basis of the maximum horse-power developed continually for one hour, the temperature rise measured at any accessible part not to exceed 75°C. above the surrounding atmosphere.

Magnetic blow-out controllers are adopted, and for the smaller sizes, these have only one handle both for controlling the speed and reversing the motion. A practical modification sometimes employed consists of two of these controllers connected by means of a simple form of universal gearing which is operated by one lever. This is so contrived that any two motions of the crane can be controlled by means of this one lever, the arrangement being such that the movement of the lever indicates the direction in which the load is travelling. Thus one of these apparatus can be employed for the hoisting and traversing motor; when the lever is raised the load will be hoisted, and when it is moved over to the right or left the load will move to the right or left respectively, whereas if the lever be moved upwards in a diagonal direction the load will be both hoisted and traversed in the direction indicated by the lever.

An electromagnetic brake is operated by the hoisting motor and is so arranged that when the load is at rest and the controller is in the "off" position the brake is automatically applied, but as soon as the current is supplied to the motor the series electromagnet controlling the brake releases the latter. The current is conveyed to the motors on the crab by means of a number of bare copper wires stretched from end to end of the main girders, and generally attached to the inside of these. They are supported at either end by insulated turnbuckles which enable the wires to be strained up as required. The



Crab of Dublin Travelling Crane.

collectors attached to the crab consist each of a sliding contact formed by means of a copper hook which supports the wire, or else of a simple slide. Two bare copper wires stretched from end to end of the longitudinal travel convey current to the crane from the main source of supply. Attached to the main girders are two standard trolley wheels, so arranged as to raise the copper wire when passing under it, the weight of the wire itself facilitating good electrical contact. Our illustrations show the overhead travelling crane built for the new power station of the Dublin United Tramways Co. The following are its main dimension and data:—

Maximum length of longitudinal travel	141ft.
Span (centre to centre of gantry rails)	78ft.
Height of gantry rails from floor	27ft.
Bottom chord of roof principal to floor level	35ft.
Load, maximum	25 tons.
Speed, longitudinal traverse, fully loaded	not less than 60 per min.
Ditto, cross traverse, loaded	ditto ditto
Speed of hoist, fully loaded	4ft. per min.
Ditto loaded to 10cwt.	50ft. per min.
Height of lift (of load)	26ft.
Longitudinal distance between centres of stanchions supporting gantry rails	25ft.
Girder	6ft. deep at centre; 24in. at ends.
Crab rails	68lb. per yard.
Crab wheels—Cast iron traverse, 12in. diameter, chain barrel grooved.	
End carriage wheels, double flanged, 2ft. 6in. diameter; wheel base, 12ft.	
Voltage of motors	500
Type of motors	"G.E." 800 E.
Controller type R 13. Number	3 controllers.

THE POLLAK-VIRÁG WRITING TELEGRAPH.

In Vol. XLIII. of *The Electrician*, at p. 835, will be found a fairly full description of the Pollak-Virág system of high-speed telegraphy as perfected in the summer of 1899. Our readers

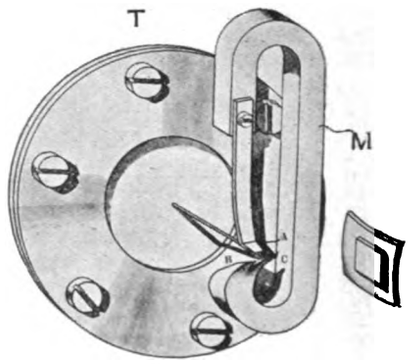


Fig. 1.

will remember that the receiver then described consisted of a telephone whose diaphragm was moved by impulses received from the line. To the diaphragm a rod was attached which

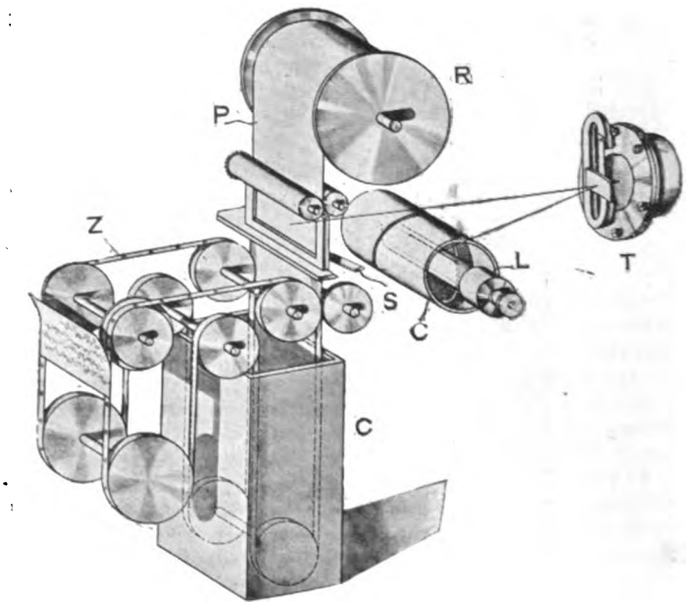


Fig. 2.

moved one of three points on which a small concave mirror reposed; and the beam of light reflected from the mirror registered the movements of the telephone diaphragm on

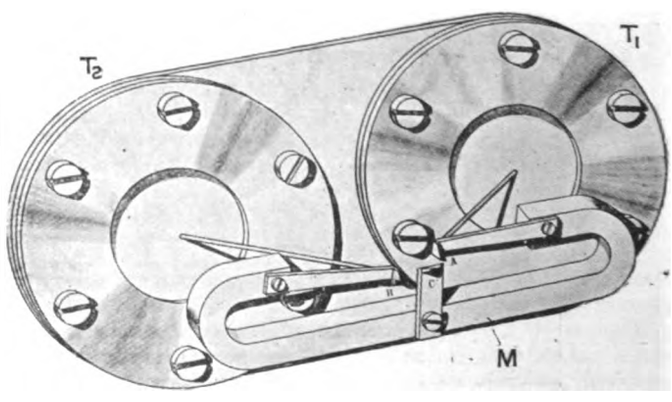


Fig. 3.

sensitised paper, which was moved forward uniformly on a drum. The small mirror was held in position on two pointed prongs of one pole of a stationary permanent magnet and one

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movable prong constituting the other pole of the magnet by having cemented on its back a small piece of soft iron. It is to this movable prong that the rod from the telephone diaphragm was attached.

During the past year the inventors have greatly improved their apparatus. Fig. 1 shows the most recent type of diaphragm and mirror connection, while Fig. 2 gives a good idea of the arrangement of the parts of the complete receiving apparatus. By this apparatus messages are received and recorded in a zig-zag line as before; but now the record is traced in lines running from left to right of a broad strip of sensitised paper. This left-to-right movement is produced as follows:

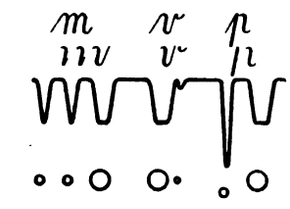

Fig. 4.

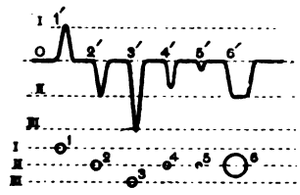

Fig. 5.

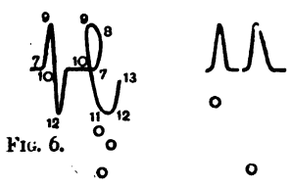

Fig. 6.

Fig. 7.

The source of light is a stationary glowing filament, which is surrounded by the cylindrical metal mantle L (Fig. 2). In this mantle a helical slit is cut, the helix having one complete turn. In consequence, when the mantle is appropriately turned about its axis, the source of the light falling on the mirror moves in effect uniformly from right to left, and hence the spot of light formed on the paper by reflection from the mirror moves uniformly from left to right. A series of motions of the mirror about a horizontal axis is recorded, therefore, on the paper as an up-and-down zig-zag line running from left to right, and commencing at the left end of a new line on the completion of every filled one. On the commencement of a despatch the revolution of the helically-slit mantle and of the sensitised paper feeder R is automatically started. At the close of the despatch the paper strip is cut, and the movement of the unexposed paper stopped, while the exposed strip is carried forward by clockwork into the developing bath C, then into a neighbouring fixing bath, and is finally pushed through a slot in the outer cover of the apparatus.

The apparatus in Fig. 1, however, yields only the zig-zag writing, of which a sample is given in Fig. 2 of our former article quoted above. For the recording of a message in the characters of ordinary handwriting, a double apparatus (Fig. 3) is necessary. This differs from the apparatus just described in having two telephones, and in having the concave mirror supported upon one fixed point and two movable points. One telephone moves the mirror about a horizontal axis, the other about a vertical axis, so that acting simultaneously the telephones can cause the reflected spot of light to trace any desired curve. A double-line wire is used. One telephone is, as before, in the loop of this wire; the other is between the loop and the earth. For producing the horizontal motion a positive current and a negative current of approximately equal voltages are required; for the vertical movements a positive current and an equal negative current and a positive current of double their voltage serve. Corresponding to these are obtained motions to left and to right, and up-and-down motions of equal amplitude, and a downward motion of double this amplitude. Fractions of this amplitude are obtained by shortening the duration of the contact at the sending end. This contact apparatus consists of a perforated paper strip, five slip rings connected to the batteries, and two brushes connected to the line. The size of the holes in the paper determines the duration of the contacts between the brushes and rings.

If the ordinary written Latin characters be dissected it will be found that certain of them, such as *m*, *v*, *p*, can be resolved into elements each consisting of a down and up stroke commencing and ending at the same height above the line. The letter *m* consists, for example, of three such elements, the letters *v* and *p* each of two. In order to cause the receiver to write letters which can be analysed in this way the currents sent from the sending end to produce vertical movements in the receiver are regulated with respect to direction, intensity, and duration. This is done by perforating the paper strip with larger or smaller holes in three rows I., II., III. (as in Fig. 5) corresponding to the three rings operated by one brush. A hole in row I. exposes to the brush the ring supplying a negative current of known voltage, in II. the ring supplying a positive current of equal voltage, in III. the ring supplying a positive current at double that tension. And the effect on the mirror of the receiver of holes punched as in Fig. 5 is shown above the plan of the perforations in the same diagram. It is a matter of trial to fix on that size of hole which allows just sufficient time for the current to exercise its full effect on the telephone. A larger hole then merely broadens the loop the spot of light traces on the moving sensitised paper in the receiver; while a smaller hole displaces the spot of light to a distance which is a fraction of the full amplitude. The perforations necessary to produce the elements of the letters *m*, *v*, *p* are shown in Fig. 4, where the elements are, moreover, so combined and spaced as to write the letters distinctly and in order.

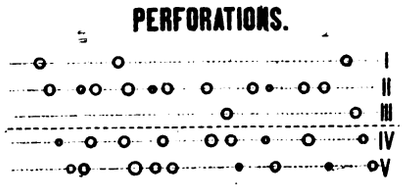

Fig. 8A.

Fig. 8B.

Fig. 8C.

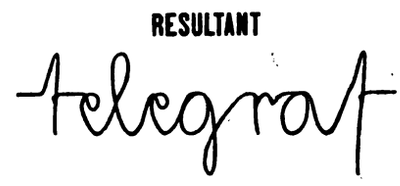

Fig. 8D.

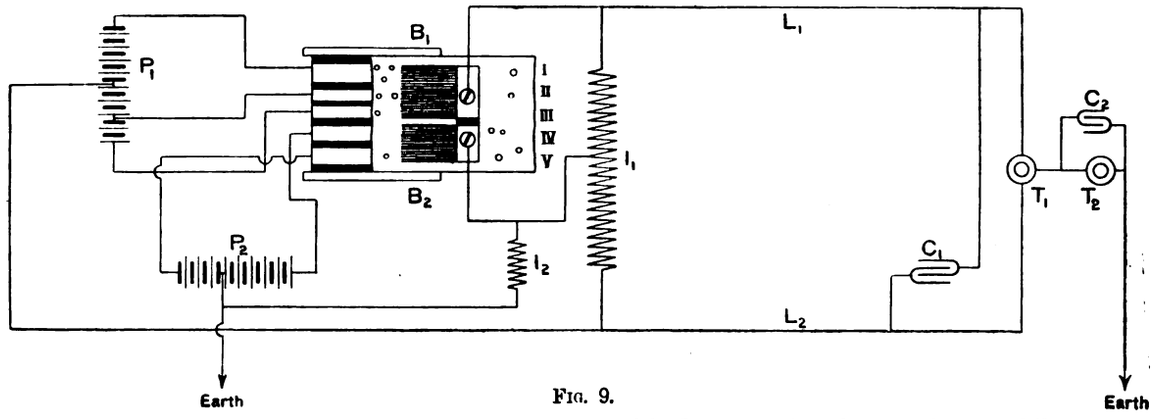

Fig. 9.

But the written Latin characters include many composed partly or wholly of closed curves, and these cannot be written by the mere up-and-down movements so far described; properly-timed to-and-fro horizontal motions are necessary in addition. Such letters are therefore resolved into and compounded from vertical and horizontal components. The movements of the

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receiver mirror corresponding to each of these components are each produced by separate current impulses, and the time intervals between these impulses are chosen and obtained by deciding on the spaces to separate consecutive holes in the perforated tape. Take for example the letter *l*, which contains a closed curve or loop. Its vertical components merely, are written by the mirror as in the left-hand portion of the diagram in Fig. 6. This up-and-down zig-zag is the result of stimuli sent into the line through the perforations I., II. acting alone. The first hole, in row I., causes the curve 7, 9, 10 to be described on the moving paper; the second hole, in row II., produces the curve 10, 12, 13. But when a hole is, as shown in the figure, punched in the row IV. so that a current deflecting the spot of light from right to left is sent into the line, as soon as the spot of light in its upward motion due to hole I. reaches the place marked 8, a deviation to the left is produced—in spite of the forward march of the paper—which carries the spot of light to 9. Here the current through hole I. ceases, and the spot of light returns to 10, where it is immediately, in consequence of the coming of hole II., given a downward motion towards 11. Here the effect of hole IV. dies out, and the mirror, in restoring itself to its normal position, then writes on the moving paper the broad loop 11, 12, 13. Thus the second of the two telephones, by its production of horizontal to-and-fro motions of the mirror's normal, makes it possible to write letters containing closed curves.

In this manner any character of the alphabet can be written. The character must be analysed at the sending end into its horizontal and vertical components defined as above and compounded at the receiving end by the two telephones. The telephone T_1, Fig. 2, gives the spot of light the vertical motions dictated by holes in rows I., II., III.; the telephone T_2 the horizontal motions demanded by the holes in rows IV., V. The construction of the complete word "telegraf" on these principles is shown in Fig. 8. Fig. 8*a* gives a plan of the perforations in the sending strip; *b* gives the written record due to the telephone T_1 operated from the rows I., II., III.; *c* represents the effect on the telephone T_2 of the holes in rows IV., V.; and *d* is the resultant of the vertical and horizontal components.

The sources of current are two comparatively small batteries connected to the rings, line, and earth, as shown in Fig. 9. From the first battery P_1 are taken equal positive and negative currents corresponding to rows I. and II. of the perforated paper, and also a positive current of double the value corresponding to row III. From the second battery P_2 are taken a strong positive for the leftward deflection of the spot of light and a weak negative for the rightward deflection. It will be noticed from this diagram that, as before mentioned, only the telephone T_1 is included in the loop of the double line, the telephone T_2 receiving its impulses after they have passed as two oppositely-directed currents of equal strength through the telephone T_1.

The self-induction and the capacity of the wires and the effects of the natural oscillation-periods of the telephone diaphragms are compensated in a manner virtually identical with the method employed by Messrs. Pollák and Virág a year ago, and described in our article above cited. These compensating coils and condensers are diagrammatically positioned in Fig. 9, where I_1 and I_2 are inductance coils and C_1 and C_2 are condensers. By modifying the condenser C_2, moreover, the phase difference between the horizontal and vertical motions can be adjusted to a certain extent. As a final detail we ought to add that the perforating of the paper sending-strip is accomplished by a simple machine which punches simultaneously all the holes corresponding to any required character.

There is in this system of telegraphy no need for the syntonising of the sending and receiving apparatus, for variations in the speed at either end merely broaden or narrow the letters; and, therefore, the inventors claim that this system is simpler and more reliable considered merely from this point of view. Besides, with the aid of a distributor (such as Bandot's), about 30 sets of apparatus can work on one line.

At some recent trials, allowed by the Hungarian Minister of Commerce, a distance of 400km. (nearly 230 miles) from Budapest to Pozsony and back was spanned by two pairs of telephone wires, and most excellent results were obtained. The rate of transmission—at which rate very good writing was produced—reached 1,000 words per minute through a resistance of 2,000 ohms.

ELECTRICITY WORKS ACCOUNTS.

Hampstead Vestry Electric Supply Works.

In our first table this week we present an analysis of the last accounts of the Hampstead undertaking. These accounts indicate a maintenance of its past excellent progress. A study of the costs column will show that while all the several items of generating costs, except repairs and maintenance at the station, have increased, the reduction in this item to less than half its former value has resulted in materially lower total generating and works costs. The fuel item, even in view of the higher coal prices in force, seems still decidedly too high at 1·24d. per unit sold.

The management and property charges, already in 1898-9 presenting an excellent figure, was last year reduced to 0·42d. per unit.

Consequent upon the virtual reduction at the beginning of the year in the prices charged for supply by the change of the maximum demand limit of two hours to one hour, the average total receipts fell from 5·69d. to 5·18d., and the revenue for supply from 5·03d. to 4·69d. per unit. In spite of this material decrease, however, the working profit has only dropped from 11·5 per cent. on the capital to 11·8 per cent.

During the year the lamp connections were increased by 28·4 per cent., and the output by nearly 42 per cent. The load also was even more satisfactory in character last year than in 1898-9, the load factor having increased from 12·5 per cent. to 13·5 per cent., both high values.

The system of charge for the public arc lighting was altered from Lady Day, 1899. Formerly the charge was 6d. per unit with discounts, now the charge is fixed at £28 per annum per arc lamp, this charge representing the actual cost of supplying the current, together with renewals, &c. As the result of the new tariff is an actual decrease in the revenue from this source notwithstanding the increased number of arc lamps, there must have been a considerable profit made formerly.

The capital outlay per kilowatt installed shows a drop from £93 to £79, while the plant capacity has increased from 1,343kw. to 2,056kw. Since last year considerable station building extensions have been taking place. Four 500kw. alternators, two by Siemens and two by Ferranti, with Belliss engines, have been or are in process of being installed. Other plant is being installed, including a 50kw. exciter by Crompton, with Belliss engine, and six Davey-Paxman boilers (each to evaporate 10,000lb. water per hour).

To meet the outlay on these extensions the Vestry have applied for the necessary sanction to raise a loan of £97,178.

Guildford Electric Supply Co. (Ltd.)

By the substantial reduction which the directors of this little undertaking made in the tariff, they effected a most beneficial change in the rate of progress.

Although, naturally, the receipts per unit sold fell considerably, the output last year increased by no less than 101·5 per cent., while the lamp connections advanced during the year by over 56 per cent. In addition to this, the very low load-factor shows a satisfactory tendency to rise. In 1898 it was 5·84 per cent., last year it had risen to 7·62 per cent.

To these changes in the nature and extent of the business done is attributable, no doubt, the lower costs which are presented by the 1899 accounts. Even taking into account these better conditions, the works costs are all well under what might fairly have been expected of them. The management and property charges have also been very considerably reduced but still stand at a figure admitting, we are sure, of further reduction. That, notwithstanding the reduced receipts, the working profit in relation to the expended capital should have been increased is an excellent result.

The net profit was just sufficient to wipe out the preceding year's deficit of £223, so that the undertaking now makes a fresh start unhandicapped.

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	HAMPSTEAD.		GUILDFORD.	
Undertaking Worked by	Hampstead Vestry.		Guildford Electric Supply Co. (Ltd.)	
Date of Commencement of Supply	1894.		November, 1896.	
System of Supply	Alt.-current trans. sub-stations feeding 3-wire [network.		3-wire continuous-current, with batteries.	
Chief Engineer	Geo. H. Cottam.		J. M. V. Money-Kent.	
YEAR ENDED	MAR. 25, **1899.**	MAR. 31, **1900.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	1,203,832	1,711,782	30,879	61,474
,, SOLD (TOTAL)	1,001,916	1,418,442	29,129	58,724
,, sold to consumers	907,772	1,296,210	29,129	58,724
,, sold for public lighting, &c.	94,144	122,232	nil	nil
,, used on works	16,000	13,720	250	750
UNITS SOLD PER 8 C.P. LAMP CAPACITY	23·86	22·1	7·77	9·4
Maximum supply demanded	917 kilowatts	1,198 kilowatts	57 kilowatts	88 kilowatts
Number of public lamps	53 arc	89 arc	nil	nil
Number of consumers	1,268	1,671	70	100
Connections to mains in 8-c.p. lamps	82,672	106,142	3,000	4,690
CAPACITY OF PLANT IN 8-C.P. LAMPS	42,000	64,300	3,750	6,250
CAPACITY OF PLANT IN KILOWATTS	1,343	2,056	120	200
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£129,130 / £96·1	£129,130 / £62·8	£20,000 / £167	£20,000 / £100
Share	— / —	— / —	20,000 / 167	20,000 / 100
Loan (including Debenture charges)	129,130 / 96·1	129,130 / 62·8	— / —	— / —
RECEIVED (TOTAL)	127,730 / 95·1	131,381[d] / 63·9	10,792 / 89·9	18,942 / 94·7
Share	— / —	— / —	10,292 / 85·8	12,942 / 64·7
Loan (including Debenture charges)	126,570 / 94·2	129,130 / 62·8	500 / 4·17	6,000 / 30·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	2,560 / 1·91	nil / —	9,208 / 76·8	1,058 / 5·29
Share (unissued)	— / —	— / —	9,208 / 76·8	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	2,560 / 1·91	— / —	— / —	— / —
REPAID (TOTAL)	3,444 / 2·56	6,340 / 3·08	— / —	— / —
RESERVE OR SINKING FUND	— / —	6,000 / 2·92	— / —	— / —
DEPRECIATION FUND	— / —		150 / 1·25	281 / 1·40
EXPENDED (TOTAL)	125,410 / 93·4	162,212 / 78·9	10,486 / 87·4	17,284 / 86·42
Lands and buildings	22,231 / 16·5	33,666 / 16·4	161 / 1·34	1,428 / 7·14
Plant	46,992 / 35·0	63,208 / 30·7	5,387 / 44·9	7,584 / 37·92
Mains	55,875 / 41·6	65,337 / 31·8	4,463 / 37·2	7,662 / 38·31
Miscellaneous	313 / 0·233	— / —	476 / 3·97	611 / 3·05
BALANCE OF CAPITAL ACCOUNT	+2,320 / +1·73	−30,831 / −15·0	306 / 2·55	1,658 / 8·29
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£23,753 / 5·690d.	£30,580 / 5·177d.	£938 / 7·730d.	£1,433 / 5·860d.
Revenue from supply	20,996 / 5·030d.	27,695 / 4·686d.	831 / 6·850d.	1,250 / 5·150d.
,, meters, &c.	802 / 0·192d.	1,108 / 0·188d.	61 / 0·503d.	91 / 0·372d.
,, public lighting	1,923 / 0·460d.	1,734 / 0·293d.	— / —	— / —
,, sale of lamps, &c.	18 / 0·004d.	— / —	4 / 0·033d.	10 / 0·041d.
,, miscellaneous sources	14 / 0·003d.	43 / 0·007d.	41 / 0·346d.	73 / 0·298d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£10,752 / 2·575d.	£14,336 / 2·427d.	£639 / 5·266d.	£945 / 3·863d.
WORKS COSTS	8,907 / 2·133d.	11,832 / 2·001d.	404 / 3·320d.	667 / 2·727d.
Generation of electricity	*8,465 / 2·026d.*	*10,793 / 1·826d.*	*403 / 3·320d.*	*665 / 2·718d.*
Fuel (including cartage, &c.)	5,131 / 1·228d.	7,357 / 1·244d.	200 / 1 650d.	462 / 1·889d.
Oil, waste, water, stores	574 / 0·137d.	856 / 0·145d.	29 / 0·239d.	40 / 0·164d.
Wages at station	1,313 / 0·314d.	1,898 / 0·321d.	163 / 1·343d.	134 / 0·548d.
Repairs and maintenance at station	1,446 / 0·346d.	679 / 0·115d.	10 / 0·082d.	29 / 0·119d.
Distribution of electricity	*187 / 0·045d.*	*674 / 0·114d.*	— / —	*2 / 0·008d.*
Wages, &c.	187 / 0·045d.	674 / 0·114d.	— / —	2 / 0·008d.
Repairs, renewals of mains, &c.			0·5 / 0·004d.	
Public lighting	*255 / 0·061d.*	*365 / 0·062d.*	nil / —	nil / —
Attendance	255 / 0·061d.	365 / 0·062d.	— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,845 / 0·442d.	2,504 / 0·424d.	235 / 1·936d.	277 / 1·133d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*353 / 0·085d.*	*381 / 0·065d.*	*61 / 0·503d.*	*40 / 0·164d.*
Management	*1,492 / 0·357d.*	*2,123 / 0·359d.*	*174 / 1·433d.*	*237 / 0·970d.*
Salaries	991 / 0·237d.	1,308 / 0·221d.	124 / 1·022d.	183 / 0·748d.
Stationery, &c.	113 / 0·027d.	220 / 0·037d.	14 / 0·115d.	13 / 0·053d.
Establishment charges	276 / 0·066d.	393 / 0·067d.	10 / 0·082d.	8 / 0·033d.
Law charges, &c.	112[a] / 0·027d.	202[c] / 0·034d.	26[a] / 0·214d.	33[b] / 0·135d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Tota'. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£13,001 / 11·5%	£16,214 / 11·29%	£299 / 3·41%	£487 / 3·51%
Sum carried to Depreciation Fund	— / —	6,000 / 4·17%	150 / 1·71%	130 / 0·936%
Sum carried to Reserve or Sinking Fund	1,197 / 1·06%	3,987[f] / 2·77%	2 / 0·023%	22 / 0·158%
Net interest on loans (incl. Debenture charges)	3,464 / 3·07%	4,073 / 2·83%	5 / 0·057%	113 / 0·814%
BALANCE FROM LAST ACCOUNT	+2,820 / 2·50%	11 160 / 7·76%	−287 / −3·28%	−223 / −1·61%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	11,160 / 9·90%	13,426 / 9·34%	— / —	nil / —
Deficit	— / —	— / —	*223 / 2·54%*	*nil / —*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	nil / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	45·3%	46·9%	68·1%	66%
Expenditure per kilowatt capacity	£8. 0s. 2d.	£6. 19s. 5d.	£5. 6s. 6d.	£4. 14s. 6d.
REVENUE PER KILOWATT CAPACITY	£17. 13s. 7d.	£14. 17s. 5d.	£7. 16s. 5d.	£7. 3s. 5d.
Expenditure per 8-c.p. lamp capacity	5s. 1½d.	4s. 5½d.	3s. 5d.	3s. 0½d.
REVENUE PER 8-C.P. LAMP CAPACITY	11s. 3½d.	9s. 6½d.	5s. 0d.	4s. 7d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 9d.	5s. 9d.	6s. 3d.	6s. 1½d.
Price charged for lighting, per unit	6d. to 2½d.[b]	6d. to 2½d.[g]	7d.	6d.
Price charged for power, per unit		[ann.[e]	4d.	3d.
Price charged for public lighting	4·2d. per unit	£23 per 500-w. lamp per	—	—

HAMPSTEAD.—REMARKS—*a* Includes £92 insurances and £20 testing of meters. *b* 6d. for first two hours and 2½d. after; on Wright system with discounts from 3 to 20 per cent., as annual bill varies from £25 to £500. *c* For 3,900 hours per year. *d* Includes £1,160 value of lands appropriated for station and £1,091 transferred from revenue account to cover capital expenditure on arc lighting and to meet deficits. *e* Includes £94 insurance, £62 certification of meters, £18 stamp duty and £16 investment expenses. *f* Inclusive of £1,091 transferred to capital account, viz., £873 to cover deficits on loans and £218 to cover expenditure on arc lighting works for year 1898-9. *g* On maximum demand system, *one*-hour scale.

GUILDFORD.—REMARKS—*a* Includes £16 to auditing and £8 to insurance. *b* Includes auditing £17, law expenses £5 and insurances £11.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

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UNDERGROUND SUBWAYS.

During the last few weeks the streets of the City of London have been in a state of disorder, rendering them in places almost impassable. The Post Office and the Charing Cross and Strand Electricity Supply Corporation are jointly responsible for this state of affairs, in their work of laying down cable for competing with the existing telephone and electric light services in the City. As this condition of the thoroughfares of our great metropolis will, in all probability, continue for some time, although work is going on in the principal thoroughfares both night and day, and as it discloses the multitude of pipes already laid under the streets for gas and water supply and hydraulic power, as well as electric light and telegraphy, the question is naturally revived in the minds of the general public: Would it not have been better to build a subway in which all these cables and pipes could be placed, and where they could be repaired, renewed, and extended without disturbing the surface of the roadway? As a matter of fact, short lengths of such subway already exist both in the City and in other parts of London. The City Corporation own about 2½ miles under various streets, and through these passages run a large number of pipes and conduits, including some belonging to the City of London Electric Lighting Co. and the Post Office, besides gas, water and hydraulic power mains. The London County Council are also the possessors of about an equal length of subway, and the Metropolitan and District Railway Companies have on some occasions permitted the use of their tunnels to the National Telephone Co. These few miles of subway are, however, practically unimportant in view of the large number of mains of various classes requiring periodical replacement and repair and the number of cables still to be laid in the metropolis for the extension of the electric light and the telephone services. The Corporation of the City of London, realising this rather late in the day, brought in a bill during the last parliamentary session, extending their powers with regard to the construction of such subways, and asking for powers to compel owners of mains to make use of these passages. This bill, with certain modifications at the instance of the Postmaster-General and others whose interests were affected, was duly passed and became law. It attracted little attention in Parliament at the time, probably because the clauses in question did not constitute the entire bill, although they formed the greater part of it. The bill was an "omnibus" bill of the usual kind; the important parts relating to "Public Service

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Works" and "Structures over Streets and Public Lighting in Streets" being sandwiched in between a set of clauses providing for the construction of a crematorium at Ilford and a clause permitting the Corporation to enforce bye-laws for the proper maintenance of water-closets, privies, cesspools, &c. Both these are excellent objects, and from certain points of view may even rank equally with the question of subways for mains, but they were calculated to draw attention away from the part of the bill most liable to meet with opposition.

The act is being printed, and the Streets Committee is considering what action it shall take with reference to the proposed subways, so it will not be amiss at the present moment to examine more closely its scope. In the preamble, reference is made to the notice given by the POSTMASTER-GENERAL of his intention to break up all the principal thoroughfares in the City, as well as to applications by the National Telephone Co. for permission to lay wires underground, and to the fact that the Charing Cross and Strand Company had obtained a provisional order and would shortly require to open the streets also; but of course it was then too late to build a subway in time to render unnecessary this disturbance to traffic by two or three independent corporations. The first important provision in that part of the act itself which we are considering is that the City Corporation, as a preliminary to commencing the building of any such "public service works," is to deposit with the Board of Trade particulars and drawings of the subway it proposes to construct, and to send copies to the companies having pipes or wires in the streets in question or having the right to lay them there. Any of these companies can lodge an objection within 28 days, in which case the matter is to be submitted to an arbitrator appointed by the Board of Trade. Once such a subway is laid under a street, the Corporation will have far-reaching powers with respect to it. It will be entitled to compel the removal into the subway (at the Corporation's cost, however) of any pipes in the street; all new mains will have to be laid in the subway; and, moreover, any company desiring to interfere with the surface of the street in order to repair or renew a pipe other than a service pipe not in the subway must give the Corporation seven days' notice. As this latter provision would be a great hardship in the case of faults arising in electric light mains or telephone wires, there is a clause waiving it in case of emergency. Hitherto the Corporation have had certain compulsory powers with respect to the existing subways, but although they have been able to compel the laying of mains in the subways rather than in the street, they have had to give a free wayleave and charge no rent. In the new act, however, a clause is inserted entitling the Corporation to a rental. The rental to be charged is not specifically stated, but it is to be determined with regard to the saving to the company which is using the subway instead of having to break up the streets. This clause will, one would think, be fruitful of disputes. The Corporation will be empowered to make bye-laws with respect to the use of the subways and the work carried on there, but these bye-laws will have to receive the approval of the Board of Trade before being enforced.

We now come to the protecting clauses in the act. A 16-line paragraph without stops, and commencing with the words "Provided that," makes the Corporation responsible for any damage to a company by the removal of its wires into the subway, such as presumably might arise from the supply through a main being interrupted. Next, the emergency waiving clause already alluded to, and two clauses protecting the Metropolitan, Metropolitan District, and Great Eastern Railway Companies from interference. The City of London and the Charing Cross and Strand Electric Supply Companies have also secured the insertion of a provision excluding from the compulsory clauses of the act any of their mains laid in streets previous to the completion of the Corporation subways in those streets, the same applying to streets, notice to lay mains in which has been given previously to the construction of the subways. Finally, the POSTMASTER-GENERAL maintains the rights he has had hitherto under the Telegraph Acts of 1863 and 1899; he can make use of the subways or not as he likes, and if he has a wire in a subway he has the right to veto the placing therein subsequently of any other pipe or wire which he thinks would be injurious to his property there.

The remainder of this omnibus act is only of interest electrically by a clause empowering the Corporation to "affix to the external wall of any building fronting any street within the City any brackets wires pipes lamps and apparatus as may be necessary or convenient for the public lighting of the streets within the City"; providing, however, for compensation to any persons sustaining injury by this action.

It is open to question whether any substantial advantage would now be gained by the building of a regular network of subways such as the Corporation evidently contemplated when they drafted the present act. By the time such subways could be built, the two electric supply companies would have assured their position in the principal thoroughfares. Consequently the compulsory powers of the Corporation with respect to the subways would be confined to the renewal and repair of the gas, water, and hydraulic power mains, or the mains of any new company—such as the one proposing to lay on real sea-water in London. The electric lighting companies might find such subways convenient when they lay additional feeders to their existing mains, but they would not be compelled to employ them if they did not choose to. The same applies to the Post Office, which would also have a free hand. It is doubtful, however, whether these services would elect to have the gas and water mains as such close neighbours. A subway exclusively for electric mains would have been a boon if it had been available at the present crisis, but it is to be hoped, at any rate, that by the time such a subway could be finished the distributing networks in the central and most crowded parts of the City will be completed, and that nearly every office will have its telephone.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

New London Boroughs: the Electors' Guide and Handbook. Edited by ROBERT DONALD. (London: Edward Lloyd, 1900.) 6d.

Public interest has been so absorbed with the General Election that another important election, which is pending, is liable to be almost forgotten. The citizens of the newly-formed London boroughs will have to elect their representative councillors on November 1. Mr. Donald's little handbook comes very opportunely therefore. It gives a list of the new boroughs and of the parishes constituting each of them, and this is embellished by sketch maps and enlivened with a recital of some of the characteristics of the various districts, and useful information as to their areas, rateable values, &c. This section of the book would be rendered still more useful, however, by an enumeration of the principal streets bounding the different boroughs. The remainder of the book contains the complete text of the London Government Act, 1899, with extracts from the other acts to which it refers, these extracts being necessary to understand fully its scope. We recommend this sixpenny volume to the large number of our readers who live, or have interests in, the great metropolis.

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Preliminary Practical Magnetism and Electricity. By JOHN HENDERSON, D.Sc. (London: Longmans, Green & Co. 1900.) 1s.

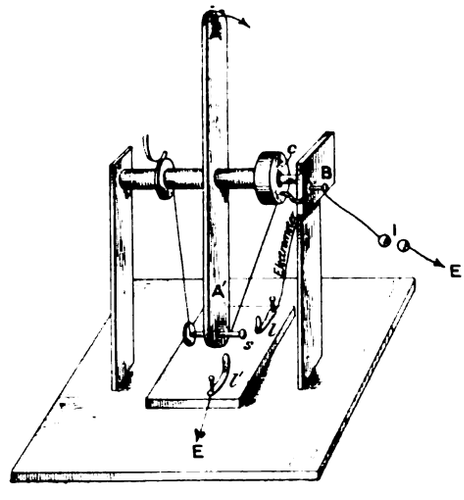
This little book is intended as a laboratory manual for beginners in electrical science, and contains a well-arranged series of elementary quantitative experiments needing for their execution but the simplest apparatus. For each experiment the necessary theoretical knowledge is briefly and lucidly outlined in a short "Preliminary," the apparatus distinctly specified, the operations to be performed by the student plainly indicated in order, and a table for the registration of data and results suggested. It is a book that will be appreciated by both students and teachers. Appendices, comprising hints on the conducting of the experiments, directions for the making of various simple pieces of apparatus, and a priced sketch of the complete equipment of a laboratory suitable for the course set forth in the book, add very greatly to the value of the little manual from a teacher's point of view.

We are, however, sorry to note in several of the paragraphs preliminary to an experiment rather serious misstatements quite unpardonable even in a very elementary text book. For instance, above Experiment No. 12 "On the Source of Energy in a Voltaic Cell," it is stated, in connection with thetheory of the simple voltaic cell, that "the difference between the amounts of energy in the zinc and the zinc sulphate [formed by the working of the cell] represents the energy expended [in heat] in the electrical circuit." Again, on page 20 it is stated that "it is only when the resistance of the external circuit is very large compared with that of the battery that adding cells will increase the current."

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Retardation of Discharge.—Jaumann was the first to show that a spark-gap is not always broken through by an appropriate difference of potential, but that sometimes several



seconds may elapse before the discharge passes. This retardation was studied by Warburg, and more recently by R. Swyngedauw. The latter first produces a gradual rise of potential by lowering the capacity of a condenser in the circuit. Having determined the potential at which the discharge sets in (the earth's potential being at one of the knobs), he next produces various abrupt potentials lasting for a small fraction of a second, and finds the higher potential now required for discharge. The difference between the two is then a measure of the retardation. The apparatus employed is shown in the diagram, where AA′ is a wooden lath driven by an electromotor at a known rate, I is the spark-gap, *c* a hollow metallic cylinder, *l* a tongue connecting with a Holtz machine, a condenser, and an electrometer, *l′* another connecting to earth, and *s* a metallic knob serving to alternately charge and discharge I through the brushes attached to B. The author finds that there is no retardation if the knobs are kept brightly polished. He also finds that ultra-violet light only lowers the discharge potential when it plays upon the knobs during the time they are being charged, but has no effect after the charging process is completed.

[R. SWYNGEDAUW, *Journ. de Physique*, September, 1900.]

New Telegraphone.—An improved telegraphone for demonstration purposes is described by E. Ruhmer. The steel band on which the records are made is wound on four rollers arranged in a rectangle, and the winding is so arranged that the band is continuous, and for a reproduction of the record it is not necessary to reverse the band and start it again, but simply to let it run on. The cores of both the recording and reproducing magnets are parallel to the breadth of the band, and not perpendicular to its surface. They are made to touch it. For the guidance of the wires, four brass combs are mounted near the rollers. The whole apparatus is driven by a $\frac{1}{16}$ H.P. electromotor, which imparts to the band a velocity of 3m. per second. The duration of speech is two minutes. That is not much for a phonograph, but, of course, it can be increased by increasing the number of rollers or the distance between them. Several hearing magnets can be arranged, and if it should be necessary to repeat a short passage that can be done by mounting a hearing magnet on another part of the wire, and switching it on as required. The author mentions a German sentence, giving the same words when reversed, which he has successfully reversed on this apparatus. It is: Ein Neger mit Gazelle zagt im Regen nie.

[E. RUHMER, *Physikal. Zeitschrift*, October 6, 1900.]

Terrestrial Magnetism in France.—Starting from Toulouse Observatory as a centre, E. Mathias has made a detailed survey of the distribution of the magnetic elements in the South of France, with special reference to the horizontal intensity, which shows a more regular gradation than the other elements. Instead of plotting the isodynamics on a map, he makes the difference in H a function of the latitude and longitude, thus

$$\Delta H = x(\Delta \text{ long.}) + y(\Delta \text{ lat.}),$$

and determines the coefficients x and y. The mean of 54 observations distributed over eight Départements surrounding Toulouse yields $-1{\cdot}26$ for x and $-7{\cdot}42$ for y, ΔH being expressed in units of the fifth decimal order and for the epoch 1896, and differences of latitude and longitude being expressed in minutes of arc. These values are not of merely local interest. By means of the coefficients, which are practically the same for the whole of France, and possibly for a larger area, the author has re-determined Moureaux's experimental values, and found his own values to agree with them within the errors of observation. Declination values treated similarly do not yield simple coefficients, as the declination, and the dip too, are affected by considerable irregularities, such as the maximum over Corsica.

[E. MATHIAS, *Comptes Rendus*, October 1, 1900.]

Platinum Thermometry.—An important piece of work has been carried out at the Kew Observatory in connection with platinum thermometers. C. Chree reports on a series of tests of six platinum thermometers by means of a Callendar-Griffiths resistance bridge. He enumerates no less than 18 sources of error which may affect the measurements, among them being thermo-electric currents, heating due to the battery current, error in the temperature coefficient, insufficient immersion, and slowness in acquiring the temperature to be measured. The effects of insufficient immersion are as dangerous in platinum thermometry as they are in mercury thermometry. Heat is conducted in from the outer air through the leads, or outwards in case of high temperatures. Unless the total immersion exceeds 10cm., the error is likely to exceed 0·01°C. The platinum thermometers tested were found to be four or five times slower in acquiring the temperatures to which they were exposed than mercury thermometers. An immersion of 3·5 minutes in ice and 2·5 minutes in steam suffices to bring the reading within 0·0005 of its stationary value. The author suggests a number of further experiments to determine the effect of long exposures to high

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and to low temperatures, the variation of the boiling point o sulphur, and the behaviour of new platinum thermometers under a variety of conditions.

[C. CHREE, *Proc.* Roy. Soc., No. 435, October 3, 1900.]

High Resistances.—The usual method of measuring resistances, viz., that in which a current is sent through them and measured by a galvanometer, and in which the whole of the joulean waste takes place within the bad conductor itself, and not in the surrounding medium, fails when the resistance becomes about 10,000 megohms. It is just at that point that the "loss of charge method" begins to be useful. O. N. Rood is making an interesting series of experiments with the latter method, in which one of the ends of the bad conductor is attached to one coating of a charged condenser, and the other to a sensitive aluminium-leaf electroscope, which hands on to the earth any charge that succeeds in reaching it. The current observed has many striking analogies to a current of pitch. The latter takes some time to reach the end of its path, and if at any time a leak is made in the middle of the path, the pitch will flow into the hole from both sides. Such a phenomenon can be observed in a glass rod, connected as above described, when the electroscope connection is afterwards made in the middle of it. Electricity flows slowly from both ends into the new channel. In the case of ebonite, the electroscope end never attains the potential of the condenser end. It often acquires an opposite potential, probably due to some kind of induction.

[O. N. ROOD, *Am. J. Science*, October, 1900.]

Simple Relay for Space Telegraphy.—A simplified relay for use in Hertzian wave and coherer experiments has been devised by W. B. von Czudnochowski. Its general construction resembles that of an electric trembling bell. The axes of the electromagnets are horizontal, and the "trembler" hangs vertically down by their side. Its extreme point is provided with a platinum contact attached to a German-silver arm. The armature is rather heavy, and is weighted with an adjustable brass ball. It is covered with tissue paper next the magnet, and to avoid adhesion as far as possible the contact piece is so adjusted that it touches the insulated electrode before the armature touches the magnets. The armature is suspended by means of a thin German-silver spring, and its normal distance from the magnets is only 1mm. The whole apparatus is very cheap, and quite sensitive enough for most wave experiments. Thus the waves from a small Hertzian oscillator consisting of two straight cylinders 5cm. long and 1cm. in diameter can be detected over a length of 80 metres or 40 metres, and all the Hertzian reflection experiments can be made with it. It is even found that in the case of vertical propagation three ceilings, worked in stone and iron, when interposed in the path of the waves, do not sensibly affect the indications of the relay. Its sensitiveness can be readily adjusted.

[VON CZUDNOCHOWSKI, *Physikal. Zeitschrift*, October 6, 1900.)

ELECTRICITY SUPPLY FOR SMALL TOWNS.

BY C. S. VESEY BROWN, A.M.INST.C.E.
City Electrical Engineer, Lincoln.

Two Papers on this subject were read at the Huddersfield Convention of the Municipal Electrical Association, one of which was contributed by the writer of this article. Further prominence has lately been given to the question by the publication of the Board of Trade report on provisional orders granted in 1900. With the exception of those orders concerning London, practically the whole of the provisional orders obtained were for small provincial towns and districts, in some cases with as low a population as 3,500. In the Paper mentioned above the writer endeavoured to point out the absolute necessity of putting down machinery and cables which had stood the test of several years' experience, and above all to avoid anything in the nature of experimenting in any shape or form; to employ experts who were capable of saying yea or nay as to the qualities of the machinery offered; and that the surest way to success was to avoid anything which required a large annual cost in maintenance, or, in other words, to buy "standardised" machinery. Unfortunately, the ideas which prevail in England on local government do not tend to the erection of large power supply stations distributing over an area containing these smaller towns, such as would be and has been the practice on the Continent and in America, and therefore one is forced to the conclusion that at any rate for the next 10 or 20 years each small town will operate it own generating plant. It is to be hoped that the general principles which will actuate each of these towns will be the same, and that, at least, the systems of distribution will be so assimilated that in the event of the establishment of central power supply works, the connection of these distributing systems will not involve complicated and expensive means of regulation and transformation.

Reverting to the Board of Trade report, there are several interesting details given which show that this department of the Imperial Government is anxious to help forward the electrical industry. Inquiry into the finances of several local authorities has revealed the fact that the Board are not willing to grant statutory powers to local authorities who are unable to fulfil their obligations.

It would be interesting to know whether the Board of Trade and Local Government Board have sufficiently investigated the position of many other local authorities to see whether, before granting statutory powers for electric lighting, if the systems for drainage and disposal of sewage are adequate to the needs of the town or district; if sufficient has been done to properly metal and pave the roads and footpaths under the local authorities' jurisdiction; if efficient accommodation is made for infectious diseases beyond that provided by the poor-law authorities; or, again, is the water supply all that it should be, and many other points of far more importance to the welfare of the people than the question of being in possession of a monopoly for the supply of electricity.

If these matters had been properly investigated before provisional orders were granted, it is not unreasonable to suppose that the electrical industry would be in a more flourishing condition than it is now, and there would not be any excuse to offer or odious comparisons to make when comparing the electrical industry on the Continent with English progress.

It is perhaps too late now for an alteration in the law with respect to the granting of provisional orders, but the writer is firmly of opinion that if each town and district was originally made the owner of the right to supply electricity, and given, say, five years in which to make up its mind to supply under statutory powers, and if nothing was done to carry out these obligations to transfer the concession, either by auction or some equally convenient means, that there is not a town or district in this country which would not be operating an electricity works at the present day.

In the provisional orders granted in 1900 there is evidence that the local authorities who have consented to companies obtaining powers have in nearly every case made an agreement as to "terms of purchase" if it is thought desirable to take over the works before the 42 years specified in the 1888 Act. These terms of purchase vary from seven years, with 12 months' notice, to 14 years, with two years' notice. In some cases the premium on the capital is fixed, and in others the price to be paid by the local authority is specified as the "fair market value of the undertaking as a going concern."

As it is probable that similar bargains will be made in the ensuing and following sessions it will not be out of place to consider these terms with reference to the consumer, the local authority and the electrical industry. In all cases it is naturally felt that whatever premium on the capital outlay is paid it is somewhat in the nature of a reward for "pioneering" the undertaking against the competition of the gas works and to put the concern into such a state that there need be no fear that on the local authority taking over the works there will be no call on the local district rate to make up deficiency of income to pay interest and redemption of capital.

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It is generally admitted that the capital cost of an electricity works is higher than for a gas works to supply the same area; the generating expenses of the two are about equal, probably less in the case of electricity where traction is supplied from the same plant; the distributing expenses are less in the case of electricity, but not sufficiently so to enable the electricity to return the same proportion of dividend that a gas undertaking is able to do, due no doubt to the residuals which are a well-known factor in gas manufacture. Following out this reasoning it is not unreasonable to suppose that, price being equal, the electricity undertaking will return say 6 per cent. where the gas undertaking returns 10 per cent. Probably 18 months will be lost in getting to work, and another 18 months in gaining sufficient clientèle to make the undertaking pay. The "fixed premium" investor, therefore, who undertakes to sell his works at the end of 8 years from the date of the order for the capital outlay plus 15 per cent., will have in five years to earn a dividend at the rate of between 9 per cent. and 9½ per cent. In other words, he will require to charge a relatively higher price than if his undertaking was carried on on the same lines as the "fair market value" investor, who hopes to obtain the corresponding amount of premium or reward by selling at such a price as will bring as many consumers into his net as possible, so that he may be able to argue before the arbitrator on the value of the undertaking that he has at least done his duty to the consumer by selling him electricity at as low a figure as is compatible with an annual return of, say, 6 per cent. on the capital invested for the time the works have been in operation. The local authority's position between the two is clear. If the "fixed premium" undertaking is bought it brings with it higher prices than a works bought on the "fair market value" price, and no sooner has it acquired the works than there is a general outcry to reduce the price and bring electricity within the reach of all, or, in other words, run the concern for the succeeding two or three years at a loss, and make up the deficiency from the rates.

The electrical industry in either case will be the better off, as will be quite understood, but it is hoped that in order to pay the relatively higher dividends on the "fixed premium" works there will be no inflating of capital due to the system of employing "middlemen" firms to supply the plant at wholesale prices, and allow the investor to charge list prices for his works, a difference amounting to as much as 20 per cent. in some cases. In this case the electrical industry would suffer by the probable decrease in the output of machinery.

The writer is quite of opinion that local authorities when making these bargains with companies willing to fulfil the obligations required by the Electric Lighting Acts should not fix a premium, but rather pay for the undertaking on the basis of the fair market value, or, in other words, payment by results, and his reasons for this conclusion are that if the company charge such a price for electricity as will not bring it within the reach of all, then their reward will be small and they have not "pioneered" the undertaking; on the other hand if the price is low enough to satisfy all classes of consumer, then there is no object in the local authority paying any premium so long as the undertaking is run on these lines and it is tacitly understood that the company are properly and efficiently carrying on their business in an equitable manner both for the investor and the consumer.

An "Economy Switch."—A correspondent has sent us an interesting circular from a German firm descriptive of an "economy switch." This contains a coil of bare wire serving as a rheostat, so that it can be employed as a "dimmer" in an ordinary lamp circuit. The following quotation from the circular speaks for itself:—

I also beg to point out that the original price is saved in current in a very short time. A 16 c.p. incandescent lamp uses as a rule 3d. worth of current in a night, whereas a 16-candle incandescent lamp used with an economy switch requires only ¾d. worth. The saving in current, then, for one night is 2¼d. The economy switch costs 12s. (*ex* my works here), and therefore the price is saved in current in 66 nights. You will further save during the first year: $360 - 66 \times 2\frac{1}{4} = ca.$ £2. 15s., and every year after $360 \times 2\frac{1}{4} = ca.$ £3. 7s. 6d. per annum.

Carrying this principle further by employing a lamp of sufficient size in the first instance, the consumer might save the entire cost of his installation within the year.

THE LIGHT EMITTED BY THE CONTINUOUS-CURRENT ARC.*

BY MRS. AYRTON.

(*Concluded from page 924.*)

It is hardly likely that rays of all colours should be absorbed with equal facility by the arc mist, and, indeed, there are certain indications that this is not so—that the absorption is distinctly *selective*.

Dr. Russell and Sir W. Abney have shown† that crater light very like sunlight, but has a slight excess of orange and green rays and a slight deficiency of blue. They measured the light in such direction that they were, as far as possible, getting rays from the crater *only*, that is to say, in a direction in which as few rays as possible from the arc itself reached the spectroscope. They were really, therefore, measuring the crater light as seen through a small quantity of arc mist, when they found it *yellower* than sunlight. But this very light, when it has penetrated through the mist of a long arc, is purple in colour, as may be deduced from the colour of the opalescent globes surrounding arc lamps when the arc is long. And this colour has nothing to do with the fact that our being accustomed to the yellow light of gas and incandescent lamps after dark makes a pure white light appear blue, for even in broad daylight the globes surrounding arc lamps in which the arc is long appear bright purple. Indeed, I have seen the inside of a screen surrounding a long arc, flooded with purple light as if lighted by a stained glass window, and retaining this colour *even when daylight was let in on it*. There can, therefore, be no doubt that the light of the crater becomes tinged with violet or purple as it passes through the arc, and that the tint deepens as the arc lengthens. If light became coloured in this way by being passed through coloured glass, we should say it was because the glass absorbed rays of certain colours and allowed other rays to pass. Why, then, should not this explanation apply to the arc mist?

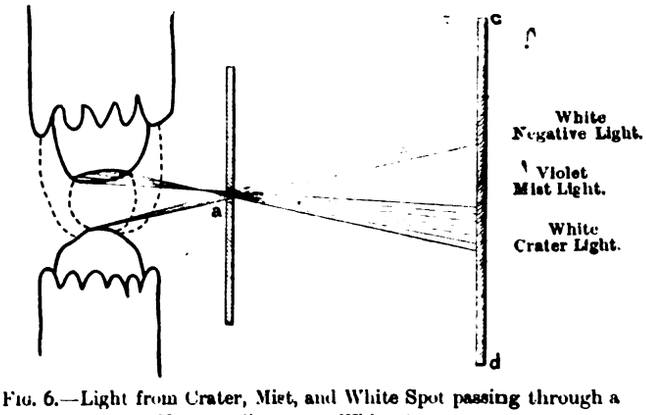

Fig. 6.—Light from Crater, Mist, and White Spot passing through a Narrow Slit on to a White Screen.

What probably happens is this. All the arc, except a thin layer quite close to the crater, consists of incandescent gases in which solid carbon particles are continually forming and falling. The vapour and gases must, of course, absorb a minute—probably an inappreciable—portion of the light that issues from the crater; were all, there would probably be no maximum of given length of arc; but the solid carbon particles in the mist have to be reckoned with. If the light were simply reflected from each of these that it encountered, and suffered only the small amount of absorption that would naturally take place, the whole quantity of light absorbed might still be too small to notice; but each ray may be reflected from particle to particle, and so the mist hundreds of times before it finally emerges. At each reflection part of the light that the particle is capable of absorbing is absorbed, and a ray that has suffered much internal reflection must emerge in a very different state from that in which it left the crater.

Suppose, now, that the carbon particles were absorbing the orange light and a certain amount of the green, but allowed all the violet light to pass. Then, after each reflection the light would become more and more violet, and that which had encountered many particles would be entirely violet. No incandescent gases give a dazzlingly brilliant light, so that when one looked at the arc mist alone, screening off the whole direct light from both carbons, the part of the crater light that was transmitted to the eye from the solid particles would entirely swamp the feeble

* Abstract of a Paper read before the International Electricity Congress at Paris.

† *Report* on the Action of Light on Water Colours, c. 5,453, 1888 pp. 23 and 69.

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ight emitted by the gases, and one would only perceive a brilliant olet or purple light.

A very simple experiment will suffice to show that the light nitted by the arc *mist* is violet, while that emitted by the crater id the white hot spot on the negative carbon is white. If a thin etal plate containing a horizontal slit *a* (Fig. 6) about $\frac{1}{16}$in. in dth, be held vertically near an arc so that the slit is about equi-stant from the ends of the two carbons, and if the light from the rc that passes through the slit be received upon a vertical white reen *cd* (Fig. 6) a foot or two away, this light will form three rizontal bands on the screen, the upper and lower ones being white d the middle one of a bright violet. The slit is, of course, simply pinhole horizontally elongated, so that the upper white light must ceed from the negative carbon, as indicated by the lines in Fig. 6, lower from the crater, and the middle violet band must be lighted by the arc mist.

A still simpler experiment is that of shading the upper carbon, and part of the arc with any opaque body, one's hand, for instance. The shadow on the screen will then be found to be edged with a broad band of reddish violet light, this band being the portion of the screen that is illuminated by the mist, and the negative carbon alone (the red-hot part of this carbon gives the rosy tinge). Below the band is the part illuminated by all three sources—crater, mist, and white hot spot, and this naturally looks quite white when contrasted with the violet band. A diagrammatic illustration of this experiment is given in Fig. 7; *ab* is a metal plate, *cd* the white screen on which the light falls. The portion above is entirely in shadow, that between *c* and *d* is lighted by mist and negative carbon alone, and that below *d* is illuminated by the crater as well as by these.

We have, then, three facts to reconcile with one another.

1. The arc mist emits a violet light, while that of the crater and white spot is practically white.

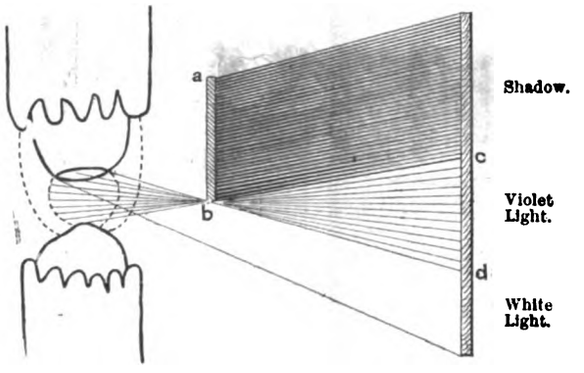

FIG. 7.—Band of Violet Light bordering the Shadow of a Metal Plate which is cutting off the Light from the Crater of an Arc.

2. The light of the whole arc, including all the sources in it, becomes more violet as the arc is lengthened.

3. The total amount of light received from all sources in the arc diminishes when the arc is lengthened beyond a certain point.

If it were not for the last fact, the first two might be accounted for on the supposition that the space between the carbons was filled with incandescent vapours and gases which emitted a violet light brilliant enough to give the white crater light a strong violet tinge. In this case, however, as the light from each of the sources in the arc [illegible] increase continuously as the arc is lengthened, condition [illegible] would not be accounted for, and consequently this explanation does not suffice. If, however, the violet tinge of the long arc is caused by the *absorption* of rays other than the violet rays, then all the facts are accounted for, and it is easy to see both why the light of the arc should be more violet as it is lengthened, and why also [illegible] quantity of light emitted should begin to diminish [illegible] arc was long enough for the increase in the amount of crater light that can get past the negative carbon to be more than counterbalanced by the increase in the quantity of that light that was absorbed by the mist.

Absorption [illegible]al reflection would also explain a curious anom[illegible]. Swinburne in the discussion on a very able Paper by Mr. Trotter* on the light of the arc. Mr. Trotter exhibited the curves [illegible] Abney which showed that crater light only differed from sunlight in having a slight excess of orange and green rays and a slight deficiency of blue rays. Mr. Swinburne pointed out that as crater light and sunlight were so very nearly of the same colour, the sun and the crater must also be nearly of the same temperature; but that, as the sun gave above ten times as much light per square millemetre as the crater, the emissivity of the sun must be ten times as great as that of the crater, which was incredible. This objection is perfectly valid if sunlight and the light *emitted* by the crater are really so nearly of the same colour. But Sir W. Abney was only able to measure the light *received* from the crater *after it had passed through a certain quantity of the mist*, for it is impossible for the crater light to get out without passing through *some* mist. Suppose, then, that the light *emitted* by the crater were very much yellower than the sun, but that even in passing through this small quantity of mist it was robbed of a considerable portion of its orange and green rays; then when it reached the photometer its colour would by this means have been brought much nearer to that of sunlight than it had been when it left the crater; it would have been rendered *bluer* in the course of transmission, and would appear therefore to have been emitted by a surface of much higher temperature than the surface of the crater actually is. Thus, if the mist does really absorb any considerable portion of the orange and green rays, Mr. Swinburne's objection no longer holds, for the crater light is probably far yellower when it is *emitted* than when it is *measured*.

* *Journal* of the Institution of Electrical Engineers, 1892, Vol. XXI., p. 381.

CABLE MANUFACTURE IN THE UNITED STATES.*

BY WM. MAVER, JUN.

The metal used for the conductors of underground electric cables is copper. Practically the only rival of copper for electrical purposes, outside of iron for overhead telegraph lines, is aluminium. This rivalry, however, extends only to overhead wires where the matter of diameter of the wire is not very material, the diameter of an aluminium wire being 1·27 times greater than that of a copper wire of equal conductivity. The weight of an aluminium wire, on the other hand, is one-half that of a copper wire of equal conductivity. At the present price of aluminium, which is slightly less than one-half that of copper, it would, therefore, be economical to use aluminium wire for overhead purposes, and this has been done recently in several instances. For underground purposes, however, it would seem that the greater diameter of the aluminium wire for a given conductivity must place it at a disadvantage, as compared with copper, on account of the greater amount of insulating material and lead required to cover the aluminium wire. The increased space that the latter wire would occupy in the underground ducts, where space is often quite a serious consideration, is also a disadvantage.

The process of manufacture of the cable may be taken up at the wire factory, where the copper is received in billets, or ingots, weighing about 200lb., which are first rolled into rods by rolling machines or mills. The ingots while red hot are passed through roll after roll, the rolls gradually reducing the wire to a desired size. In the first stages the rods are passed back and forth by men on each side of the mills, but as the rod increases in length and diminishes in diameter, it is passed from one set of rolls to another by curved guides. These rolls will break down 50 tons of copper per day of 10 hours from the ingot to a rod or wire equal to No. 5 B. & S. gauge (No. 7 B.W.G.). This process, however, does not leave the wire as uniformly round as desired; hence the rods are usually subjected to a "drawing" process, which consists in drawing the wire, while cold, by means of suitable machinery, through dies of hardened steel. It is usually necessary to repeat this drawing process several times with dies of gradually diminishing diameter, until the desired gauge of wire is finally reached. The drawing process hardens the wire and also materially increases its strength; at the same time it renders the wire less pliable. The strength of the copper wire thus hardened appears to rest very largely in a thin shell formed by the drawing process, for when the shell is nicked, even if only very slightly, the wire breaks readily at that point. Before each drawing the wire is covered with flour paste, baked on the wire in an oven. This acts as a lubricant while the wire is passing through the die. When the wire has been drawn to the desired size, it is annealed to the required degree of softness and pliability by heating, the extent of the annealing depending upon the use for which the wire is designed. For the conductors used for overhead telegraph and telephone purposes, it is not annealed after the final drawing, or but very slightly, and this wire is termed "hard-drawn." But for larger wires, such as No. 00 or No. 0000 B. & S. gauge (0·364in. and 0·460 in. diameter, respectively), the wire is always "soft-drawn." The wire used in cables is always soft-drawn, regardless of the size, to insure flexibility.

The wire being thus reduced to the desired diameter, the treatment which it will next undergo will depend on the nature of the insulating material with which it is to be covered. If a rubber compound is to be used, the wire will be tinned, it being supposed that this is a protection against any possible deleterious effects of the sulphur used in vulcanising the rubber. The tinning is effected by passing

* Abstract of an article on "Electric Cables for High-Tension Service, How they are Made and Tested in the United States," in *Cassier's Magazine*.

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the wire through a vat of molten tin. When the insulating material is fibre or paper, the wire is not tinned.

The wire is now practically ready for use in the cable. There is, however, another matter to be considered first, that is, whether the conductor of the cable is to be "solid" or stranded. When the diameter of the conductor does not exceed 0·257in. diameter (No. 2 B. & S. gauge), the conductor is usually solid; that is, it consists of one wire. Above this size the conductor is stranded, chiefly to obtain greater flexibility of the cable.

The work of stranding the wire is usually done in one process. The wires of the strand are wound on reels, which are placed on suitable spindles, on frames around the stranding machine, the reels for each layer of wires being in the same circle. The circle of reels for each layer is, of course, placed a suitable distance behind or before its neighbouring circle, the reels for the larger layers being, naturally, behind those of the smaller. The centre wire of the strand passes from its reel, which is stationary in one place, and is held taut by a take-up drum or reel. The wires of the first layer are wound around this wire, and the wires of the second layer are wound snugly around the first layer, and so on, the reels of contiguous layers of wire being caused to revolve with their respective frames, in opposite directions, which gives the respective layers of the strand a right and left-hand lay. Machines for such work may be designed to carry 130 reels of wire, weighing 1,000lb. each.

As previously remarked, the insulating material of high-tension cables is now either a rubber compound or paper saturated with a resinous oil. Gutta-percha, which has been used so extensively—in fact, it may be said, exclusively up to this time—as the insulating material for long submarine cables, is not used at all for high or low tension cables in cities, its low melting point, about 120°F., being fatal to its employment for such purposes, inasmuch as this temperature is frequently encountered in city streets. Indeed, a temporary overload of a conductor might raise the temperature to this point, in which event the conductor would settle to the lead armour or sheathing of the cable, thereby, of course, ending its usefulness.

The pure rubber used in the rubber compounds employed as an insulating material is brought to the factory in balls, which weigh from 5lb. to 60lb. While this is termed "pure rubber," it is quite impure in a strict sense, and during the purifying process it undergoes a shrinkage of about 20 per cent. The first step in its preparation consists in soaking for about 12 hours in water at a temperature of about 200°F. or 212°F. After undergoing this boiling process the ball is passed through corrugated rolls or mills, by which the rubber is pressed into a thin rough sheet about the size of a sheep's hide. As the rubber is thus passed and repassed through this mill streams of water are caused to fall upon it, washing away the impurities which the roller exposes. After the sheets have been thoroughly washed they are taken to a drying room, where they are usually kept for two, three, or more weeks. The sheets are then taken to the "break-down" mills, where they are passed repeatedly through rollers which are kept at a temperature of about 200°F. This reduces the sheet to a homogeneous, plastic mass of pure rubber. The rubber is then folded into thick sheets and passed into the mixing room. Here, as the pure rubber is passed time after time between the rolls, the attendants add the ingredients, which make the completed compound, in such proportions as may be deemed advisable for any particular case, the proportion of such added ingredients, or adulterants, and pure rubber varying with every manufacturer.

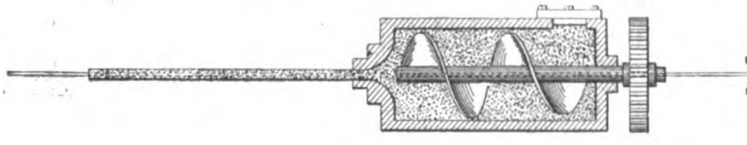

Fig. 1.—Diagram Illustrating the Operation of an Insulating Machine.

The ingredients composing a well-known rubber compound are as follows: 15lb. Para rubber, 4·5lb. litharge, 6lb. whiting, 4·5lb. blue lead, 7oz. sulphur. The amount of pure rubber used in the better classes of cable varies from 35 per cent. to 50 per cent. The various ingredients are added gradually to the rubber during the process of mixing, which requires for its proper operation a high grade of shop skill. The mills are kept at a temperature of about 200°F. during the process. In the mixing room of one large manufacturing company 6,000lb. of the insulating compound are prepared in a day of 10 hours.

When thoroughly mixed, the rubber compound is ready for placing over the wire. This is done in two general ways, first, by the use of insulating machines somewhat similar to the machines used in making rubber tubing. In the second method the compound is formed into a strip which is placed over the conductor. In the latter process the wire is rolled off a drum or reel, and passes through a guide to and between a pair of grooved wheels, where the rubber strip is lapped closely around the wire, the pressure causing the edges of the strips to adhere, and at the same time the surplus rubber is removed by suitable cutting edges on the grooved wheels. This produces a seam in the insulation.

The principle of the insulating machines used in the first-named method is shown in Fig. 1. Here the prepared compound is fed by an attendant into an opening in the machine; a worm draws the compound towards the die through which the wire is passing, and the wire is covered with the compound to the thickness desired, this being regulated by the excess of diameter of the die over the diameter of the wire. The compound is maintained in the desired plastic condition while in the machine by suitably arranged water jackets, the temperature of which is governed by valves which admit steam or cold water. The rate at which the wire may be covered in this way depends largely on the size of the wire and the thickness of the covering, which is termed the "wall." This method produces what is termed a "seamless" insulation. The wire, while being drawn through the die, is held by guides directly in the centre of the die to ensure an equal distribution or centering of the compound over the surface of the wire. The conductor, after issuing, covered, from the insulating machine, is drawn along a table through powdered talc, a distance of 40ft. or 50ft., to a drum, upon which it is carefully coiled. The wire thus covered may then be taped prior to vulcanising, or it may be vulcanised without taping, but in the largest sizes of cables it is customary to first tape the insulated wire.

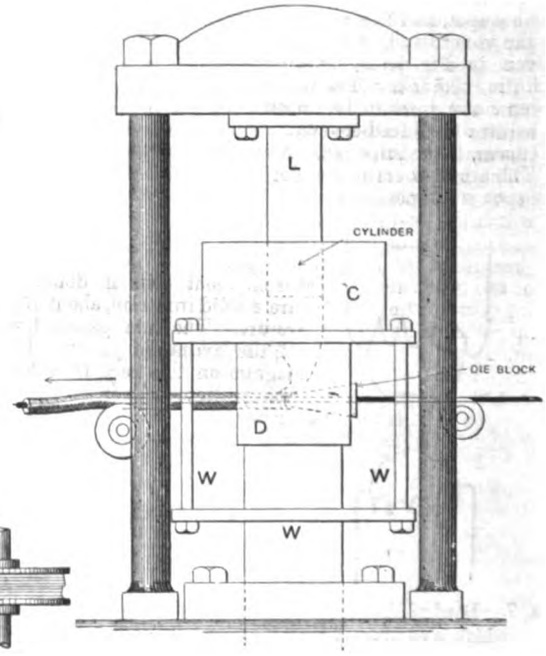

Fig. 2.—Elevation of a Lead Press.

The taping apparatus consists of a revolving disc on the face of which a reel holding the tape is suitably supported. The insulated wire or cable passes through a sleeve in the centre of the disc, and as it does, the reel, in the act of revolving with the disc, wraps the tape spirally around the cable. The latter passes from the iron take-up drum, to a reel, and is then ready for vulcanising. The process of vulcanising the compound consists in placing the wire and reel in an oven, where it is subjected to a steam or dry heat at a temperature of 250°F. to 300°F. Steam heat is preferred by many manufacturers as giving the best results. Much care is required in the process, and the most favourable temperature and the length of time required to bring the compound to the desired degree of hardness and tenacity are matters of experiment. They vary with different compounds.

At this point the manufacture of paper-covered cables may be considered. This consists essentially of winding strips of manila paper in reversed layers to any desired thickness over the conductor. When the conductor is covered it is wound on a suitable reel which, with the conductor, is placed in a "bake" oven, where it is subjected for hours to a temperature sufficiently high to drive all the atmospheric moisture out of the paper. The oven in which this baking is done is tightly sealed, except at a vent at the top. An attendant, by holding his hand above this orifice, is able to tell when the drying has proceeded sufficiently far by the nature of the air which passes out. After proper drying, the reel and conductor are immersed in a vat of boiling resin oil, often termed London oil, and as the baking process has rendered the paper exceedingly hygroscopic, it absorbs the oil with avidity.

Formerly the paper was placed over the wire as tightly as possible, but this plan has been abandoned for several reasons, one of them being that it imparted too great rigidity to the completed cable, with the result that the cable could not be bent without breaking the

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insulation. Further, it retarded the heat in the bake oven from reaching into the inner layers of the paper to such an extent that the outer layers were injured by too long exposure to the heat of the oven. Again, when the paper was put on under strong pressure, the compound could not readily penetrate to the inner coils, and as the ability of such cables to resist high electrical pressure is largely due to the presence of the oil, the importance of this latter point is obvious. By placing the paper layers more loosely over the conductor the layers slip easily over one another when the cable is bent, and the heat and the oil more readily penetrate to the inner layers, thereby improving the insulation resistance and increasing the pressure-resisting quality of the covering.

The conductors thus insulated are now ready for bunching into cable form. For the high-tension cables here particularly referred to three insulated conductors are usually employed. These are laid up in a strand, or spirally, and are taped, the interstices being filled in with jute, after which the conductors are ready for lead-covering. In other instances the conductors are bunched, and a "jacket" of paper strips or rubber compound, as the case may be, is put around the conductors thus bunched. This latter method is sometimes termed "split" insulation, because of the fact that the insulation is divided between the jacket and the insulation over each conductor.

All cables intended for use in underground conduits in cities are now lead-covered to protect the insulating material from destruction by the acids, alkalies, &c., found in such conduits. In the case of paper or fibre cables it is absolutely necessary that they be covered with lead to protect them from moisture in the underground conduits. Rubber cables are, of course, moisture-proof, and if nothing but water were to be encountered in the conduits they would not require to be lead-covered. Rubber immersed in salt or fresh water appears to be imperishable, barring mechanical injury.

The lead-covering of the cable is an interesting process. Fig. 2 shows the appearance of a vertical type of lead-covering machine, in which the lead is put on hot. The framework and the other parts of this machine are of massive construction to withstand the heavy pressure which is applied in putting on the lead casing. The pillars of the frame are of solid iron, about 10in. in diameter. The working parts of the machine are a solid iron ram, about 15in. in diameter, operated by hydraulic pressure. The ram passes down several feet into a vault in the ground, the hydraulic pressure being applied at the lower end. In the diagram on this page D is the die block, C a hollow cylinder into which molten lead is poured; L is the lead ram, or plunger, of solid iron, 5in. in diameter, rigidly bolted to the framework. Its lower end fits snugly into the receptacle in the cylinder C, as indicated by the dotted lines. As the die block must be changed to suit the size of cable to be lead-covered, the frame WWW is provided to permit of its easy removal. There is a curved opening in the die block, which reaches to the guide through which the cable is seen to pass. The die block rests on the top of the lower ram, and the cylinder C rests on D, in which respective positions they are held by bolts.

In preparing the lead and machine for the operation of lead-covering the insulation, the operation is practically as follows: The hydraulic ram is dropped down, and carries the die block and cylinder with it, withdrawing the cylinder from the lead plunger L, which is stationary. The cylinder is then filled with molten lead, which is termed a "charge." As it is not desirable to place the lead in a melted state over the insulation, the charge is allowed to chill somewhat before the operation of covering is begun. The time for this varies with the size of the cable, and may be from 3 minutes to 4 minutes. To prevent undue chilling of the lead, gas jets are placed around the cylinder. At the proper time hydraulic pressure is slowly applied to the ram. The pressure exerted on the end of this ram, which, in some cases, amounts to 500 tons, causes the cylinder to rise up against the plunger, with the result that the lead is pressed down into the die, forming a tube or casing around the insulated conductor. At the same time, by suitable take-up reels, the cable is drawn through the die block. In other types of lead-covering machines the hydraulic pressure is applied from the top.

The lead is frequently alloyed with a small percentage of tin, about 2 per cent. This was done originally to protect the lead from the attack of acids, &c., but its utility in this respect is questionable. The tin, however, adds a certain amount of rigidity to the cable, which is useful in facilitating the operation of drawing it into the underground ducts. The tin, at the same time, adds a difficulty to the process of lead-covering the cable, the small percentage above mentioned almost doubling the pressure that would be required to put on the lead pure. The rate at which the cable may be lead-covered depends largely on the size of the cable, ranging from a few feet per minute in the case of large cables to several hundred feet per minute for the smaller cables.

The cable is now practically ready for drawing into the underground ducts. Some of the manufacturers of high-tension cables, however, first subject them to a severe breaking-down, or puncture test, by applying an electrical pressure from one and a-half to three or four times the pressure to which the cable will be subjected in actual service. The pressure test varies with the length of time the test is to be applied. Thus, a cable designed to withstand a working pressure of 500 volts may be subjected to a pressure of 2,500 volts for one hour, or to 4,000 volts for a few moments. If intended to withstand a working pressure of 10,000 volts, it may be subjected to 15,000 volts for one hour or to an instantaneous pressure of 30,000 volts. The high pressures for these tests are developed by means of an alternating-current generator and step-up transformers. When the apparatus is ready, the wires leading from it are connected to the conductor, and to the lead cover of the cable, respectively. In the case of rubber cables, these tests are sometimes applied before the lead cover is put on, the cable being immersed in a tank of water. The ends of the cable are, of course, kept out of the water. In this latter case the wires run from the testing machine to the conductor of the cable and to the water in which the cable is immersed. If the cable is defective at any point, or if the pressure is too great for the inherent puncture-resisting quality of the insulating material, the current will "jump" and puncture the cable.

At such high pressures it is obviously essential that much care should be exercised in making these tests. The lead is removed, in the case of rubber cables, for a distance of several inches from the ends of the cable, as, otherwise, when a pressure of 20,000 volts or 25,000 volts is reached, the electricity will creep along the surface of the insulation (as it may be seen to do also on a sheet of thick glass subjected to high pressures), thereby reducing the tension of the current.

The maximum electromotive force used in the city of New York on underground cables is about 6,600 volts. This is employed by the electric traction and electric lighting companies. The longest circuit on which this pressure is used measures about 10 miles, while many other circuits range from 1 mile to 5 miles and 6 miles in length. The maximum electrical energy transmitted over these circuits from the power-houses to the various sub-stations or points of distribution ranges from 1,300 H.P. to 2,700 H P. Both rubber and paper cables are employed for this service. The dimensions of one of these cables may be given; for instance, a three-conductor cable, rubber, now operating at 6,600 volts. Each conductor is made up of 37 copper wires, giving a total cross-section of 250,000 circular mils, equal to 0·5in. diameter. The thickness of the rubber insulating wall around each conductor is $\frac{5}{32}$in. high. This is a rubber-jacketed, or "split" insulation cable. The jacket is also $\frac{5}{32}$in. thick. This ensures $\frac{19}{32}$in. of rubber compound between conductors, and between any conductor and the ground. Each conductor, and also the jacket, is covered with a tape, put on spirally outside of the rubber. The lead-covering of this cable is $\frac{1}{4}$in. thick. The outside diameter of the cable is 2·56in. The interstices between the conductors are filled in with jute.

The highest working pressure for underground cables thus far proposed is that soon to be operated by a Western company in the United States. This company has an electric plant, driven by water-power, from which the current is to be transmitted at a pressure of 25,000 volts, on overhead wires, a distance of about 20 miles to the city limits. From this point to the point of distribution in the city the power is to be transmitted through underground cables, at the same pressure, a distance of 3 miles. This cable consists of three conductors, each of No. 2 B. & S. gauge. The thickness of insulation around each conductor is $\frac{7}{32}$in., and the thickness of the jacket is $\frac{5}{32}$in. The cable is lead covered.

Inasmuch as some authorities consider that 40,000 volts represent the maximum electrical pressure that can be advantageously employed on overhead lines for the transmission of electrical energy on a large scale, it is thought that the safe maximum pressure for underground cables has, perhaps, been reached, if not exceeded, in the installation referred to, owing to the difficulties to be encountered in maintaining the insulation at such high pressures. The operation of this circuit will be watched with much interest, and doubtless by its success or failure the pressure of subsequent installations of a like nature will be measurably gauged.

A DETERMINATION OF THE MECHANICAL EQUIVALENT OF HEAT.

BY DR. HOWARD TURNER BARNES.*

The method employed is that proposed three years ago by Prof. Callendar and the author at the British Association meeting at Toronto. In essence it consists in warming by a steady, measured supply of electrical energy, the volume of water passing at a constant determinate rate through a short small-bore glass tube containing the current-conveying wire. The small-bore tube connects two larger

* Abstract of a Paper, "On the Capacity for Heat of Water between the Freezing and Boiling Points, together with a Determination of the Mechanical Equivalent of Heat in Terms of the International Electrical Units," read before the Royal Society, being an account of experiments by the continuous-flow method of calorimetry, performed in the Macdonald Physical Laboratory of McGill University, Montreal.

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tubes in which are fixed the two members of a pair of differential platinum thermometers. These thermometers are used, when everything has become steady, to measure the difference between the temperatures of the water entering and leaving the middle small tube.

A glass vacuum jacket, itself surrounded by a copper jacket containing water at the inflow temperature, embraces this middle tube; and thus the heat lost by radiation from the water as it is warmed in and flows from the tube is reduced to a small yet measureable amount. Errors in the final results arising from this loss of heat by radiation, from the loss of heat by conduction, from the tendency of the water to follow unvarying stream-lines, and from the thermal capacity of the apparatus, with others of smaller import, were all estimated and allowed for. The most important of the measurements involved are the electrical; and the accuracy of these depends ultimately upon the accuracy of an international standard resistance and upon that of the voltage assigned to a Clark cell. The Clark cells employed in the present series of experiments gave values agreeing with all the best results obtained in setting up this electro-chemical combination.

The results of the experiments, which extended over a year, are given in 55 tables. From these the author constructs another table of the values of the specific heat of water at temperatures between 0°C. and 100°C. differing by 5°C. In terms of a thermal unit at 16°C. the specific heat at 5°C. is 1·00530, at 40°C. is 0·99735, and at 95°C. is 1·00370. It is a minimum at 37·5°C. In terms of the thermal unit at 16°C. the mechanical equivalent is 4·18876 joules—about 0·132 per cent. higher than that obtained by Reynolds and Moorby in their direct mechanical method. This discrepancy is due, the author concludes, to the fact that the E.M.F. of his standard Clark cell should be taken as 1·43325 int. volts, and not as 1·43420 volts, as used in his calculations. With this new value for the E.M.F. of the Clark cell, the author's results come into most excellent accord with those obtained by Prof. Rowland. The author, however, ascribes the slight differences still existing between his results and the results obtained by the electrical methods of Griffiths and of Schuster and Gannon to the radical difference in the methods of calorimetry.

Atmospheric Electricity and Dew-ponds.—Writing to *Nature* Mr. Arthur Marshall, of the Chemical Department of Woolwich Arsenal, describes as follows some interesting experiments designed to throw light on this subject:—

On the chalk hills in the south-east of England there are a number of ponds known as dew-ponds. One of these was described by Gilbert White ("Natural History of Selborne," Letter 29). There is a pond of considerable size at one of the highest points of the main ridge of the South Downs close to Chanctonbury Ring. From its position it is obvious that this pond can only be fed by water precipitated into it directly from the air. Yet it always contains a considerable volume of water. At the end of the dry weather last year, when most of the ponds in the valleys were empty, this dew-pond still contained several thousand gallons. How does this pond obtain the enormous quantities of water necessary to compensate for the rapid evaporation in such an exposed position, and also to supply large flocks of sheep?

It appeared to me that there was but one possible explanation: A difference of electrical potential must cause an attraction between the particles of moisture and the summit of the hill upon which the pond is situated. It is, of course, well known that drops of rain, &c., usually have an electrical charge, but it was necessary to ascertain whether this was capable of producing such a great effect. In order to test this point I took two porcelain basins of equal size and suspended them by means of silk threads from stakes driven into the ground at a high part of the ridge of the South Downs. In each of these basins was fixed an upright piece of sheet copper. The two pieces of apparatus were placed in exactly similar positions and were in every respect identical, except that in the one case the copper screen was connected to earth by means of a wire, whereas in the other case it was insulated by the silk threads.

The apparatus was left thus during the night of April 1, 1899. There was a thick mist on the hills, so much so that I was unable to select the most favourable position for the apparatus. In the morning the amount of water in the two basins was measured. In the basin with the insulated screen there were 15·5cc. of water; in that with the screen connected to earth there were 18·0cc. This clearly confirmed my theory, for the insulated apparatus would tend to acquire an electrical charge from the particles of moisture. Consequently the attraction would be less than in the case of the apparatus which was not insulated. The insulation must have been very imperfect, for the silk became saturated with moisture as soon as the apparatus was erected. The position chosen also, was not so favourable as it might have been. Nevertheless, there was a difference of 16 per cent. in the quantities of moisture collected.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"The Chemistry of the Materials of Engineering." By A. H. Sexton. (London and Manchester: John Heywood.)

"Pocket Book of Colliery Engineers' Notes and Formulæ." By T. A. O'Donohue. 2nd edition. (Wigan; "Mining Engineering" Office.) 1s. 3d.

POWER GENERATION: COMPARATIVE COST BY THE STEAM ENGINE, WATER TURBINE, AND GAS ENGINE.*

BY J. B. C. KERSHAW, F.I.C.

There is no question of greater importance at the present moment to those engaged in the management of our manufacturing industries than that of power generation. The supremacy which the steam engine has so long enjoyed is now assailed from two sides. The water turbine and the gas engine have become dangerous rivals; and there are those who assert that early in the twentieth century we may expect to find the steam engine ousted from its place as the most economical prime mover by one or other of these later forms of power generator. During the past 10 years a most remarkable development of hydraulic power has been taking place on the Continent of Europe and in America. The large power installations in the Haute-Savoie in France, at Rheinfelden in Germany, and at Niagara in America, have already become of considerable industrial importance. The success which has attended these earlier installations of turbines and dynamos, operated by water-power, has led to the exploitation of numberless schemes of a similar character. The aggregate amount of power at the present date generated from falling water forms no inconsiderable portion of the total power utilised in manufacturing industries; and two years ago it was estimated by the writer to be between 236,000 H.P. and 350,000 H.P.† On the other hand, gas engineers have been busily engaged in working out the problems presented by large gas engines, and by the utilisation of the waste gases of blast furnaces. Trials which have been made during recent years, show that both of these problems are capable of successful solution. Gas engines up to 650 H.P. have been built and have worked smoothly and economically; while at Seraing, in Belgium, and at other places, the blast furnace gases have been utilised for driving the engines which supply the blast.

The question, therefore, which the engineer now has to settle, when deciding upon the site and locality for a new factory, or when deciding upon the system of power generation to adopt for extensions of the old, is no longer so simple as when only one method of power generation in large units was open to him. It is no doubt true that the choice between the three possible sources of power is one, which in many cases will be settled purely by local considerations; and the proximity of a large waterfall, or of an extensive coal field, to the factory will be held to point to the turbine, or to the steam engine, as the most economical power generator.‡ In a great number of cases, however, especially when the decision of the engineer covers the choice of a site for the factory, the problem is capable of no such easy solution; and the most economical source of power can only be determined after an exhaustive study of comparative costs data. There has been an immense mass of information bearing on this subject, published in recent years, but no attempts have been made to co-ordinate these facts and data; and comparison between them in their existing form is unproductive of any useful results.

The aim of the writer in the present Paper has, therefore, been to collect and arrange in comparable form some of the more important figures bearing on the cost of power generation. Full references are given to all the original articles from which these figures are drawn, and it is hoped that this summary of a large mass of scattered information may be of considerable service to all interested in the question.

I.—Steam Power.

1. Estimate by Dr. Emery of cost of electrical horse-power-hour with coal at 12s. 6d. per ton, and interest charges at 5 per cent. Cost varies between 0·347d. and 1·22d., being lowest with 500 H.P. triple-expansion engines. This estimate is for United States of America conditions of labour.—(*Street Railway Review*, 1897, p. 391.)

2. Inquiry by Sheldon into *actual costs* of power in New England mills. The minimum and maximum costs found by the investigator were:—

(*a*) For 365 × 24 hours per annum, $45.69 to $261.00.
(*b*) For 307 × 10 hours per annum, $11.64§ to $14.85.

—(Abstract from "Engineering Record," *Electrical Review* (London), Vol. XLI., p. 314.)

3. Similar inquiry by H. A. Foster. The costs at the 22 plants which were examined varied between the following limits:—For 308 × 10 hours per annum, $15 29 to $200.53 (*Electrical Review* (London), Vol. XLI., p. 421).

* Paper read before Section G of the British Association at Bradford.

† See *Lightning*, January 20, 1898. Also estimate of 200,000 H.P. for United States of America, by Washington, in Paper read before Franklin Institute, July, 1899.

‡ The question of freight charges, and of proximity to markets for the manufactured goods, also requires attention before a decision is taken, but this question is outside the scope of the present Paper.

§ (Fuel 7s. 4d. per ton. Engine, 1,100 H.P.)

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4. Estimate by Raworth of cost, using superheated steam with best types of modern engines and boilers. Schmidt or Universal engine, using 11b. coal (8lb. steam) per indicated horse-power-hour and coal at 7s. per ton, taken as basis of calculation. Cost per indicated horse-power-year (365 × 24 hours) = £3. 14s. or 0·101d. per indicated horse-power-hour.—(Presidential Address, Northern Society Electrical Engineers, 1898.)

5. Paper by Dr. Bowman on "Power Generation." States that with a 500 H.P. compound condensing engine, the actual cost in a South Lancashire chemical works was £4. 3s. 3d. per indicated horse-power-year (2,825 hours).—(*Jour.* Soc. Chem. Industry, December, 1897.)

6. Inquiry by H. A. Mavor as to actual costs of steam power in the United Kingdom. Average of 10 factories generating in large units 0·130d. per indicated horse-power-hour; coal 5s. 5d. per ton. Best result of these 10 obtained by a weaving mill using power generated by two 375 H.P. engines, and coal at 4s. 10d. per ton. Cost in this case only 0·072d. per indicated horse-power-hour.—(Paper read before Institution Engineers and Shipbuilders in Scotland, March, 1898.)

7. Details by A. Siemens, Esq., of actual cost of electrical power at Charlton Works. Cost works out to 1·287d. per kilowatt-hour at the switchboard of the generating plant.—(British Association Paper, Bristol Meeting, *Electrical Review*, September 16, 1898, p. 407.)

8. Estimate by Prof. Kennedy of cost of electrical energy from steam power in Scotland, with coal at 3s. 6d. per ton. The average cost is given as £9 per electrical horse-power-year.—(*Jour.* Soc. Chem. Industry, 1898, p. 314.)

9. Paper by Webber upon comparative costs of water and steam-power. Gives detailed estimate of cost of latter with 1,000 H.P. plant. With coal at $3.85 per ton, cost equals $17.84 per indicated horse-power-year.

The best actual results known to author were with an engine running with an average load of 1,950 H.P., and coal at $2.26 per ton (d/d.). Cost worked out to $11.55 per indicated horse-power per annum. These estimates are for a year of 3,070 working hours. —(*Engineering Magazine*, Vol. XV., p. 922.)

10. The actual cost of steam power in Switzerland, in the cantonal district of Zurich, lies between 224fr. and 635fr. per indicated horse-power-year.—(*Electricity* (New York), from *Le Genie Civil*, March 15, 1899.)

11. The actual cost of power for the electric street railway in Montreal is stated by Cunningham to be slightly under 0·25d. per kilowatt-hour.—(*Engineering*, June 16, 1899.)

12. Estimate by Kershaw of cost of the electrical horse-power-hour, using best types of engines and dynamos, and coal at 7s. per ton. Cost worked out to 0·141d.—(*The Electrician*, December 25, 1896.)

13. In his evidence before the House of Commons Committee on the Power Bills, Mr. Harris, of Bramwell and Harris, stated that at Liverpool the cost of power for the overhead railway had varied between 0·53d. and 0·31d. per unit.—(*Lightning*, July 5, 1900.)

14. Mr. Philip Dawson, in *Engineering*, has tabulated a large number of costs data for generating stations in Europe and America. The lowest costs for generating the kilowatt-hour for tramway work is given in Table I. as 0·1275d.—(*Engineering*, June 1, 1900.)

Table I.—*Actual Costs of Steam Power per Indicated Horse-Power-Year of* 8,760 *Hours.*

Country.	Cost.	Remarks.	Ref. No.
America	£3 12 10	Compiled from lowest items in any stations	14
United Kingdom ...	3 14 0	Engines 375 H.P., coal 4s. 10s. per ton, weaving mill	6
United Kingdom ...	4 14 10	Average of 10 factories generating in large units	6
Canada (Montreal).	5 1 9	Generating station of electric street railroad	11
America	6 2 6	Engines 1,100 H.P., coal 7s. 4d. per ton, cotton mill	2
America	6 6 3	Engine 1,950 H.P., coal 9s. 5d. per ton	9
United Kingdom (Liverpool)	6 6 3	Generating station of overhead railway	13
America	7 19 0	Cotton mill.....	3
Switzerland	9 0 0	Lowest cost of steam power	10
United Kingdom (S. Lancashire)	12 17 2	Actual cost in chemical works.....	5
United Kingdom (Woolwich)	26 5 1	Cost at switchboard in cable works	7

In order that these estimates and actual costs may be compared, the lowest costs noted by each authority have been converted into costs per indicated horse-power-year of 8,760 hours, and gathered into Tables I. and II. The relationship between the cost of the indicated horse-power-year and of the electrical horse-power-year has been taken as 75:100, an energy efficiency of 85 per cent. being assumed in the combined machinery; the management, interest, and depreciation charges on the increased capital expenditure for dynamos making up the balance. The ratio of interest and depreciation charges to running charges has been taken as 40 to 100, in the two cases where these are known to have been omitted from the estimates of cost. Where the data have permitted it, allowance has been made for the fact that interest charges remain stationary, whether a 10-hour or 24-hour day is worked. The most remarkable fact about these costs, when studied in this way, is their wide variation. That the cost of steam-power should be high in Switzerland where no coalfields exist, is not surprising; but one would hardly expect to find the cost in Switzerland exceeded by that found in certain South Lancashire and Metropolitan works.

The details of two of the lowest costs, namely, Dawson's for the lowest practicable cost of generation in the United States of America, and Raworth's estimate for a South Lancashire central power station, using superheated steam, are given below, since it is of interest to have these two sets of figures brought prominently forward. The wide gap that separates these from the greater number of figures in Table I., is the measure of the improvement possible in power generation by steam.

Table II.—*Estimated Costs of Steam Power per Indicated Horse-Power-Year of* 8,760 *Hours.*

Authority.	Cost.	Remarks.	Ref. No.
Raworth	£3 14 0	Superheated steam. Coal 7s. per ton	4
Kershaw	3 18 0	Coal 7s. per ton.....	12
Kennedy	6 15 0	Coal 3s. 6d. per ton	8
Webber.....	8 17 4	Coal 16s. per ton	9
Emery	9 9 11	Coal 12s. 6d. per ton	1

The reference numbers in these and the following tables refer to the details given in Sections I, II., and III. of this Paper.

Dawson's estimate for the lowest practicable costs of generation, obtained by compiling a return which includes the lowest cost of each item attained in *any* generating plant in the United States of America:—

	Per B.T.U.	Per kw.-year of 8,760 hours.
Fuel	0·090d.	£3 5 8
Wages and salaries	0·030d.	1 1 10
Oil, waste, stores	0·005d.	0 3 8
Maintenance	0·0025d.	0 1 10
Total	0·1275d.	£4 13 0

—(*Electrical Review*, July 6, 1900).

Raworth's estimate of cost of steam power, by use of highly superheated steam in combination with suitable steam engine. (Universal or Schmidt.) *Basis.*—50,000 H.P. plant. Coal at 7s. per ton. 8,760 hours per annum.

Coal, 4 tons at 7s.....	£1 8 0	
Margin for bad coal and starting boilers, 25 per cent.	0 7 0	
Labour and management	0 10 0	
Repairs and stores.....	0 7 6	
Total operating expenses		£2 12 6
Interest, 5 per cent.	0 12 0	
Depreciation (average on total capital, 4 per cent.).....	0 9 6	
Total fixed charges		1 1 6
Total per indicated horse-power-year		£3 14 0

The capital outlay, including land, buildings, and 20 per cent. spare, is taken at £12 per horse-power.

(To be concluded.)

"Compression Splices."—An American firm has recently brought out a compression apparatus for producing joints in wires and cables by simple compression and without solder. In one form the apparatus consists of a 75-ton press, the hydraulic pump being located on a small truck with a crane attached so that the press can be lowered into a manhole for splicing the feeder cables which occupy the ducts of underground conduits. Recently a smaller and more portable form has been brought out in which a 20-ton press is used with an independent hydraulic pump and flexible connection. The press is said to be capable of exerting a pressure of 40,000lb., yet the press alone, with its splicing dies, weighs only 14lb., the pump 15lb., and the connector and couplings about 11b. This apparatus is intended for wire to a maximum size of No. 0 S.W.G., and can make T and Y joints as well as straight-through joints.

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CORRESPONDENCE.

COHERERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May not the cases of cohesion mentioned in Prof. Lodge's letter in the last number of *The Electrician* be one aspect of a many-sided phenomenon?

From the fact that the diminution or increase of resistance under electric radiation depends on the chemical nature of the substance, and from the further fact that there is in many cases an after-recovery, it would appear that that phenomenon is one of molecular strain.

It is evident that the molecularly-strained substance should undergo a physico-chemical modification of its properties. Take, for example, the modification of yellow phosphorus into the red variety under the action of visible radiation. Here we find the following apparently diverse effects as results of the same molecular strain:—

1. The substance becomes *chemically* less active.
2. It becomes of a higher specific gravity.
3. Its electric conductivity is increased.
4. It becomes insoluble in CS_2.

As another illustration of the change of physical properties due to molecular strain under radiation, the variation of *adhesive* power may be mentioned. This is seen in Daguerreotype plates, where mercury vapour used in the development of the latent image adheres to the light-impressed portions only. Similar developments by water vapour are also well known.

If we have in some cases a variation of adhesive power by radiation, why not in other cases a variation of power of *cohesion?* The phosphorus exposed to light has its density increased, evidently by the mutual approach of its molecules. Is this due to an increase of cohesion?—Yours, &c.,

London, October 15. J. C. BOSE.

THE EFFICIENCY OF THE CONTINUOUS-CURRENT ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the beginning of your leading article on "The Efficiency of the Continuous-Current Arc," in your issue of October 12, you attribute the discovery of the entire phenomena in question to Prof. Carhart and myself, and only credit Mrs. Ayrton with having found out the explanation. This, however, is far from being the fact. What we published at the Chicago Congress in 1893 was, that, when a fixed direct current passed between given carbons, the mean spherical candle-power increased until a certain P.D., as Prof. Carhart put it, or until a certain length of arc, as I stated it, was reached, and then the candle-power decreased again. But, that a short arc sends out more light than even a somewhat larger one, and that this quite short arc converts more of the power developed by the dynamo into *useful* light than an arc of any other length, are new and unsuspected facts, the discovery of which is entirely due to Mrs. Ayrton's observation as are their scientific explanation to her intuition.—Yours, &c., W. E. AYRTON.

MUNICIPAL, FOREIGN & GENERAL NOTES.

Airdree.—The Scottish House-to-House Electricity Co. have acquired the New General Traction Co.'s parliamentary powers for the construction of electric tramways in this town. The Scottish Company are now applying for similar powers for the adjoining burgh of Coatbridge. The Airdrie Council are recommended to transfer their provisional electric lighting order to the company, who will then have electric lighting and traction powers for Airdrie and Coatbridge.

Alleged Receiving of Stolen Property.—Two brothers, Harry and John Thomas Simpson, trading as Thomas Simpson, brass founders, Orange-street, Halifax, were charged last week with receiving a large quantity of telephone wire, the property of the National Telephone Co., knowing the same to have been stolen. The case was a sequel to a charge of burglary against two labourers named Barnham and Broadbent of entering the premises of the National Company in Raglan-street, Halifax, and stealing therefrom a large quantity of goods. The evidence went to show that the prisoners had received the stolen property, but this was denied by both of them. After evidence had been given the prisoners pleaded not guilty, and were committed for trial, bail being allowed.

Automobile Exhibition.—An exhibition of automobile vehicles was held at Chicago from Sept. 18 to Sept. 22, and attracted a very large number of visitors. No European firms were represented. Electric machines were in the great majority and in large variety. Several neat and handy delivery waggons were exhibited, as well as the usual types of carriages—hansoms, broughams, victorias, and buggies. The majority of the racing machines were gas driven, but several small, high-speed, steam-driven vehicles were also exhibited.

Barry.—A special meeting of the Council has been summoned to consider the question of applying for a provisional order.

Bermondsey (London).—The Vestry have instructed their consulting engineers (Messrs. Kincaid, Waller and Manville) to prepare a specification for the supply of arc lamps and columns, for which tenders are to be invited.

Bexhill.—The advisability of adopting a system of "free" wiring of premises is to be considered by the Electric Light committee.

Birmingham.—A special Tramways committee has been constituted by the Council. Hitherto traction matters have been dealt with by the Public Works committee.

Blairgowrie.—The Council are to confer with Mr. W. C. C. Hawtayne on the electric lighting question.

Brighton.—The resident electrical engineer (Mr. J. Christie) has submitted an estimate of the further capital expenditure required for the electricity undertaking during 1901-2. His estimate for machinery and plant is £26,500—£15,000 for two steam dynamos and switch gear, £2,500 for a condenser, with pumps and connections, and £9,000 for three boilers and accessories; while £28,500 will be needed for mains and house service connections, £11,500 for new feeders, £5,000 for new distributors, and £12,000 for house services and meters, leaving £1,500 for contingencies. The town council have applied for sanction to borrow £56,500 to cover this work.

Brisbane (Queensland).—The result of the poll of ratepayers on the question as to whether the Municipality should itself undertake the erection of electricity works or lease its powers to a company is a majority of 229 in favour of the latter proposal. Only a small percentage of the ratepayers voted.

Cardiff.—The Tramways committee, acting on the advice of their electric tramway engineer (Mr. Arthur Ellis), recommend the Council to undertake the track equipment themselves, and that Mr. Ellis be authorised to appoint his own chief assistant at a commencing salary of £225, rising to a maximum of £300 by annual increments of £25. By this arrangement, it is calculated a saving of between £5,000 and £6,000 will be effected.

The Electricity committee are considering the advisability of adopting a system of "free" wiring in the district.

Chatham.—It was announced at the last meeting of the Council that the Chatham and District Light Railways Co. had deposited a cheque for £6,000 under the Chatham and District Light Railway Order, and that the construction of the electric tramways would shortly be proceeded with.

Chelsea (London).—At the Vestry meeting last week the surveyor (Mr. T. W. E. Higgens) submitted a communication asking permission "to erect wires on the lamp-posts in King's-road, and Lower Sloane-street, from World's End towards Victoria, for the purpose of running electric cars." Mr. Higgens said that if the system were as sound as the invention declared it to be it would afford the solution of many difficulties now experienced, and he suggested that the matter be referred to the Works committee, but upon the motion of Major Doll it was agreed that the consideration of the project be adjourned for 12 months.

Chesterfield.—The maximum demand system of charging for electric current is to be adopted. The charge for the first hour's maximum demand will be 7d. per unit and 3d. after. For power the charge will be 3d. after 4 p.m., and between midnight and 4 p.m. 1½d. Consumers are to be allowed, if they so desire, instead of doing the wiring themselves, to have the work carried out by contractors under the Corporation to the satisfaction of the resident engineer, and to pay off the cost of such work by paying an extra 1d. per unit on the quantity consumed, or in the alternative to pay off the amount by 20 quarterly payments, carrying interest at 5 per cent. on the balance owing. The Watch committee have been offered arc lamps for lighting the Market-place at a cost equal to the amount now paid for gas.

Chivilcoy (Argentina).—The local gas company recently decided to establish electricity works.

City of London.—At the meeting of the Common Council last week, the consideration of the recommendations of the Streets committee as to the testing of electricity meters, and the increase of the salary of the electrical inspector (Mr. A. A. Voysey), referred to in our last issue, was postponed.

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Cleethorpes.—Mr. C. S. Vesey Brown has been appointed consulting electrical engineer.

Coatbridge.—Mr. W. M. Murphy has declined to sign the agreement for the construction of an electric tramway, and the Council have now made an agreement with the Scottish House-to-House Electricity Co., who propose to apply for parliamentary powers to construct tramways in Coatbridge and Airdrie.

Corrientes (Argentina)—A proposal to erect electricity works is under the consideration of the Municipal Council.

Croydon.—Owing to the increase in the price of coal the charge for public arc lamps has been increased from £18 to £21 each per annum. There are at present 135 arcs.

Dorchester.—A provisional order is to be applied for by the Council.

Dungannon.—A provisional electric lighting order is to be applied for by the District Council.

East Cowes (Isle of Wight.)—The application of Edmundson's Electricity Corporation (Ltd.) for sanction to a provisional order is to be considered by the Council.

Eccles.—Application has been made for sanction to borrow £5,308 for electric lighting.

Edinburgh.—The Council on Wednesday discussed the question of cabling the Portobello tramway route. Estimates were presented for £20,000 for the erection of a cable power station at Portobello. Mr. Gray said that cabling was not the proper motive power for tramways on the Portobello section, and that electricity should be tried. Mr. Kellock, in seconding, said no doubt the underground system was expensive, and he therefore suggested the adoption of the trolley system. They could provide the overhead trolley system for the sum they were voting for the cable power station. Everywhere the cable system was being abandoned except in Edinburgh. Mr. Steel (a builder) said it was too late in the day to come forward and stop the works. He denied that electric haulage was better than the cable system. After further discussion, however, the motion for approval of the estimates was carried.

The accounts of the Electricity department for the year ended May 15 have been issued. The total receipts for public and private lighting, meter rental, &c., amount to £63,659. 9s. The expenditure amounted to £32,686. 19s. 10d., leaving a gross profit of £30,972. 9s. 2d. After taking into account the balance from the previous year (£5,886), and after payment of interest (£13,178. 14s. 2d.), and sinking fund instalment (£14,119. 5s. 8d.), and setting aside £5,886. 9s. 6d. for reserve, there was a balance of £3,674. 9s. 4d., which has been carried forward. The total capital expenditure to date is £595,655. 8s. 1d., and of this sum £200,298. 16s. 3d. was expended during the past year. 6,273,397 units of electric current were generated, of which 3,780,343 were sold for private lighting, 579,612 for motive power, 1,191,773 were supplied for arc lighting, and 329,903 were used on the works.

Edmonton.—A special meeting of the Council is to be held to pass a resolution in favour of applying for a provisional electric lighting order.

Electric Traction in France.—The Compagnie Générale de Traction has sent us an interesting and well-illustrated pamphlet descriptive of several of the electric tramways built by them. This company, which is connected with the Westinghouse Company, has done a great deal of excellent work, including the equipment of the power station which drives the electrical extension of the Western Railway of France into Paris, and also provides the energy for the moving platform and electric railway in the exhibition. The pamphlet also includes an interesting description, with typical illustrations, of a tramway built in Alexandria (Egypt).

Featherstone.—The Council are seeking assistance from the neighbouring local authorities in opposing the proposals of the Northern Counties Electric Supply Co. to establish electricity works in the district.

Gloucester.—The Council are recommended to acquire the undertaking of the local tramways company and to convert the lines to electric traction. At present the only difficulty is the terms upon which the Corporation will supply the company with electric current.

Guisborough.—The Council have unanimously resolved to oppose the Northern Counties Electricity Supply Co.'s application for a provisional order.

Harrogate.—Application has been made for sanction to a further loan of £10,000 for electric lighting extensions. The net profit on the undertaking for the past year, after payment of interest and sinking fund, was £777, against a deficit of £729 in the previous year.

Hawthorn (Victoria).—The Council has given up its proposal to establish municipal electricity works, and the provisional order has been transferred to the Electric Lighting and Traction Co. for £150.

Hebburn.—Mr. J. A. Jeckell (of South Shields) has been asked to submit terms for preparing plans and estimates for an electricity supply scheme. A canvass of manufacturers and ship builders in the district is being made to ascertain their probable requirements in regard to a supply of current for lighting and power.

Hexham—Opposition is to be offered to the application of the Northern Counties Electricity Supply Co. for a provisional order.

Holyhead.—Electric lighting was again discussed by the District Council last week. It was reported that between the island of Anglesey and Holy Isle there is a culvert through which the sea rushes with considerable force, the period of rest being only one hour in 24. Mr. Thunderbolt (hydraulic engineer) had assured the Council that there was enough power in the rush of these waters to generate electricity to illuminate Anglesey. Mr. Thunderbolt is to prepare a report which will be submitted to the Council at the next meeting, when, if favourable, the question of applying for parliamentary powers will be considered.

Hornsey (Middlesex).—Col. C. H. Luard, R.E., held an enquiry on Friday last into the application of the District Council for a loan of £73,500 for electric lighting for this district. A large number of local residents, tradesmen, and property owners supported the proposal that the District Council should have control of the electric lighting, especially as electric lighting was profitably established at Islington and St. Pancras—adjoining districts. Gas is 3s. per 1,000ft. as supplied by the Hornsey Gas Co., and by the Gas Light and Coke Co. 3s. 5d. The scheme of electric lighting proposed at Hornsey is due to Mr. Robert Hammond, who is consulting engineer to the Council. He proposed the three-wire continuous current at 480 volts. The public lighting will include 94 arc lamps. The revenue from private lighting at an average of 5d. per unit is estimated at £9,775, and from public lighting at £1,787; the cost of generation at 2·25d. per unit, interest and sinking fund £,4226, leaving a net profit of £1,764 per annum upon 539,000 units generated. The station will adjoin the Great Northern Railway. The population of Hornsey is 80,000.

Huddersfield.—At the meeting of the Corporation on Wednesday Mr. Berry drew attention to the deficit of £2,068. 10s. 2d. on the working of the Tramways department for the past half-year. Ald. Walker pointed out that the deficiency was made up by taking into account sinking fund and interest on money borrowed. The tramways were not losing money but were making a profit. Ald. Kendall considered it a strong reason why the conversion to electric traction should be hurried on, for they were paying interest on money that was earning nothing.

Ilford.—The consulting engineer (Mr. W. C. C. Hawtayne) has been requested to prepare estimates of the cost of extending the electric lighting mains.

Inverness.—The dispute between the Council and its late consulting engineer (Mr. E. G. Craven) is likely to be settled amicably. The Finance sub-committee, which was appointed to report on the account submitted by Mr. Craven, and after consideration of all the circumstances, they recommend that he be paid 2½ per cent. on the total cost (£27,000) of the scheme which was provisionally accepted. They further recommend that the claim of £59. 4s. 9d., incurred by Mr. Craven for outlays and expenses be also paid, making the total £734. 4s. 9d., of which £300 has already been paid on account.

Launceston.—Owing to a quarrel with the gas company the surveyor (Mr. Thorp) has been instructed to make inquiries as to the cost of electric lighting and other forms of illumination.

Leigh.—The Council have instructed the town clerk, borough surveyor and electrical engineer to prepare a report upon the advisability of (1) constructing and working tramways; (2) constructing and leasing same; (3) permitting a company to contsruct and work same.

Light Railways.—An inquiry was recently held at Newcastle into the application of the British Electric Traction Co. for an order to construct a light (electric) railway between Jarrow and South Shields. Mr. Morse appeared for the promoters, and there was opposition as to the gauge of the proposed line. The promoters specified the standard, but the local tramway is constructed to a 3ft. 6in. gauge. Mr. S. Sellon said the total length of the tramway was a little over 3¼ miles, and the overhead trolley system would be adopted. The South Shields Corporation opposed, and Mr. Burgess, borough engineer, stated that his experience was that 3ft. 6in. gauges were better for tramway tracks through public streets than 4ft. 8in. gauges, and Mr. Laws, city engineer of Newcastle, concurred in this. In the first place, there was the question of "rutting," which was a very serious one. It was impossible to repair "rutting." The Commissioners will report in due course.

The Light Railway Commissioners held an inquiry at Kidderminster on Wednesday into the application of the Kidderminster and Stourport Electric Tramway Co. for powers to construct a line from Kidderminster to Bewdley with a branch to Franche. Mr. S. Morse appeared for the promoters, and said the line would be nearly 4½ miles long, and the same system of traction would be adopted as that employed on the Kidderminster-Stourport line. Evidence having been given in favour of the application, technical details were supplied by Mr. W. R. P. Hederstedt, representing Mr. S. Sellon.

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An inquiry was held at Sheffield on Friday into the application of the British Electric Traction Co. to construct an electric tramway a little over 4 miles in length between Barnsley, Worsbro' and Hoyland. The scheme is an extension of the Barnsley electric tramways authorised last Session. The tramway will follow the main road from Barnsley towards Sheffield to Hoyland Common, passing through Worsbro' Bridge and Birdwell. Mr. Sydney Morse appeared for the promoters, and technical details were supplied by Mr. Stephen Sellon. The Great Central Railway Co. opposed, urging that they would be seriously interfered with in the working of their line, because it was intended shortly to ask the Board of Trade to permit its use for passenger as well as mineral traffic, and there was cause for apprehension that if the proposed light railway was made to cross the Great Central Railway at Worsbro' Bridge, the Board would refuse to sanction its being used for passenger traffic. Counsel for the railway company also asked them to consider the danger to passengers on the light railway that would arise from their being carried over a railway level crossing, especially if, as the promoters proposed, the light railway crossed the metals at right angles, instead of with an S curve. After hearing the evidence, Lord Jersey intimated that the Commissioners were willing to grant the order, including the level crossing, but they thought a clause should be put in to the effect that any extra expense which the Board of Trade might put the Great Central Company to in consequence of the light railway crossing their line, should be thrown upon the promoters, at least to such extent as the Board thought reasonable.

The Dartford District Light Railways order has been submitted to the Board of Trade for confirmation. Objections by Nov. 3.

The Rhyl and Prestatyn Light Railways Extensions Order has also been submitted to the Board of Trade for confirmation. Objections by Nov. 10.

Liverpool.—At Wednesday's Corporation meeting it was decided to apply for a provisional order to authorise the construction of additional electric tramways.

Mr. S. W. Higginbottom, M.P., made an interesting statement at the last meeting of the Electric Power and Lighting committee on the present position of the electrical department. During the present year the first half of the Pumpfields station had been fully equipped with five 1,200 H.P. machines, which were now in working order. The buildings of the Lister-drive station had been completed, and the supply of electric energy from that station was commenced on Aug. 5, and three 1,200 H.P. generators were in working order. The sub-stations at Cobb's Quarry and Fairclough-lane were practically completed, and electric energy was supplied from them. The capacity of the steam plant in use by the department was now more than 20,000 H.P., or double that of 12 months ago. The equivalent number of 16 c.p. incandescent lamps connected to the supply mains was 134,000 on Oct. 1, against 108,000 last year. The total number of units sold during 1899 was 5,700,000. Electric energy was now being supplied to the tramways at the rate of 8,000,000 units, and for other purposes at the rate of about 5,000,000 units per annum. There were 142 arc and 288 incandescent electric lamps used for public lighting.

London County Council.—At Tuesday's meeting a loan of £3,100 to Islington for electric lighting was sanctioned.

The Highways committee reported that the Council had decided to seek parliamentary powers for the construction of new tramways (No. 14), one of which was from York-road to High-street, Tooting. The Wimbledon Council had since intimated that it proposes to seek powers next session for the construction of tramways, for a system of electric traction, from near the Wimbledon railway station to the county boundary at Waterfall bridge; and the Wimbledon Council suggested that the County Council should seek powers for the construction of tramways from the present tramway terminus at High-street, Tooting, to Waterfall bridge to connect with the proposed tramways at Wimbledon. This line, if constructed, would form an extension to the county boundary of the tramway (No. 14) above referred to. It was estimated that the cost of construction of this proposed extension (about 3 furlongs) would be about £11,250. The Wimbledon Council is prepared, in the event of the necessary powers being granted, to construct its tramcars for the same system of traction as that which the Council may adopt, and to lease the Wimbledon tramways to the County Council, or to enter into an agreement for mutual running powers, or for any other arrangement which might be agreed upon between the County Council and Wimbledon. The committee recommended that the Council apply for powers to carry out the work. The report stood over for a week.

The Highways committee also reported on the result of the question of the alteration from 100 volts to 200 volts of the standard pressure given by the City of London Electric Lighting Co. in respect to their Southwark Electric Lighting Order, 1891. The Council gave permission subject to 12 conditions, but the company were unwilling to accept the conditions, and appealed to the Board of Trade. After having held an inquiry the Board had issued its award, in which only the first of the 12 conditions was allowed. This condition was, shortly, that any necessary alterations to the wirings or fittings on a consumer's premises, and the repair of any damage incidental to such alterations, shall be carried out by the company at its own cost, and makes provision for reference to arbitration in case of dispute between the company and a consumer.

In May last the magistrate at Southwark dismissed six summonses taken out by the Council against the London Electric Supply Corporation for not maintaining a constant supply of electric energy. The magistrate stated a case, but the company had stated that it was very improbable that there would be any failure of supply in the future, and had asked that further proceedings might be abandoned. The Highways committee recommended this course, and this was agreed to.

Manchester.—The Manchester Corporation General Powers Bill (1901), in which powers are to be sought for the construction of additional electric tramways, has been approved by a meeting of ratepayers.

Marylebone (London).—The question of the purchase by the Marylebone Vestry of the portion of the undertaking of the Metropolitan Electric Supply Co. situate in the parish of Marylebone, at an estimated cost of between £900,000 and £1,000,000, was again discussed at the meeting of the Vestry last week. Mr. White, L.C.C., moved

"That the Vestry non-confirm that part of the minutes of August 2, 1900,* which related to the proposed purchase of the Marylebone undertaking of the Metropolitan Electric Supply Co., and which empowered the advisory Special Electric Lighting committee to conclude negotiations with the company for the transfer of its undertaking under the West London (Marylebone) Electric Lighting Order, as embodied in the provisional agreement dated 25th June, 1900, it being a condition of the contract that the figures supplied by the company be verified by a chartered accountant and an expert electrical engineer to be employed by the Vestry."

Mr. WHITE said the Vestry probably had never had a matter of such great importance before them—certainly nothing ever involving anything like the expenditure the scheme entailed, and he thought the Vestry would do well to give it calm and dispassionate consideration before they agreed to confirm the minutes. The early history of electric lighting in the parish showed that the Vestry had in the past discussed whether they would become themselves electricity supply undertakers or would accept the offer of a company. After careful consideration, and after receiving many applications from companies, they finally decided to come to an arrangement with the Metropolitan Company. Their Parliamentary committee of that period were unanimous, and, after extracting the best possible terms from the company, the committee agreed that the Vestry should not themselves undertake the supply of electricity. No other public authority had, at that time, decided to supply electric current on their own account. It was only later, when local authorities had had the advantage of the experience gained by the Metropolitan Co, and numerous other company pioneers in electric lighting, that some of them ventured to be their own undertakers. Electrical experiments had then passed the pioneer stage. Things went on comfortably for some years, until certain energetic spirits sprang up who wanted them to take over the electric lighting undertaking or run a competing supply. They obtained a new order, but its confirmation was denied them. If the Vestry had obtained confirmation of that order they would not to day have been asked to incur an expenditure involving the charge of a million of money. The Vestry had openly avowed on two separate occasions by their action that there ought to be competition in electricity supply, and the Marylebone Electric Supply Co. came forward last year. A curious state of affairs then arose. Three members of the Vestry were appointed to oppose the new company's bill in Parliament, but, instead, entered into surreptitious negotiations with the Metropolitan Company and virtually said, "If you help us to oppose the bill of the Marylebone Company, we will enter into some arrangement with you to buy out your Marylebone concern." The Vestry would remember that at the early part of last year there was a proposal made for the purpose of buying the undertaking. Accountants were appointed by both parties to inquire and report as to what was a fair amount to pay. The Vestry's accountant's report was much discussed, the £600,000 mentioned as the purchase price being regarded as a ridiculous and outrageous sum. They were unable to consider the question of purchase on that basis. The figure of the company's accountants was, however, roundly £900,000. The Vestry were so dissatisfied, even with the lesser sum of £600,000, that they decided not to consider the proposal at all. Well, the committee of three they had appointed brought up a report advising the Vestry to give all the money the company's accountants stated to be the value of the concern, although the sum put upon it by the Vestry's accountants was one-third less. They were told in this report that they would be well advised to take over the Marylebone area of the Metropolitan Company, as it would involve no direct expenditure—they were to simply issue 5 per cent. or 3 per cent. bonds at the option of the company, obtain the transfer of the undertaking, and pay interest on the capital sum. Those who were responsible for this scheme knew little about procedure in Parliament in such

* See *The Electrician*, August 3, 1900, p. 576.

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matters or they would not have devised a project which, if carried out, would prove disastrous to the ratepayers. He was also surprised at a statement in the report that a profit of £12,500 would accrue to the Vestry in the first year of the working of its proposed electricity undertaking, but in this estimate there was nothing provided for the redemption of capital, for the sinking fund proposal was the most amusing part of the scheme. It provided for 1 per cent. for sinking fund, but they were not told what was to be done with this 1 per cent. He had gone to the trouble to make some calculations, taking as his basis the figures given in the report he was criticising (which, however, he did not sponsor), but instead of making a profit of £12,500 on their first year's work he apprehended considerable loss, but the calculations made in the report went on increasing the profits of the Metropolitan Company year by year, and if this was to be continued he was afraid to calculate what the company's profits would be 20 years hence. To suppose that the concern would admit of indefinite expansion year after year, as in its earlier stages, was absurd. What they had to do, if they pursued this matter any further, would be to go to Parliament for powers to raise money for a given period. Hitherto Parliament had not sanctioned a longer period than 42 years, but supposing this was extended to 50 years, and they were able to borrow money at 3½ per cent., they would make an annual payment of £53,300 in interest, or £4. 5s. 3½d. per cent. per annum. No mention had been made of the enormous expense involved in providing supplementary stations for supplying the district. They were constantly receiving applications from the Metropolitan Co. for sanction to connect up various parts of the district. The company had two stations in the parish, which were quite insufficient for the work they were called upon to do, and in 1901, when the Vestry takes up this undertaking, if the project now before them were passed, they would have to overtake one-third of the requirements of the district for current. Suppose they had to purchase one-third of the current, and suppose they paid only 2d. per unit for it. He doubted if they would get current supplied to them by the company for that sum, as he failed to see that the company were pledged as to the price at which they would supply current in bulk, and the increase in the price of coal might mean a great deal in this connection. He would, however, take the price at 2d., which was lower than St. Pancras, Islington, or Hampstead, where the vestries generated their own current. The current required would therefore cost them, in round figures, £9,300, and adding the £53,300 for redemption, they had a total of £62,600. In addition, if the increased cost of coal continued, the company's coal bill for the same number of units they now generated would increase by £10,000, and if the undertaking which they were to take over was to produce a net profit of £45,000, as had been calculated, this involved a much larger output and consequently a much greater consumption of coal than would be covered by the £10,000 increased expenditure, and yet they were asked to believe that the profit was to remain at £45,000, and after paying all charges and 1 per cent. sinking fund they were to have a balance profit of £12,500. He submitted, however, that there would be a deficit of £27,600. They had been told that with the profits to be derived from electricity supply they would be able to take 2d. off the rates, but Parliament had declared that no part of the margin of profits derived from electricity supply can be applied in relief of rates, but was to be applied for the benefit of the consumers only. Supposing there were a loss, however, who was to pay this? It was obvious if they once reduced the price of current they could not put it back to a higher price. [At this point Mr. T. H. Brooke-Hitching, the chairman, said that Parliament had not refused to sanction the application of electricity profits to the relief of the rates; this was only a recommendation of a Joint Committee of both Houses, but had not been embodied in any act of Parliament. As a matter of fact, local authorities owning electricity undertakings had applied these profits in relief of rates.] Mr. White (continuing): It is likely, I contend, to become the rule of Parliament in dealing with these matters. In the face of a loss which he estimated at £27,600, he asked was the Vestry prepared to agree that a contract should be entered into with the Metropolitan Company? The history of electric lighting bills so far as Marylebone parish was concerned was a fiasco from beginning to end. Mr. Crook followed Mr. White, and seconded his motion. He pointed out that the committee's report advised them that unless they accepted this opportunity of acquiring the company's electric light undertaking in their district the opportunity was gone for ever, but he reminded them that they would have full opportunity 32 years hence to take over the concern lock, stock, and barrel, at a valuation of the buildings and plant according to their then condition. Mr. S. Chick, who also opposed the committee's proposal, said he could not agree with the previous speakers, who had exaggerated matters. The facts were that the Metropolitan Electric Supply Co. had spent in Marylebone £394,000, and by October, 1901, when this proposed purchase was to be completed, they would have spent about £500,000 in the parish, and the Vestry was asked to issue either 5 per cent. stock or its equivalent in value in 3 per cent. stock at the option of the company. As a member of the committee he opposed the report. He agreed with Mr. White on the question of the increase in expenditure which would be sure to follow the acquisition of the undertaking by the Vestry. In all their experience of public corporations he did not think there was a case where a public body was able to manage any concern as cheaply as a private company could do. He had another objection to the proposal, and that was that he considered it should be left to the new Borough Council. The present Vestry was an expiring body, in a few weeks they would pass out of existence, and had no right to pledge the parish to the expenditure of nearly a million of money. He hoped they would make it a test question at the forthcoming elections, and then if the ratepayers approved the committee's scheme they would have taken the matter out of the Vestry's hands, and if there was any suffering they would suffer with their eyes open. One other point required to be made. He thought if they went to the Board of Trade again they would obtain a provisional order. He was in the House of Commons when the Marylebone Electric Lighting Co.'s bill was, on the motion of Mr. Ritchie, shelved on the ground that negotiations were pending between the Vestry and the Metropolitan Company for the purchase by the former of the Marylebone section of the Metropolitan Company's undertaking. [The Chairman again interposed, and said that Mr. Chick's recollection of the parliamentary incident was wrong. Mr. Ritchie's amendment was that the bill should be passed, and if the agreement between the Vestry and the Metropolitan Company was not carried out, then the order was to be given to the Marylebone Company.] Mr. Chick (continuing) thought the chairman was right in this matter, but it came to the same thing, that no support was to be given to the passing of the Marylebone Company's bill if the Vestry purchased the undertaking of the Metropolitan Company within its district. He thought that the rejection of the Marylebone Company's bill was unfortunate, as by throwing out that bill, which was a competing bill against the Metropolitan Company, they had done themselves. If that bill had passed they would have had a lever to go to the Metropolitan Company with in the matter of greatly reducing the amount which that company asked the Vestry to pay for the purchase. Evidently, if they had applied to the Board of Trade they would have obtained a provisional order. There was, in his view, no doubt about that, and he therefore thought that if they needed it, a competing order could be obtained if they applied for it another Session. In any case they would not be prejudiced by rejecting the present proposal. Other speakers having favoured and opposed the motion, the debate was adjourned until Tuesday.

On Tuesday a special meeting of the Vestry resumed the debate on Mr. White's motion. The discussion lasted over three hours. At the close of some remarks by Sir E. Galsworthy, in opposition to the proposed purchase, a division was taken, when the non-confirmation of the minutes of Aug. 2, 1900, was carried by 31 to 26. A division was demanded and was taken, but the voting remained the same. By the non-confirmation of the minutes the scheme proposed by the Special committee has fallen through.

Matlock Bath.—An interview has been arranged between the Council and representatives of the North British Electric Supply Co., who propose to apply for a provisional order to establish electricity works in the district.

Municipal Telephony.—The Postmaster-General has granted a licence for 25 years to the Portsmouth Council to establish a municipal telephone exchange. A special committee is to be appointed to take charge of the undertaking, and the local authorities of several contiguous districts have offered their co-operation.

Oldham.—An inquiry was held on Tuesday by Mr. A. P. Trotter into the application of the Council to borrow £28,000 for electric tramways.

Paisley.—A report has been issued under instructions from the Council as to the finances of the electricity department. The cost of the new station is put at about £95,000, and the report deals in detail with the extra cost beyond the estimates. The following figures are given: Building estimate £5,500, cost £20,562; machinery and plant estimate £18,200, cost £33,277; mains for arc lamps estimate £5,050, cost £20,724; transformers and sub-station estimate £1,100, cost £9,416. The original works were designed to supply current to 10,000 8 c.p. lights, and the estimated cost was £33,750, or £65 per kw. Taking the capital expended at £95,000 and the capacity at 1,100 kw., the cost of the installation was about £86 per kw. But the extensions to mains, &c., required to take up the current still in reserve will probably make the cost from £90 to £95 per kw. The explanation, however, appears to be that a mistake has been made in putting down too much plant ahead of their needs, and that all will come right in due time. The report is to be discussed at the next Council meeting.

Patent Amendment.—The Reason Manufacturing Co., 111, Gloucester-road, Brighton, have applied for leave to amend specification of letters patent No. 5,863 of 1894 granted to Mr. Henry Reason for "Improvements in fuse boxes for electricity supply mains." Particulars of the proposed amendment are set out in the

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Illustrated Official Journal (Patents) for Oct. 10, and notice of opposition must be sent in within one calendar month from that date.

Patents and Trade Marks in the Transvaal and Orange River Colonies.—Messrs. Seymour Salaman, Townroe & Co., solicitors, write us on this subject as follows:—

In view of the great influx of trade which will doubtless follow the pacification of the countries which have been formally annexed to the British possessions in South Africa, we made inquiries on behalf of intending exporters what changes had taken place with regard to patents and the registration of trade marks, and we think it may be interesting to state that all applications can now be filed with the military governor, who will grant a receipt for the documents and note particulars of the application. When the registry office is re-opened the applications can be proceeded with under the existing laws of the former States. The procedure is intended to grant to patentees the protection accorded to them in terms of the former acts, which appear still to regulate patent and trade-mark law. The same fees will have to be paid as heretofore. The forms were simple under the former procedure, and no difficulty existed in obtaining certificates in due course.

Penzance.—The Council recently advertised for a consulting electrical engineer, and at the last meeting the Electric Lighting committee reported the receipt of 28 applications. These have been reduced to eight, from which the committee will make a final selection.

Personal.—At the last meeting of the Worcester Electricity committee it was announced that the 12 months' leave of absence granted to Mr. C. J. Sutherland, the borough electrical engineer, owing to ill-health, had enabled the doctors to combat the complaint from which Mr. Sutherland was suffering, and his many friends will learn with satisfaction that the further two months' leave which he has been granted will probably suffice to quite restore him to health and strength.

Perth (Western Australia).—The second electric tramway route has been opened. There are now 9 miles of tramway in operation out of the 20 miles authorised.

Post Office Telephones in the Metropolis.—A contemporary states that a firm at the West End, wishing to obtain a Post Office telephone, applied to know the terms of the General Post Office, and received the following official answer:—"Post Office system in the City and certain other districts will be working by the beginning of 1901, but the Department fear it will be some 18 months or two years before the system can be extended to Paddington or Vauxhall. Not yet in a position to state rates, but hope to do so shortly."

Power Transmission.—La Société Electricité et Hydraulique, Charlerol, is furnishing an electric-power transmission plant at the works of the Société de Sambre et Moselle (Belgium). The plant has a capacity of 1,500 H.P., and supplies current for 80 motors and 10 cranes.

Presentations.—On Friday last the directors and London staff of the Brush Company presented their general manager (Mr. R. Percy Sellon) with a silver bowl and a silver inkstand, together with an illuminated album containing the autographs of the 80 subscribers to the gift. The occasion of the presentation, which was made at the head office, was Mr. Sellon's approaching marriage.

A presentation of plate was recently made by the staff of the Ashton-under-Lyne electricity works to the chief engineer (Mr. W. H. Vincent) on the occasion of his marriage. The presentation was made by the first assistant engineer (Mr. Bruton). It will be seen by our "Appointments" notes that Mr. Vincent is about to proceed to Bermondsey (London) to take up a new appointment there.

Ripon.—A provisional order will be applied for by the City Council. The consulting engineers are Messrs. G. Harrison & Co.

Rochester.—Negotiations are in progress between the Council and the Chatham, Rochester, and District Electric Light Co. regarding the purchase of the company's undertaking in Rochester.

St. George's Hanover-Square (London).—A special meeting of the Vestry was held last week to receive a report from the Electric Lighting committee in regard to the electric lighting of the streets. At the outset a communication was read from the Gas Light and Coke Co. asking the Vestry to postpone their final decision, as the company had under consideration a more comprehensive scheme for the better gas lighting of the parish at much less cost than the scheme for electric lighting. Notwithstanding this the committee recommended that the agreement with the Westminster Electric Supply Corporation be approved and adopted, and that the seal of the Vestry be affixed. The agreement provided that the company should commence the works immediately, and should complete the work of erecting 600 arc lamps by June 30, 1902. Lighting according to schedule was to be at the rate of £32 per annum for each 750 watt and £22 for each 500 watt arc, £4 per annum for each 120 watt and £3 for each 60 watt incandescent lamp, these rates to be subject to a cumulative rebate of ½ per cent. per annum for each year after the first full year during which any lamp had been used. A clause provided that in the tenth and twentieth year after the date of the agreement the Vestry should be entitled to refer to an arbitrator the question whether the charge should be varied in consequence of the adoption by the company of any improvement or method which had resulted in a substantial alteration in the cost of public electric lighting, with power to the arbitrator to vary the payment, but no variation should be made which should cause the future profits of the company to be less then they were immediately prior to the adoption of such improvement or method. If, however, any increase in profit should result from the adoption of such improvement or method, the increased profit might be apportioned between the company and the Vestry in such manner as the arbitrator should think fit to award, but the award is not to be retrospective. Mr. ANTROBUS moved that the committee's report be received. The letter of the Gas Company did not commend itself to him. Full consideration had been given to the vast question of lighting the parish, and he thought that the Gas Company's letter asking them to postpone the consideration for two years on such a flimsy and out-of-date application was out of all reason. The Westminster Corporation had met them on two points, and this induced the committee to make their present recommendation. The first point was in regard to arc lamps and posts. The committee considered that those should be part of the capital outlay the company would have to expend, but the company thought otherwise. The company eventually conceded this, so that the cost of the lamps would not be an additional item, but would be included in the tender. The other objection raised was the duration of the agreement. The way in which the committee proposed to meet it was that at the end of 7, 14, and 21 years there should be, on the part of the Vestry, the right of calling in an arbitrator to have the terms altered. The company objected strongly at first, but finally they agreed to give the right of revision at 10 and 20 years. Mr. TASKER moved an amendment that the matter be referred to the new municipality. Mr. EVERITT said the matter of lighting the parish had been before the Vestry for 14 years. The new Council would not be able for 31 years to supply private consumers, and they could not make it pay if they had a municipal supply for street lighting only. At the termination of the agreement the Corporation would be able to embark on a scheme of their own for both public and private lighting. The amendment was defeated by 32 to 28.

After further discussion the seal of the Board was affixed to the agreement.

Singapore.—This city boasts a considerable German community, which has recently erected an extensive club building to replace the old "Teutonia" Club, and chiefly for the lighting of this club there has been put down an electric lighting installation far in advance of anything of the kind previously known in Singapore. The work has been carried out by Messrs. Howarth Erskine (Ltd.), under the direct supervision of Mr. G. E. V. Thomas. There are in all 270 incandescents of 32 and 16 c.p., besides several arc lamps; 63 of the 32 c.p. lamps are placed in the roof of the assembly rooms, and the light is filtered through panels of silk with striking effect. The Teutonia Club installation is of some general importance, as it forms the nucleus of a small supply station for neighbouring residences, some of which are already connected up. The club house is a semi-public building, and is supplied with current from plant erected in an outside station, and paid for by meterage, the charge being 50 cents. (1s.) for the first 300 kilowatt-hours per mensem and 40 cents. (10½d.) after. These charges appear heavy, but it must be remembered that the wretched gas at Singapore costs 8s. per 1,000 cubic ft.

Smethwick.—Negotiations are proceeding between the British Electric Traction Co. and the Corporation in regard to electric tramways and the supply of electricity in the district. The Council have called in Mr. J. G. Aldridge as their consultant, and he will report upon the advisability of accepting the company's terms, which include powers to the Council to take over the concern in 7 or 14 years after the expiration of the present lease, the company paying all expenses of management, and handing to the Council a percentage of the gross receipts, and also undertaking to supply electricity for lighting and other purposes to private consumers at the rates current in neighbouring districts.

Southampton.—At the last meeting of the Corporation a notification was received that it had been decided that the machines in use at the Ordnance Office were gradually to be adapted for electric driving, and that the question whether to generate their own electricity or to take it from the Corporation was under consideration. The Corporation are asked to state at what price they will supply current for power, and whether current for power would, like that for lighting, be alternating; also, whether the Corporation would, in the case of the department, make a reduction in the present price of 6d. per unit for lighting. The subject is being considered by a committee.

Mr. Smith has resigned his position as mains superintendent.

Southport.—The salary of the electrical engineer (Mr. C. D. Taite) has been advanced to £400 per annum, increasing to £600 by annual increments of £50.

Sunderland.—The Council have applied for sanction to borrow £73,035 for the erection of a new electricity station at Hylton-road to

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the plans of the electrical engineer (Mr. J. F. C. Snell). A very complete report has been prepared by Mr. Snell, in which it is stated that the capacity of the Dunning-street station will not permit of further extensions after next year. In 1898-9 the total units of current supplied by the Corporation were 472,343, and in 1899-1900 640,079. For the next three years Mr. Snell estimates the figures to be as follows: 1,026,740, 1,730,000, and 1,919,000. From Jan. 1 electric light consumers will have the option of being charged on the present maximum demand system or at a uniform rate of 5d. per unit. A reduction of meter rents, to date from Oct. 1, has been approved.

Stratford-on-Avon.—Opposition is to be offered by the Council to the application of the Union Electric Light and Traction Co. for a provisional order.

Taunton.—The agreement with the National Electric Wiring Co. has been terminated. During the past quarter the equivalent of 410 8 c.p. lamps were connected to the mains.

Telegraph Regulations.—The Postmaster-General gives notice that regulations have been made in pursuance of the Telegraph Acts, 1863 to 1899, relating to foreign-written telegrams.

Telephone in Manchester.—A conference of local authorities was held last week at Salford to discuss the question of providing an improved telephone service within the Manchester area of the National Telephone Co. The Mayor of Salford presided, and there also attended Ald. Holland (chairman of the Salford Telephone committee) and other members of the Corporation, and about 30 representatives of neighbouring authorities. Ald. Holland said the Salford Corporation had no cut-and-dried programme to propose for acceptance, but desired to hear the views of the authorities comprised within the Manchester area, so that there might be a consensus of opinion in regard to the ultimate steps to be taken to secure the end in view. Salford did not, in taking the initiative, seek any position of precedence, and whether the improvement was to be effected by the municipalisation of the telephonic system or by the formation of a new competing company was entirely a question to be decided after general consideration of the subject by those interested. After a long discussion, a resolution was approved appointing a committee to consider the question and to report their recommendations to a future meeting. It was decided that the committee should consist of one representative from each of the local authorities invited to the conference, including Salford, Eccles, Bowdon, Failsworth, Prestwich, Levenshulme, Swinton and Pendlebury, Whitefield, &c.

Telephone Trunk Extensions.—Trunk line telephone communication has been extended to Bishop Stortford.

Tiverton.—The Lighting committee have not yet been able to meet the objections of the Board of Trade in regard to the construction of a weir across the river, which formed a part of the electric lighting scheme of the consulting engineer (Mr. W. P. Adams). The Council are, however, recommended to authorise the immediate prosecution of scheme.

Trade Unionism Run Mad.—It is not unusual in the printing trade to put machine-room labourers to many kinds of miscellaneous work. Amongst the odd jobs performed by some of these men is the cleaning of the windows of the machine-rooms in which they are employed. Amongst employers there is a difference of opinion as to whether this is the sort of work a labourer should be called upon to perform, and it is not, therefore, surprising that some of the better class of labourers decline to clean windows. In one of the large printing offices in London the labourers have gone a step further, and have insisted that all the windows of the establishment shall be cleaned by the Window Cleaners' Society! If this claim is admitted it is not unlikely employers of labour will be instructed to place their laundry work in none but trade union hands. In fact, the idea admits of indefinite extension, and may be considered a step in advance towards Collectivism.

Vienna.—A large lighting and power transmission plant has been installed at the engineering works of the Austro-Hungarian State Railway Co. by Messrs. Ganz & Co. The plant supplies current for 40 arcs and 200 incandescents, and also for 40 motors ranging from ½ H.P. to 30 H.P.

Walsall.—Sanction to a loan of £9,470, out of £15,000 applied for, has been obtained by the Council. Details of a loan of £5,678 for the extension of the electric lighting mains to Bescot are to be submitted.

Westminster (London).—The question of petitioning the Board of Trade to hold an inquiry into the charge made for electric current by the Westminster Electric Supply Corporation was raised at last week's Vestry meeting. The committee to which the question was referred reported they were of opinion that the section of the public now concerned in the matter was not sufficiently numerous to justify the Vestry in taking further action in the matter. An amendment was, however, proposed that a communication should be sent to the Board of Trade urging the importance of holding an inquiry with a view to bring about a reduction in the price, and this was carried by 21 votes to 10.

Wigan.—The Tramways committee have applied to the Councils of Standish and Aspull for sanction to construct electric tramways in those districts. The Wigan Corporation recently offered to give a supply of electric current for lighting in various adjoining districts, including Aspull, Standish, Pemberton and Ince-in-Makerfield, but these local authorities have decided to apply for provisional electric lighting orders and independent works will probably be erected.

Wireless Telegraphy.—The Southend Council have given permission to the Signals Syndicate to give demonstrations from the pier of their system of wireless telegraphy in signalling to vessels at sea, &c.

Worcester.—The City Council have now decided to acquire the Tybridge-street site for a new electricity station for £4,450. The electrical engineer (Mr. C. J. Sutherland), whose 12 months' leave of absence, granted in consequence of ill-health, has now expired, is to be granted a further two months' leave to complete a cure, which, we are glad to learn, the doctors certify is already practically complete.

Wycombe.—The Council have approved the scheme for the construction of electric tramways, and parliamentary powers are to be applied for.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.

Swansea Corporation require tenders for electricity meters, demand indicators and main fuses. An advertisement gives further particulars, and specifications may be obtained after 22nd inst. at the Guildhall, Swansea. Specifications may also be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders must be sent to the town clerk (Mr. Jno. Thomas) before noon of 29th inst.

Lowestoft Corporation invite tenders for the supply of two water-tube boilers, fittings, economiser, &c.; pipework, &c., in engine and boiler house; and a 250kw. steam dynamo (vertical, enclosed, high-speed engine). An advertisement gives further particulars, and specifications may be obtained from the town clerk (Mr. R. Beattie Nicholson), 115, High-street, Lowestoft, after 20th inst. The works are to be carried out in accordance with the plans of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C. Tenders to town clerk's office by noon of Nov. 2.

Lowestoft Corporation also invite tenders for wiring the town hall. An advertisement gives further particulars, and tenders must be delivered at the offices of Mr. R. Beattie Nicholson before noon on Nov. 2.

Bradford Corporation invite tenders for a 30-ton electric travelling crane for their Valley-road electricity works. An advertisement gives further particulars, and specifications may be obtained from the city electrical engineer (Mr. R. A. Chattock). Tenders to town clerk (Mr. Frederick Stevens), Town Hall, Bradford, before 25th inst.

Heywood Corporation invite tenders for wiring premises in the district. Copies of regulations may be obtained from the consulting engineer (Mr. W. P. Adams), 35, Queen Victoria-street, London, E.C., and tenders must be sent to the town clerk (Mr. J. H. Baldwick). See advertisement.

Belfast Gas and Electric Light committee invite tenders for steam pipes, pumps, &c., condensing plant, boilers, mechanical stokers and superheaters, coal and ash-conveying plant and switchboard extensions. Tenders to town clerk (Sir Samuel Black) by noon Nov. 23.

The Streets committee of *City of London* Corporation are again inviting tenders for a mechanically-driven dust cart. Tenders to town clerk (Sir J. B. Monckton) before Nov. 10.

The *Postmaster-General* is inviting tenders until 22nd inst. for red fir telegraph poles and for creosoting. Forms of tenders from Mr. Chas. E. Stuart, controller of stores, General Post Office, London.

London County Council require tenders for 12 months' supply of engineers' goods and electrical stores. Tenders to clerk, County Hall, Spring-gardens, S.W., by 29th inst.

Strand (London) District Board of Works invite tenders for a steam dynamo, switchboard, &c., for their destructor works at Lambeth. Tenders to 5, Tavistock-street, W.C., by 24th inst.

Whitechapel (London) Electrical committee require tenders for a hand-driven overhead travelling crane for their electricity station. Tenders to chairman must be delivered by noon 23rd inst.

Cardiff County Borough invites tenders for slow-speed vertical engines, slow-speed converters, and boilers and economisers, &c. Tenders to Town Clerk by 23rd inst.

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The Council of the *Glasgow International Exhibition*, 1901, require tenders for wiring for arc and incandescent lamps and electric motors. Particulars from 4, West Regent-street, Glasgow.

Partick Burgh Commissioners invite tenders for the erection of an electricity station and refuse destructor buildings. Tenders by 29th inst.

Grimsby Corporation invite tenders for a refuse destructor. Tenders by Nov. 6.

Grantown-on-Spey Burgh Commissioners invite tenders for electric lighting. Tenders by Nov. 6.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey (London) Vestry have referred to their Electric Lighting committee the following tenders :—

Steam, Feed, and Exhaust Pipes, Feed Pumps, &c.

G. Hopkins & Sons	£5,673 0 0
Alley and Maclellan	4,500 0 0
Babcock and Wilcox	3,483 0 0
Crompton & Co.	£3,292 and 3,023 0 0
John Spencer (Ltd.)	2,672 10 0
Thos. Horton & Co.	2,006 10 0

Steam Dynamos, Belting, Charging Motor, Booster, and Balancer.

Siemens Bros. & Co.	£5,447
British Westinghouse Co.	£5,409, £5,000, and 5,109
Electric Construction Co.	4,942
D. Bruce Peebles & Co.	£4,924, £5,024, £4,768, and 4,764
Crompton & Co.	4,906
Mather and Platt	£4,840, £4,830, £4,760, and 4,400
E. J. Macdonald	4,788
E. Scott and Mountain	4,495
Bergtheil and Young	4,113
Thames Ironworks Co.	3,835

Brighton Town Council received the following tenders for (1) 2,000 tons of steel girder tramway rails (including curve rails), 78 tons of steel fishplates, and 90 tons of steel joists :—

Bolckow, Vaughan & Co. (*accepted*)	£18,397 0	Barrow Hematite Co.	£18,564 0
William David	19,700 0	Westfalisch Stahlwerke	16,975 18
Leeds Steel Works	18,970 0	Witting Bros.	16,941 13
R. White & Sons	18,564 10	Edward Le Bas & Co.	15,718 0

Only Nos. 1 and 2 complied strictly with the specification.

(2) For motor cars (for 57 passengers) :—

*British Westinghouse..each	£630 0	‡Hurst, Nelson & Co. each	£440 0 0
Witting Bros. ,,	765 0	†Queen's Dock Electrical Works ,,	435 0 0
Brush Co. ,,	728 0	†Siemens Bros. & Co. ,,	340 0 0
Dick, Kerr & Co. ,,	724 0	§Geo. F. Milnes & Co. ,,	295 0 0
‡Gottfried Lindner ,,	710 0	‖R. W. Blackwell & Co. ,,	72 1 9
British Schuckert Co. ,,	685 0	‖Loraine Steel Co. ,,	63 0 0
British Thomson-Houston Co. ,,	647 17	‖F. Nell ,,	55 16 0

* *Accepted* for 25 cars, total £15,750. † Electrical equipment only. ‡ Bodies and trucks only. § Bodies only. ‖ Trucks only.

London County Council has accepted the following tenders for supply of lamps, &c., for the electric light installation on the Victoria Embankment and Westminster Bridge :—

	5 lamps in series (enclosed arcs).	10 lamps in series (open arcs).
St. Helens Cable Co (*accepted*)	£5,016 5 0	£4,300 0 0
Western Electric Co.	8,429 12 0	7,582 3 6
W. T. Henley's Co.	6,288 1 10	5,552 5 10
British Insulated Wire Co.	5,786 16 10	5,013 1 8
Siemens Bros. & Co.	5,762 12 6	4,947 17 6

Tenders and designs were recently invited by the consulting engineers (Messrs. O'Gorman and Cozens-Hardy) for 16 large electroliers for Bridgewater House, the town residence of the Earl of Ellesmere. The work has been given to Messrs. Donnison, Berlyn, Sillem & Co. at £1,030, the large cut-glass bowls forming part of the electroliers being by Messrs. F. and C. Osler.

The contract for the electric lighting and power distributing plant at the Free Wall Paper Co., Louth (Lincs.), has been placed with Messrs. Crowther & Co., of Manchaster.

Southampton Harbour Board have accepted the tender of the Clayton Engineering and Electrical Construction Co. for the supply of an electrical travelling crane at £785.

The tender of Messrs. G. N. C. Mann & Co. has been accepted for the electric lighting of the Suffolk County Asylum, Melton, at £3,000.

Middleton Corporation have accepted the tender of Messrs. R. Partington & Son for the erection of electricity station buildings.

APPOINTMENTS VACANT AND FILLED.

A mechanical engineering assistant is required for the office of a municipal engineer of a large town in the Midlands. Candidates must have had experience in electric tramway construction and steam practice. Applications by 26th inst. See advertisement.

A new accumulator company requires an electrical engineer with experience of accumulator traction. Applications to Messrs. O'Gorman and Cozens-Hardy, consulting engineers, 82, Victoria-street, Westminster. See advertisement.

An assistant is required in the meter-testing department of the Edinburgh electricity works. Applications to resident electrical engineer (Mr. F. A. Newington). See advertisement.

Worthing Council require a borough electrical engineer. Applications by 25th inst.

Bray (Ireland) Council will on 22nd inst., elect a resident electrical engineer. Applications to clerk.

Mr. W. H. Vincent, borough elctrical engineer, Ashton-under-Lyne, has been appointed resident electrical engineer to the Bermondsey (London) Vestry. There was no less than 46 applications, and five of the candidates were interviewed by the Vestry on Monday. Mr. Vincent served his articles with Messrs. James Simpson & Co., Pimlico, and subsequently entered the service of the Scottish Oriental Steamship Co. as marine engineer. In 1891 he was engaged on the staff of the Metropolitan Electric Supply Co ; in 1892 entered the service of Messrs. Siemens Bros. & Co. ; and in November, 1898, he was appointed borough electrical engineer at Ashton-under-Lyne.

Mr. G. H. P. Morgan has been appointed assistant engineer at Belfast.

BUSINESS NOTICES.

The Direct United States Cable Co.'s branch station at South Sea House, Threadneedle-street, London, E.C. (adjoining the Baltic) has been removed to 4, Bishopsgate-street Within, E.C , and a station has also been established at 142A, Winchester House, Old Broad-street, E.C.

We are asked to state that Mr. Ernest J. Pond, who was lately with the Telegraph Manufacturing Co. (Ltd.) as London traveller, has joined the staff of Henley's Telegraph Works Co. (Ltd.) as country traveller.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Cornelius Bennett Harness, 20, Macaulay-road, Clapham, late managing director of the Medical Electrical Institute (Ltd.). 52, Oxford-street, London.

A supplementary dividend of ½d. will be payable on 23rd inst. at the office of the trustee (Mr. E. H. Hawkins), 3, Barbican, London, E.C., in the bankruptcy of A. G. Inrig (lately trading as the Globe Electrical Co.), 46, White Post-lane, London, E.

A meeting of the Sussmann Electric Miners' Lamp Co. (Ltd.) (in liquidation) will be held at 10, Walbrook, London, E.C., on Dec. 1, to receive an account of the winding-up. Mr. R. Warner is liquidator.

Creditors of the Aluminium Co., Ltd. (in voluntary liquidation), must send particulars of claims to liquidator (Mr. P. L. Court), 13, Abchurch-lane, London, E.C., before Nov. 5.

Claims against the Printing Telegraph Recorder Co. (Ltd.) must be sent by Nov. 15 to the liquidator (Mr. G. A. G. Robertson), 13, Basinghall-street, London, E.C.

Winding-up Petition.—A petition for the winding-up of the Coventry Gas Fitting, Electrical and Engineering Co. (Ltd.) has been presented, and will be heard on 24th inst. A receiver and manager on behalf of the debenture holders was appointed by the vacation judge (Mr. Justice Buckley) on Wednesday.

Sales by Auction.—Particulars, plans, and conditions of sale are now ready of the sale by auction, by Messrs. Wheatley Kirk, Price & Co., at the Mart, Tokenhouse-yard, London, E.C., on Friday, 26th inst., at 12:30 for 1 o'clock prompt, of the long leasehold works of the Ormonde Cycle Co. (in liquidation), at Hornchurch-road, Romford, Essex, together with motive power, fixtures, erections, &c. There is also for disposal the goodwill, contracts, and trade marks of the Ormonde Company, together with valuable leasehold premises at Wells-street, Oxford-street, London, W., the whole as a going concern. Catalogues can be had of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester, who will furnish all further particulars.

Messrs. Fuller, Horsey, Sons and Cassell, 11, Billeter-square, London, E.C., will sell by auction on the premises, Tower House, Chiswick-lane, Chiswick, Middlesex, on Wednesday, Nov. 7, at 11 o'clock precisely, a small electric generating plant, particulars of which are set out in an advertisement elsewhere.

Plant for Sale.—Leeds Lighting committee invite tenders for the purchase of rope-driven electric generating plant about to be replaced by plant of larger capacity. Particulars are given in an advertisement, and conditions, &c., may be obtained from the manager of the Electric Lighting Department (Mr. H. Dickinson), 1, Whitehall-road, Leeds. Tenders, addressed to town clerk (Mr. W. J. Jeeves), by Nov. 18.

Oldham Electric Light committee invite offers for lead battery boxes, plates, and copper connections. An advertisement gives some further particulars, and offers are to be sent to the superintendent (Mr. Arthur Andrew), Gas and Water Offices, Oldham, by Nov. 4.

Paris Exhibition Souvenir.—The literature of the Paris International Exhibition, 1900, has been somewhat meagre, making

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all the more welcome a handsome souvenir sent out by Messrs. Witting Bros. (Ltd.), of 49, Cannon-street, London, E.C., in which opportunity is taken to illustrate a number of the machines exhibited at Paris by the Charleroi and London branches of the firm. The souvenir is in the form of an album, and contains some good views of many of the principal architectural features of the Paris show.

"Ediswan" Electrical Apparatus and Accessories.—For many years past the Edison and Swan Co. have made a prominent feature of their sectional catalogues of electrical apparatus, and

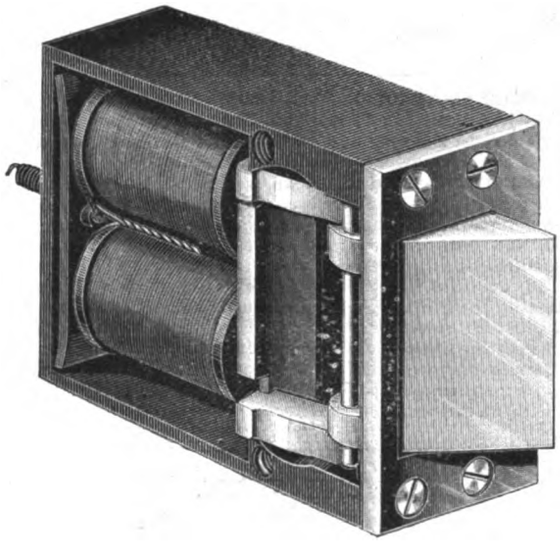

FIG. 1.

especially of those sections dealing with electric bell and indicator work, fire-alarm movements, instruments, and electrical sundries. We have now to acknowledge the receipt of Section 12 of the main catalogue, and below we illustrate and describe a few of the latest forms of "Ediswan" specialities. Fig. 1 shows an electric latch, with projecting nosing for releasing heavy weights.

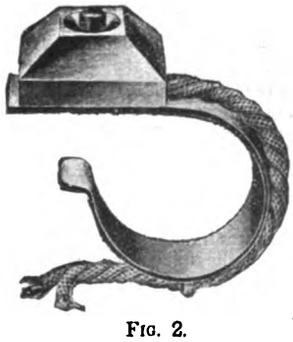

FIG. 2.

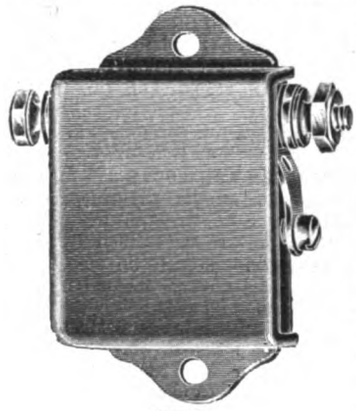

FIG. 3.

Switching on current causes the armature of the electromagnet to be attracted, releasing a catch, and the latch is instantly pushed on one side by the weight it has been supporting. Fig. 2 shows a useful form of bell push with spring clip for fixing to table or other projection. Fig. 3 shows a metal frame electric buzzer for use where a sharp ring of an ordinary bell would be objectionable. This

FIG. 4.

buzzer has platinised contact points. The section on pushes illustrates these goods in infinite variety. Fig. 4 is a midget metal push which fits into a ⅜in. hole and is provided with spring clips which hold it securely in place. We have room to illustrate a few only of the examples of which the catalogue contains a large number. Crowded with excellent illustrations, it is a credit to its compilers, and the printing is in the usual excellent style of the "Ediswan" catalogues. To the supplies dealer this publication must be as useful as it is interesting.

"Brockie-Pell" Arc Lamps at Poplar.—The Brockie-Pell Arc Lamp (Ltd.) inform us that the whole of the arc lamps supplied to the Poplar electricity works, which were opened last week, were of their patent Brockie-Pell type and manufactured by them under the patents of which they are the sole owners.

Auer Electric Lamp.—At a meeting of the Welsbach Incandescent Gas Light Co. on Wednesday, it was announced that Dr. Auer's new electric lamp had been installed that day in the Austrian pavilion of the Paris Exhibition, and was now on view there. The lamp is said to have been tested by the Emperor of Austria, with the result that His Majesty has given orders for the lamp to be installed in all his palaces throughout Austria.

"Papristeel" Conduit.—The General Electric Co. (Ltd.) forward a circular describing an improved form of "Union" steel tubing, for which it is claimed that to the mechanical advantages of this material have now been added good insulation and damp proofness. The tubing can be supplied with screwed fittings, standardised to use with the company's "Union" system of accessories. "Papristeel" conduit is manufactured of paper tube drawn over with the "Union" steel conduit, the whole being enamelled inside and out and stoved together.

Plant Price List.—Messrs. J. P. Hall & Co., of Oldham, have just issued a new price list of dynamos, motors, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 10 to Oct. 16, with the ports of destination :—

Africa.—Cape Town, £317; Durban, £280; East London, £61; Port Elizabeth, £222. *Argentina*—Buenos Ayres, £200 (telegraph material). *Australasia*—Auckland, £178; Fremantle, £944; Launceston, £138; Melbourne, £176; Otago, £305; Perth, £138; Sydney, £2,353 (including £614 telegraph material); Wellington, £125. *Belgium*—Ostend, £219. *Canada*—Halifax (N.S.), £29 (telegraph material); Vancouver (B.C.), £19. *Ceylon*—Colombo, £239. *China*—Newchang, £11; Shanghai, £16. *Germany*—Hamburg, £260 (including £200 telegraph material). *Holland*—Amsterdam, £64; Rotterdam, £55 (including £45 telegraph material). *Hong Kong*, £201. *India*—Bombay, £234; Calcutta, £2,423; Madras, £108. *Japan*—Hiogo, £48; Nagasaki, £6,602 (telegraph cable); Yokohama, £7,057 (including £4,586 telegraph material). *Malta*, £452 (including £302 telegraph apparatus). *Russia*—St. Petersburg, £225 (telegraph material). *Seychelles*, £11 (telegraph instruments). *Straits Settlements*—Penang, £138 (telegraph material); Singapore, £60. Total £23,908, against £340,335 in the corresponding week last year (Oct. 11 to Oct. 17).

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

September 4, 1900.

15,748. G. W. PARTRIDGE. London. Improvements in or relating to electric switches, fuses and other apparatus in which destructive electric arcs are liable to be formed.

15,752. H. HIRST and G. H. IDE. London. Improvements in and relating to electroliers, pendants and fittings, or connections therefor.

September 5, 1900.

15,774. W. CLAR. London. An improved electrical signalling apparatus for fire alarms and other purposes.*

15,793. H. GULLIVER and T. C. FOWLER. London. Improved electric travelling contact appliances for establishing telephonic and signal communication on railways between the signalman in the box and the driver of a locomotive.

15,818. H. M. HOZIER, C.B., and A. W. SHARMAN. London. Improvements in and relating to electrical signalling apparatus.

September 6, 1900.

15,864. W. C. C. HAWTAYNE. London. Improvements in and relating to street lamp fittings for incandescence electric lamps.

15,865. W. E. LANGDON. London. Improvements in shades for electrical and other lamps.

15,870. T. J. RICALDONI. London. Improvements in apparatus for producing electric waves.*

15,872. J. LENDERYOU and T. S. M. WYATT. London. Improvements in arc lamps.

15,878. A. VANDAM and G. C. PILLINGER. London. Improvements in fuse boxes and fuse boards.

15,888. J. C. FELL. London. Improvements in electric meters. (W. Stanley, United States.)*

September 7, 1900.

15,890. S. BEETON and M. BARR. Cheshire. Improvements in electric cable connections.

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15,907. F. Booker. Shepherd's Bush. Improvements in electric arc lamps.
15,918. The British Thomson-Houston Co. (Ltd.). London. Improvements in electrical phase transformation. (A. D. Lunt, United States.)*
15,919. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric rotary transforming apparatus. (A. G. Davis, United States.)*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

14,304. Thompson (Cantono). Application of electric motors for automobile vehicles.
17,274. Needham. Process of galvanizing iron.
17,445. Heyl-Dia. Electric cables.
17,722. Crehore and Squier. Telegraphic apparatus.
17,786. Brown. Electric telegraph apparatus.
18,005. Lucas and New. Secondary galvanic batteries or accumulators.
18,468. Chamberlain and Hookham (Ltd.) and Holden. Electricity meters.
18,547. Wilson. Continuous-current electric motors or generators of enclosed type.
18,754. Meyer. Galvanic batteries.
18,759. Fowler and Reason Manufacturing Co. (Ltd.). Disconnecting boxes for electric cables.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Ltd.).

The report of the directors of this company for the half-year to June 30, states that the total receipts amounted to £15,336. 1s. 6d., and gross expenditure to £6,296. 13s. 5d., leaving £9,039. 8s. 1d., which, with £5,165. 7s. 3d. brought forward leaves £14,204. 15s. 4d. to credit of revenue. The traffic receipts show a large decrease compared with the corresponding period of last year, due to competition and the bad state of business in the West Indies and Cuba. £2,000 has been added to reserve, which now stands at £132,000. The dividend on the preference shares absorbs £3,000, leaving £9,204. 15s. 4d., out of which the directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares, free of tax, £5,204. 15s. 4d., being carried forward.

The company's cables have continued in good working order throughout the half-year.

The negotiations between the Foreign Office and the Government of the United States in reference to payment of the subsidy of £2,000 per annum, and the claim for damage done to the cables during the Spanish-American war are still proceeding. The subsidy was paid by the Spanish Government to Dec. 31, 1898, but since that date no payment has been received.

Consolidated Telephone Construction and Manufacturing Co. (Ltd.).

The directors' report for the year ended March 31 states that it was not until the end of October, 1899, that the new board of directors were in a position to complete arrangements for re-organising the management both in London and Coventry. The results for the five months immediately following that date, and ended March 31 last, were very satisfactory compared with the preceding seven months, the sales for the first-mentioned period showing an increase of over 56 per cent. above those for the corresponding months of the previous year. The steady increase in the business during the 12 months ended Sept. 30, 1900, justifies the opinion regarding the prospects of the company which the new board held when they undertook the direction of affairs. The assets of the company have been revalued where necessary. The trading profit for the year amounts to £1,192. 0s. 9d. (almost the whole of which was made during the last five months) and the total credits to revenue amount to £9,703. 13s. 9d. Deducting expenses (£2,386. 8s. 2d.) and including amount from last year (£185. 2s. 2d.), there remains after writing off £4,334. 8s. 4d. on depreciation account, a balance credit to profit and loss of £3,167. 19s. 5d. The average dividend paid during the last seven years (1893-1899) was, the report states, £1. 12s. 10d. per cent., and taking into consideration the conditions under which the year's trading has been carried on, the directors do not feel justified in recommending the payment of a dividend for the year ended March 31 last, but consider that the present position of the company justifies the payment of an interim dividend at the rate of 3 per cent. per annum for the first six months of the current financial year, and they propose to pay such dividend. The directors have reason to expect that, in the near future, this rate of distribution will be increased.

Satisfactory arrangements have been effected with several of those railway companies with whom the company had not been able for some years past to do business, and many new accounts have been opened. The friction which for several years existed between the company and the National Telephone Co. has been removed, the result being that orders have been received from that company which there is every reason to believe will be increased in the future. Considerable orders have also been received from the War Office and other Government departments, and arrangements have been made for developing the company's business in South Africa and the colonies generally. The business of the Anglo-Portuguese Telephone Co. has shown considerable expansion, and the directors believe that the position of that company can shortly be placed on a still more satisfactory basis, with consequent benefit to the Consolidated Company. The law-suit initiated by the Edison Gower-Bell Telephone Co. against manufacturers in Belgium who had infringed that company's patents has made satisfactory progress, and has entered upon its final stage, the appeal of the defendants having been decided against them.

Mr. Henry Grëwing resigned his position as a director in April last, and on the advice of Sir William Preece, Mr. C. H. Reynolds, C.I.E., late director-general of telegraphs to the Indian Government, was elected to the vacancy.

Accompanying the report is a circular issued to the shareholders opposing the election to the board of Col. Gouraud, who has given notice of his intention to offer himself as a candidate at the meeting of shareholders on 24th inst.

NEW GENERAL TRACTION CO. (LTD.)—The chairman's half-yearly report has just been issued, and deals with the present position of the company's various undertakings—viz: The Norwich and Coventry electric tramways, the Philadelphia Suburban Traction Co., and the Douglas (Isle of Man) tramways, in all of which the company has a large controlling interest, and which have been constructed and equipped under the company's direction. The Norwich lines were opened for traffic on July 30, and have since worked most successfully, producing results beyond anticipations. In Coventry the tramway was finished and opened on Jan. 18, and the directors anticipate getting a fair return on their investment. The Philadelphia Suburban Traction Co. will own tramway lines of about 20 miles, connecting Philadelphia with Chester and Media. These are nearing completion, and since July 1 a portion of the system has been in successful operation. The Douglas Southern line has been in operation some time, and the board expect the same dividend as last year (6 per cent.) on the preference shares.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29¼d. per oz. (Oct. 18). Consols (2¾ per cent.) 98⅞—98⅞ for money, 98 1/16—98 3/16 for account; 2½ per cent. 97½—97⅝ (Oct. 18). Stocks and Shares Continuation Days, Oct. 24 and Nov. 11; Ticket Days, Oct. 25 and Nov. 13; Pay Days, Oct. 26 and Nov. 14; Mining Share Carry-over Days, Oct. 23 and Nov. 10.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The directors have decided to pay an interim dividend at the rate of 10 per cent. per annum on Nov. 1.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—During the week this company has invited applications for an issue of £200,000 4½ per cent. second debenture stock at par.

EASTERN TELEGRAPH CO. (LTD.)—This company announce payment, on Nov. 1, of interest for the half-year ending 31st inst. on their 4 per cent. mortgage debenture stock. The transfer books will be closed from 26th inst. to Nov. 1, inclusive.

EASTERN AND SOUTH AFRICAN TELEGRAPH CO. (LTD.)—This company announce the payment, on Nov. 1, of interest on the 4 per cent. Mauritius Subsidy debentures. The transfer books will be closed from the 26th inst. to Nov. 1 inclusive.

GENERAL ELECTRIC CO. (1900) (LTD.)—In reference to the prospectus of this company commented upon in our columns last week we have received the following:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We notice in your comment on the public issue of our company in your paper dated 12th, the remark that no mention is made in our prospectus of the Incandescent Electric Light Co. (Ltd.) We wish to reply that at the time this company was started, we thought it wise to interest one or two friends of the technical manager, Mr. Robertson, in the matter, necessitating thus a formation of a separate company, in which it is true we hold a managing control, as well as the principal amount of the capital. You will understand that for that reason the lamp factory cannot be enumerated in the prospectus as property of the General Electric Co., but it figures as the principal item of the amount of investments stated in the prospectus.—Yours, &c., H. Hirst.

We learned on inquiry yesterday that the issue this week of this company's shares and debentures has been "an unqualified success, and has been largely over-subscribed."

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—An interim dividend has been declared for the half-year ended June 30 at the rate of 5 per cent per annum, free of tax, payable on and after Nov. 1. The transfer books will be closed from 16th inst. to 31st inst. inclusive.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold by this company for the quarter ended Michaelmas, is returned at 888,883 units, estimated to produce £15,852, against 734,763 units, which produced £13,256, for the corresponding period last year.

STOCK EXCHANGE NOTICES.—Wednesday, Oct. 31, has been appointed a special settling day in the further issue of 23,361 5 per cent. cumulative £5 (£3. 10s. paid) preference shares (Nos. 16,640 to 40,000) of the *United River Plate Telephone Co. (Ltd.)*, and the securities have also been ordered for quotation in the official list. The committee has also been asked to appoint a special settling day in 20,000 vendors' ordinary £1 fully-paid shares (Nos. 27,001 to 47,000) of Messrs. *Davis and Timmins (Ltd.)*, and also the further issue of 10,000 ordinary £5 shares (Nos. 90,001 to 100,000) and 10,000 6 per cent. cumulative preference £5 shares (Nos. 70,001 to 80,000) of Messrs. *Willans and Robinson (Ltd.)*

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WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended Sept. 30, 1900. The following statement, dated Sept. 12, shows the condition of the company at the close of the quarter ended June 30, 1900:—

Surplus April 1, 1900, as per last quarterly report ...		$8,298,224 26
Net revenues, quarter ended June 30, 1900		1,600,925 75
From which deducting for—		$9,899,150 01
Dividend of 1½ per cent. paid July 16	$1,217,000 00	
Interest on bonded debt.....	223,945 15	
		1,440,945 15
Left a surplus July 1, 1900, of		$8,458,204 86
The net revenues of the quarter ending Sept. 30, based upon nearly completed returns for July, partial returns for August, and estimating the business for Sept. will be about		1,600,000 00
From which appropriating for—		$10,058,204 86
Interest on bonded debt		239,040 00
		$9,819,164 86
It requires for a dividend of 1½ per cent. on capital stock issued, about		1,217,000 00
Deducting which leaves a surplus, after paying dividend, of		$8,602,164 86

In view of the preceding statements, the committee recommend that a dividend of 1½ per cent. on the capital stock of the company be declared payable on and after the 15th inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Oct. 13	4,698	+ 263	14	64,415	+ 2,907
Blackpool Corporation...	„ 11	466	+ 171	28	25,613	+ 6,660
Blackpool and Fleetwood	„ 13	333	– 16	15	18,406	+ 96
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation...	„ 14	539	+ 165	28	14,577	+ 3,200
Brisbane Trams	Aug. 29	1,785	+ 388	8	14,844	+ 3,053
*Bristol Trams & Carriage	Oct. 12	3,329	+ 284	15	52,905	+ 742
*Buenos Ayres & Belgrano	Sept. 16	2,508	+ 420	11	24,749	+ 146
Central London Railway	Oct. 13	5,421	+ 318	11	52,931	...
City & South London Ry.	„ 14	1,647	+ 616	15	22,884	+ 8,649
Cork Elec. Trams	„ 11	428	+ 36	41	17,053	+ 1,421
Dover Corporation	„ 13	218	+ 18	28	6,808	+ 378
Dublin & Lucan Rly.	„ 13	87	+ 8	15	1,676	+ 307
Dublin United	„ 12	3,847	+ 445	15	57,934	+ 7670
Dublin Southern Dist....	„ 12	834	– 17	15	16,370	
*Glasgow Corporation ...	„ 13	9,191	– 84	...	...	...
Hull Corporation	„ 13	2,151	+ 803	15	20,662	+ 11,959
*Liverpool Corporation...	„ 6	8,648	+ 1,554	40	313,705	+ 39,190
Liverpool Overhead Rly.	„ 14	1,510	– 14	15	25,782	+ 1,179
*Sheffield Tramways	„ 14	2,539	+ 617	41	91,333	+ 31,947

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 10.	Price Wednesday, Oct. 17.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 17. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜ ⅝	⅜ ⅝	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	12½ 13½	12½ 13½	3 14 1	...	10⅜	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
£70,000	Stock	19/8	Do. 4½ per Cent. Debenture Stock (red.)	101 104	101 104	4 6 7	...	103	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6 6½	6 6½	...	...	6 1/16	...
50,000	5	4/3	Charing Cross & Strand Electricity Supply Corp.	9 10	9 10	4 12 6	February and August	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5⅞	5½ 5⅞	3 18 3	...	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	6½ 7½	6½ 7½	4 0 0	March	7 1/16	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 11	June and December...	...	...
$,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October.....	...	...
70,579	10	8/0	City of London Electric Lighting Ord.	8½ 9½	8 9	4 8 11	February and August	8⅝	8
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½ 13½	12½ 13½	4 9 0	January and July.....	12 15/16	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	124 129	124 129	3 18 2	June and December ...	125	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½ 9½	8½ 9½	6 6 4	...	9	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11 12	11 12	5 0 0	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	108 111	4 1 10	...	102½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	6½ 7	6½ 7	4 2 7	January and July.....	...	...
110,000	3	...	London Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛	...	...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4½ 5⅛	4½ 5⅛	5 9 1	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	6/0	Metropolitan Elec. Supply Ord.	13 14	13½ 14½	3 15 10	April and October.....	14	13¾
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 114	112 115	3 18 7	June and December ...	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	97 100	3 10 7	...	99½	98½
6,452	10	6/0	Notting Hill Electric Ordinary	14½ 15½	14½ 15½	4 10 4	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	5½ 6½	5½ 6½	3 16 11	„	...	...
300,000	1	1/6	Rand Electric	9/16 11/16	⅝ ¾	12 16 0	...	...	...
£135,000	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	January and July	...	...
15,000	$100	$2	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6	April and October.....	...	...
£115,500	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103 106	102 104	4 6 7	„ „	104	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	15 16	15 16	4 10 8	February and August	15 9/16	...
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8 9	3 17 8	„ „	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2 2½	2 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	85 95	85 95	4 4 3	—	...	...
65,000	5	...	South London Electric Supply Ordinary	3 4	3 4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12 13	12 13	5 0 0	March and September	12⅝	12 9/16
29,437	5	...	Do. Do.	11 12	11 12	...	...	...	...
			ELECTRIC RAILWAYS TRAMWAYS, &c.						
15,000	10	4/0	Blackpool and Fleetwood Tramways	14 16	14 16	3 15 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	101 103	101 103	4 17 1	...	...	...
50,000	10	7½%	Bristol Tramways and Carriage Ordinary	22½ 23½	21½ 22½	3 8 11	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10½ 11½	10½ 10¾	3 15 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 120	118 120	3 6 1	February and August	...	...
13,600	10	5/0	British Columbia Electric Railway 5% Pref.	10 10½	10 10½	4 15 3	May and November ...	...	...
45,000	10	11/0	British Elec. Trac. Ord.	13½ 14½	13½ 14½	6 17 11	...	14½	13¾
50,000	10	6/0	Do. 6% Cum. Pref.	12 13	12 13	4 12 4	February and August	12⅝	...
£350,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	120 123	120 123	4 1 4	...	121⅛	121
40,000	5	3/0	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4¾ 5	4¾ 5	6 0 0	...	4 15/16	...
27,500	5	...	Do. "B"	3¾ 4¼	3¾ 4¼	...	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104 107	104 107	4 14 8	...	...	...
£120,000	Stock	13/9	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	96 99	96 99	5 1 0	...	...	...
206,297	10	3/0	Central London Ordinary	10½ 10⅞	10 10½	2 17 1	June and December ...	10⅝	10 5/16
£855,000	Stock	1¼%	City and South London Railway Con. Ordinary	58 61	58 61	2 5 2	February and August	...	...
37,500	10	1/5.75	Do. Ordinary (Nos. 22,501 to 60,000)	5 6	5 6	2 9 4	„ „	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	138 143	133 143	3 9 11	„ „	...	...
£200,000	Stock	5%	Do. (1896)	130 135	130 135	3 14 1	...	...	...
£244,315	Stock	4%	Do. 4 per Cent. Perpetual Debenture	120 125	120 125	3 4 5	May and November ...	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	20½ 21½	20½ 21½	3 12 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14½ 15	14½ 15	3 18 8	„ „	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July.....	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	9⅜ 10½	...	...	May and November ...	...	...
37,500	10	3%	Liverpool Overhead Railway Ordinary	8⅜ 9	8⅜ 9	4 8 11	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13½	3 15 6	„ „	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	104 103	3 16 0	January and July.....	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1903)	104 105	103 105	4 15 6	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	103 105	103 105	4 6 4	...	...	...
24,000	5	...	New General Traction Ordinary	3½ 3¾	3½ 3¾	...	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5	4½ 5	6 0 0	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	17 19	...	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½ 10¾	...	...	„ „	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9½ 10½	4 15 3	February and August	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	104 107	104 107	...	...	...	...
240,000	Stock	5%	Waterloo and City Ordinary	94 97	94 97	3 2 2	June and December ...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 10.	Price Wednesday, Oct. 17.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 17. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£96,000	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	...	...	...	June and December	...	...
£119,700	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£832,720	Stock	15/0	Anglo-American xd	59 61	58 59	5 1 8	Feb., May, Aug., Nov.	58	56
£2,088,640	Stock	30/0	Do. Preferred xd	109 110	105½ 106½	5 12 8	" "	109½	106½
£2,088,640	Stock	27/0	Do. Deferred	10¾ 11¼	10¼ 11	12 5 5	" "	11	10¾
13,333,300	$100	$1½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,589,496	Stock	4%	* Do. 4 per Cent. Debenture Stock	100 102	100 102	3 18 5	" "	101½	100½
16,000	10	6/0	Cuba Submarine Ordinary	6½ 7½	6½ 7½	10 0 0	February and August	7	...
6,000	10	10/0	Do. Preference 10 per Cent.	15 16	15 16	6 5 0	" "	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	" "	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	100% 104%	100% 104%	4 6 7	January and July	100½	...
60,710	20	3/0	Direct United States Cable xd	10¾ 11¼	10⅛ 11	6 7 3	Jan., Apr., July, Oct.	10⅝	10⅜
£111,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 0	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary xd	149 154	148 153	4 11 4	Jan., Apr., July, Oct.	153½	149
£1,836,888	Stock	17/6	Do. 3½ per Cent. Preference Stock xd	99 102	99 102	3 9 0	" "	10 ⅛	9⅞
£1,492,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	114 119	115 120	3 7 10	May and November	...	...
250,000	10	2/6	Eastern Extension xd	15 15⅛	15 15⅛	4 10 4	Jan., Apr., July, Oct.	15⅛	15
50,000	10	...	Do. (Nos. 250,001 to 300,000 is'd at £3 pm, all p l	...	6¾ 7¼	...	...	...	...
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113 118	113 118	3 8 6	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb. 1909	99 102	99 102	3 18 6	February and August	100⅛	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100% 103%	100% 103%	3 17 8	May and November	...	...
180,227	10	4/6	Globe Telegraph and Trust	10⅞ 11¼	10⅜ 11	4 13 4	Jan., Apr., July, Oct.	11 1/16	10⅝
180,042	10	2/0	Do. 6 per Cent. Preference	15 15½	15 15½	3 17 5	" "	15⅞	...
150,000	10	5/0	Great Northern of Copenhagen	31 35	32 34	3 13 6	January and July	...	...
£94,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	99 101	99 101	4 9 1	June and December	...	...
17,000	25	37/6	Indo-European	43 53	49 53	4 14 4	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	103 106	103 106	5 13 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	100 103	100 103	3 17 8	June and December	...	...
11,839	8	4/0	Reuter's xd	7 8	7 8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust xd	126 131	124 129	4 13 0	" "	129½	...
15,600	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£171,100	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	98 101	4 19 0	March and September	...	...
20,000	2½	...	West Coast of America	⅛ 1	⅛ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 13 4	January and July	...	...
88,321	10	1/0	West India and Panama	¾ 1	¾ 1	...	May and November	⅞	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	6½ 7½	6½ 7½	8 0 0	" "	7 1/16	7 1/16
4,689	10	6/0	Do. 6 per Cent. 2nd Preference	6 7	6 7	8 11 6	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	105 108	105 103	4 13 6	January and July	...	...
207,980	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾ 15½	14¾ 16½	4 11 10	Mar., June, Oct., Dec.	15⅞	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	103 106	103 106	4 14 4	June and December	...	...
£313,777	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	100 103	101 104	3 16 11	...	...	...
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3½	2½ 3½	5 14 4	August	...	...
224,350	10/0	1½d.	Consolidated Telephone Con. and Manfg.	...	...	...	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¾ ⅞	¾ ⅞	5 0 0	November	...	...
96,493	1	1/0	Do. 5 per Cent. Preference	¾ 1	1	5 0 0	" "	...	...
590,000	5	3/0	National	4⅛ 4¾	4⅜ 4¾	6 9 9	February and August	4 1/16	4⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13 15	13 15	4 0 0	" "	...	..
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	13 15	13 15	4 0 0	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5 5½	5 5½	4 15 3	" "	5 1/16	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 8	June and December	98⅛	93
171,504	1	0/3	Oriental	⅞ 1⅛	⅞ 1⅛	4 8 11	April and October	...	...
58,000	5	4/6	United River Plate	4¾ 5¼	4¾ 5¼	6 13 4	July	...	...
16,639	5	2/6	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	104 107	4 13 6	" "	...	...
			ELECTRIC MANUFACTURING &c. COMPANIES.						
70,000	1	3d.	Alliance Electrical Co. 5% Cum. Pref.	⅞ 1⅛	1 1⅛	4 8 11	...	1 1/16	1
126,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	7 7 8	March and September	...	...
85,000	1	...	British Electric Works Co. Ordinary	⅞ 1⅛	⅞ 1⅛	...	...	...	...
60,000	1	...	Do. 5 per Cent. Cumulative Preference	⅞ 1⅛	⅞ 1⅛	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	97 99	97 99	4 4 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
40,000	5	3/0	Do. 6 per Cent. Preference	5⅜ 6⅛	5⅜ 6⅛	4 16 0	...	...	...
100,000	5	1/6½	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	4 1/16	...
90,060	2	1/2½	Brush Electrical Engineering	1⅝ 2	1⅝ 2	6 0 0	September	1⅝	...
15,731	2	...	Do. £1 paid	...	...	...	...	...	...
90,000	2	1/2½	Do. 3 per Cent. Pref. Non-Cum.	2⅛ 2⅝	2⅛ 2⅝	5 1 1	"	2⅛	...
15,731	2	...	Do. £1 paid	...	...	...	...	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	106 111	106 111	4 0 11	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	102 104	103 104	4 7 2	January and July	...	...
80,000	5	10/0	Callender's Cable Construction Ord.	12½ 13½	12½ 13½	5 11 1	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 5½	5 5½	4 10 11	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 114	110 114	3 18 11	November and May	5 1/16	...
300,000	1	0/3½	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	6 8 0	...	1 1/16	...
£150,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	97 100	97 100	4 10 0	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1	⅝ 1	6 10 0	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
54,000	3	2/6½	Crompton and Co. (Nos. 1 to 32,099)	3½ 4¼	3½ 4¼	5 5 10	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99 101	99 102	4 19 0	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	1½ 2⅛	1½ 2⅛	8 0 0	February and August	...	...
17,139	5	2/9½	Do. (£5 paid)	3⅛ 4⅛	3⅛ 4⅛	6 13 4	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	90 92	90 92	4 7 5	June and December	90⅜	90
£100,000	Stock	2 5/16%	Do. 5% 2nd Deb. Standing Prov. Certs (all pd)	98 100	98 100	...	...	...	...
35,500	5	6/0	Edmundson's Electricity Corporation Ord.	4⅜ 5	4⅜ 5	6 0 0	Half-yearly	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	101 103	101 104	4 7 6	...	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2 2½	2 2½	5 6 8	January and July	5⅛	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅞ 3⅛	2⅞ 3⅛	4 6 2	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	102 105	101 105	3 16 2	January and July	103½	...
80,000	5	4/0	Henley's Telegraph Works Ordinary	12½ 13½	12½ 13½	5 11 1	February and August	12⅝	...
80,000	5	2/3	Do. 4½ per Cent. Preference	5 5½	5 5½	4 1 10	" "	5⅜	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	108 112	108 112	4 0 4	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20 21	20 20½	3 13 3	" "	20½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 18 5	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	34 38	34 38	4 14 8	March and July	34	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
20,000	5	9/0	Do. Manufacturing Ordinary	10½ 11½	10½ 11½	5 4 4	...	10½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 5½	5 5½	4 10 11	...	...	...
30,000	5	7/0	Willans and Robinson Ordinary xd	10½ 11½	10½ 11½	6 1 9	April and October	11⅛	10⅜
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference xd	6½ 7½	6½ 7½	4 2 9	" "	7⅛	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105 107	105 107	4 0 4	May and November	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption
† The London Stock Exchange Committee refuses to quote these.

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